Vestibular testing: what patients can expect

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Disclosures

• I have nothing to disclose
Objectives

• Discuss the common, and a few of the uncommon, diagnostic tests used in evaluation of patients with disorders of equilibrium. For each test we will review:
  – The purpose of the test
  – Some of the disorders in which it is useful
  – Patient’s perspective (what it feels like)
• The specific tests are:
  – Vestibular evoked myogenic potentials
  – Videonystagmography
  – Rotatory chair testing
  – Computerized dynamic posturography
  – Electrocochleography
  – Tilt table testing
We will not cover auditory tests here

• There are a number of tests of auditory function that are also useful in the workup of disorders of equilibrium, but we will not discuss these in detail here. They include:
  – Audiometry
  – Otoacoustic emissions
  – Brainstem auditory evoked responses
• The specific tests are:
  – Vestibular evoked myogenic potentials
  – Videonystagmography
  – Rotatory chair testing
  – Computerized dynamic posturography
  – Electrocochleography
  – Tilt table testing
Vestibular evoked myogenic potentials

- Vestibular evoked myogenic potentials (VEMPs) are an electrophysiologic test that involves presenting a repetitive acoustic stimulus in one ear, while measuring low level changes in muscle activity with surface electrodes.
Vestibular evoked myogenic potentials, purpose

• The sound stimulates a part of the balance apparatus of the inner ear called the saccule. This structure then sends signals along the inferior division of the vestibular nerve to the vestibular nuclei in the brainstem. From there, signals are sent to various muscles relevant for maintaining posture and balance.

• An abnormal (usually reduced) response reflects a problem in one or more of the structures in this pathway.
Vestibular evoked myogenic potentials, purpose

- The VEMP response can be reduced in disorders that damage:
  - The inner ear, such as labyrinthitis.
  - The vestibular nerve, such as vestibular neuritis or a vestibular schwannoma.
  - The brainstem, such as a stroke or multiple sclerosis.
Vestibular evoked myogenic potentials, purpose

• Less commonly, the VEMP response can be abnormally large, such as in superior semicircular canal dehiscence.
Vestibular evoked myogenic potentials, purpose

• What does the “response” look like?
Vestibular evoked myogenic potentials, patient’s perspective

- The VEMP most commonly tested in clinical practice measures the response from the neck.
- The acoustic stimulus (delivered through headphones or ear inserts) usually sounds like a series of loud clicks or tones presented several times per second over 60 – 90 seconds.
- While listening to these, the patient is usually lying down, raising the head up off the table.

Photo courtesy of Dr. Guy Lightfoot
Vestibular evoked myogenic potentials, patient’s perspective

• The acoustic stimulus is loud (usually 95 dB), and some patients find it uncomfortable, but it is not dangerous.

• Many people become fatigued while trying to maintain the head raised off the table for 60–90 seconds. Sometimes sufficient data can be collected in a shorter period and still produce a useful result.
Topics

• The specific tests are:
  – Vestibular evoked myogenic potentials
  – Videonystagmography
  – Rotatory chair testing
  – Computerized dynamic posturography
  – Electrocochleography
  – Tilt table testing
Videonystagmography

- This test essentially measures eye movements while the patient performs various tasks or is subjected to various stimuli.
Videonystagmography

- Originally the eye movements were recorded by placing electrodes around the eyes — this was called “electronystagmography” (ENG).

Videonystagmography

• Today the eye movements are instead recorded using an infrared video camera, and this is called “videonystagmography” (VNG).

This technique permits viewing out of only one eye


This technique uses half-silvered mirrors and thereby permits viewing out of (and recording of) both eyes
Videonystagmography, purpose

- Eye movements are controlled directly by the brain, and indirectly by the balance apparatus of the inner ear.
- Therefore, some disorders of the brain and ear can be diagnosed or monitored by close observation of eye movements.
Videonystagmography, disorders

- A large number of neurologic (brain) and otologic (ear) diseases are associated with specific eye movement abnormalities.
- Neurologic diseases in which VNG may be useful include disorders of the cerebellum, brainstem, frontal, parietal and occipital lobes.
- Otologic diseases in which VNG may be useful include benign paroxysmal positional vertigo, labyrinthitis, vestibular neuritis, vestibular schwannoma and Meniere’s disease.
Videonystagmography, disorders

• The “output” of this test consists primarily of tracings of the eye movements.

Videonystagmography, patient’s perspective

• You may be asked to refrain from taking certain medications for 24 – 48 hours prior to this test.
• The test is fairly long (45 – 90 minutes), and usually has many sub-sections.
• Some of the tasks are trivial, such as following a moving dot on a screen.
• Some of the tasks are uncomfortable. Specifically, the section called “caloric testing” involves squirting warm and cool air or water in each ear while eye movements are measured. This part of the test makes some patients nauseated, though rarely induces vomiting.
Topics

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  – Videonystagmography
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Rotatory chair testing

- Rotatory chair testing (RCT) is pretty much what it sounds like. A patient is seated in a chair that turns in various patterns while eye movements are recorded via infrared goggles.

http://www.stopdizziness.com/resources_rotational_chair.asp
Rotatory chair testing, purpose

• Most of this test evaluates various aspects of the vestibulo-ocular reflex — the magnitude of the eye movement in response to rotation of the head.

• Rotation of the head in the horizontal plane stimulates the horizontal (lateral) semicircular canal, which sends signals through the superior division of the vestibular nerve to the vestibular nuclei in the brainstem, which then send signals to other areas of the brainstem that control eye movements.
Rotatory chair testing, disorders

- Rotatory chair testing is the gold standard test for diagnosis of bilateral vestibular loss (BVL).
- Bilateral vestibular loss can occur in patients who have sustained damage to the balance apparatus of both inner ears (such as autoimmune inner ear disease) or both vestibular nerves (such as bilateral vestibular neuritis).
Rotatory chair testing, disorders

• What does the “output” from rotatory chair testing look like?

http://www.dizziness-and-balance.com/testing/ENG/rchair.html
Rotatory chair testing, patient’s perspective

• You may be asked to refrain from taking certain medications for 24 – 48 hours prior to this test.
• The test is somewhat long (30 - 45 minutes), and usually has several sub-sections.
• Some of the sections involve visual deprivation (i.e., you’re in the dark), while others may involve you focusing on or following a point light source.
• Occasionally the rotation makes a patient nauseated. Rarely does it induce vomiting.
Topics

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Computerized dynamic posturography

• Computerized dynamic posturography (CDP) is sometimes also called “moving platform posturography.”

• Basically, a patient is secured in a harness and stands in a phone-booth-sized device while put through a series of balance tasks.
Computerized dynamic posturography

• The patient is either blindfolded or not.
• The platform wiggles or not.
• The visual surround wiggles or not.
• These different “sensory perturbations” are presented in different combinations.

Computerized dynamic posturography, purpose

- The brain essentially relies on three sources of information to help you navigate through space:
  - **Vestibular** (balance) information from the inner ear.
  - **Visual** information from the eyes.
  - **Proprioceptive** information from the soles of the feet and from joint position sense.

- Posturography attempts to impair selectively these sensory inputs in different combinations. (It cannot truly impair vestibular sensation, but can sometimes indirectly figure out whether there is a vestibular deficit by interfering with visual and proprioceptive input.)
Computerized dynamic posturography, purpose

• As such, posturography can sometimes help distinguish between vestibular (inner ear), visual (eye) and proprioceptive causes of imbalance.

• It also provides an overall quantification of balance.
Computerized dynamic posturography, purpose

• Although the result can to some degree quantify and characterize imbalance, it does not, in itself, provide a diagnosis.

http://www.audiologyonline.com/articles/article_detail.asp?article_id=311
Computerized dynamic posturography, disorders

- CDP can be helpful in corroborating the clinical suspicion for vestibular disorders such as vestibular neuritis.
- CDP is sometimes also used in physical therapy settings to monitor progress during recovery.
Computerized dynamic posturography, patient’s perspective

- You may be asked to refrain from taking certain medications for 24 – 48 hours prior to this test.
- The test is fairly short, around 15 minutes.
- Some of the tasks are very simple (such as simply standing still with eyes open).
- Other tasks are hard (such as standing with eyes closed while the floor wiggles).
- The test is generally not uncomfortable.
Topics

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  – Tilt table testing
Electrocochleography

- Electrocochleography (ECoG) is an electrophysiological test that is conducted by presenting a series of acoustic stimuli while measuring a very low-level set of reflex responses via an electrode placed on the eardrum.
Electrocochleography, purpose

• The ECoG “result” is a tracing of various waveforms whose timing and amplitude proportions are measured.

• From this result, the ECoG indirectly assesses pressure in the inner ear.

http://www.dizziness-and-balance.com/testing/ecog.html
Electrocochleography, disorders

- The condition of elevated inner ear pressure is called “hydrops.”
- Hydrops occurs most commonly in the setting of Meniere’s disease, and the test’s greatest utility lies in helping establish this diagnosis.
Electrocochleography, patient’s perspective

• The acoustic stimuli consist of a series of tones.
• Electrodes are placed on the forehead.
• The ears must be cleaned out, because an electrode also needs to be placed on the eardrum.
• The test is fairly long (30 – 45 minutes) and is rather boring. Many patients fall asleep during the test.

http://shs.asu.edu/clinic-h-assess
• The specific tests are:
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  – Tilt table testing
Tilt table testing

• The tilt table test (TTT) is pretty much what it sounds like.
• A patient is secured to a table and tilted in various positions while blood pressure and cardiac pulse are measured over a period of time.
Tilt table testing

http://www.worldofhealth.co.uk/the-tilt-table-used-in-cardiology/

http://www.hopkinsmedicine.org/heart_vascular_institute/conditions_treatments/treatments/tilt_table.html
Tilt table testing, purpose

- The TTT assesses how blood pressure and cardiac pulse change in response to changes in body position (with respect to gravity).
- The “result” is a plot of these values.
Tilt table testing, purpose

http://www.dizziness-and-balance.com/testing/tilttabletest.html
Tilt table testing, purpose

• When you go from a lying position to a standing position, gravity pulls blood into the legs.
• Consequently, less blood is available up in the thorax to be pumped by the heart and to perfuse (circulate within) the brain.
• If the body does not rapidly compensate for this “downward shift” of blood (and therefore for the lowering of blood pressure), a person will feel faint, or will actually faint.
Tilt table testing purpose

• In order to compensate for this “downward shift” of blood, a healthy person’s body invokes several compensatory mechanisms:
  – There is an increase in cardiac pulse (“heart rate”).
  – There is an increase in the ejection fraction (amount of blood expelled from the heart with each contraction).
  – There is peripheral vasoconstriction (peripheral blood vessels “clamp down”).

• The purpose of these compensatory mechanisms is to insure that there is adequate “venous return” from the legs – i.e., insure that blood does not pool in the legs.
Tilt table testing, disorders

• Some diseases affect one or more of those compensatory mechanisms.
• The result is that blood pressure, or pulse, or both, will fluctuate abnormally when a person is tilted from a lying position to an upright position.
• The most common disorders assessed by TTT are:
  – Orthostatic hypotension, which is an overly robust drop in blood pressure upon tilting up.
  – Postural orthostatic tachycardia syndrome (POTS), which is an overly robust increase in heart rate upon tilting up.
Tilt table testing, patient’s perspective

• The test usually takes about 30 minutes.
• You spend about the first 7 minutes lying flat.
• The table is then tilted head-up by 70 degrees, and you remain in this position for up to 25 minutes.
• Patients with disorders of regulation of blood pressure or cardiac pulse may experience symptoms such as lightheadedness, sweating, palpitations, or fainting.
• Sometimes an electrocardiogram is also performed.
Thank you!

Questions?

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