

Assessing the Patient with Vestibular Symptoms

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Introduction

Understanding the benefits of ICS Impulse

Head Impulse is an ear-specific test that detects a deficiency of the vestibulo-ocular reflex and identifies which ear and which semicircular canal is affected in cases of peripheral vestibulopathy.

How does Impulse compare to caloric testing?

HIT

- Ear-specific
- Detects abnormalities in all six semicircular canals in cases with peripheral vestibular loss (Lateral, Anterior and Posterior)
- Ability to test patients even if they have middle ear disorders
- Ability to test patients who do not tolerate calorics (young children, elderly, or patients with severe hearing loss)
- Tests with stimuli replicating the patient's everyday situations (physiological stimulus)
- Stimulus does not persist between tests

Note: A head impulse should not be performed on patients with a neck injury, or on patients who have been told by their physicians to limit or avoid neck movement activity.

Caloric

- Ear-specific
- Detects cases of peripheral vestibular loss in Lateral semicircular canal
- Tests at Low Frequencies (~0.025 Hz)
- Stimulus can persist between irrigations especially if not performed properly
- Middle ear disorder may prohibit performing the test
- Some patients will not tolerate caloric testing or will not allow the caloric test to be completed

How does Impulse benefit the patient?

Patient comfort is greatly enhanced by the lightest goggles in the industry. Due to the sophisticated cameras, smaller amplitude head impulses of only 15 to 20 degrees are used, making the test more pleasant for the patient. Even in patients with acute vertigo. Unlike caloric testing, Impulse does not result in adverse reactions; therefore, making it easy to perform Impulse on multiple patient visits.

How does Impulse benefit the physician?

ICS Impulse assesses all 6 semicircular canals and is the only test to assess the anterior and posterior canals. Impulse is small and portable allowing for patients to be assessed in a clinic and at the bed-side. It is easy to assess anyone of any age who can wear the goggles and Impulse detects more abnormalities than visual observation and reduces false negatives. Due to the fact that Impulse does not result in adverse reactions, one can easily assess the patient multiple times (e.g. after vestibular rehabilitation, during drug therapy, etc).

Time savings

What time savings can be expected in the clinic with ICS Impulse in the test battery? 2.5 days a month can be saved.

Assumption: 10 patients seen per day. Impulse test time = 10 mins; Caloric test time = 30 mins

Abnormality	% of patients with disorder	Patients pr. month	Number of calorics saved	Time saved due to fewer calorics
BPPV	40%	80	Not needed	
Vestibular neuritis	10%	20	20	7 hours
Menière's	15%	30	May perform caloric	
Vestibular migraine	20%	40	40	13 hours
Other (SCD, Central, perilyph fistula, etc)	15%	30		
Total	100%	200	60	20 hours/month

Determining if the Patient has a Disorder affecting the Peripheral Vestibular System

This short guide to assessing the patient with a peripheral vestibular disorder is intended to be used as a quick reference of the most frequently diagnosed peripheral disorders and is no way an extensive list. The guide represents the global trend for assessing the patient with vestibular disorders in the most efficient and effective manner. And it emphasizes the diagnostic tools which are most valuable for determining the presence or absence of particular vestibular disorders. This is only a quick guide and is in no way a substitute for your medical training or clinical judgment.

Case History: This is one of the most important steps of assessing the patient. A thorough case history will assist in determining the diagnosis of the patient.

The important information is:

- Onset of symptoms: spontaneous, head or visual motion provoked
- Temporal course: Is dizziness intermittent or continuous? Does it last seconds, minutes, hours, days or weeks?
- Type of dizziness: objects in room spinning, feeling of spinning in the head, imbalance, light headedness, disorientation, falls, unsteadiness
- Does the patient have signs of a central disorder (e.g. double vision, dysarthria, disturbances of sensation)?
- Other symptoms: nausea, vomiting, headaches, motion sickness, intolerance of light, oscillopsia, heart palpitations, feeling of panic, drop attacks
- Hearing: aural fullness, tinnitus (low or high frequency), progressive loss of hearing, fluctuating hearing loss, sensitive to noise, intolerance of sound
- Past medical history: head trauma, back surgery, ototoxic drugs (e.g. gentamicin), diabetes, perilymphatic fistula

Note: It is necessary to rule out central causes of dizziness (e.g. stroke, traumatic brain injury, cardiovascular disease, neurological disorders (Multiple Sclerosis), anxiety, and side effects from medications or street drugs.)

Test Descriptions and Purpose: These are the most common tests for assessing the patient with peripheral vestibular disorders. Which tests are performed depends on the results of the case history and the physical exam. It may also depend on your facility's protocol.

Physical Exam (e.g. one minute eye exam): During the one minute eye exam you can have a general idea if the disorder is central or peripheral. This exam can be performed using the Impulse video only mode or VNG goggles. Watch for nystagmus and pathological eye oscillations. A physician assesses the patient by asking them to watch their finger as it is moved to assess gaze, smooth pursuit and saccadic eye movement. It should also be determined if the patient has Strabismus (cover test and alternating cover test) or Internuclear ophthalmoplegia. A basic neurological exam may also be necessary.

Hearing Exam: The assessment of hearing is a major step for the differential diagnosis of peripheral and central vestibulopathies and for the planning of treatment. A pure tone audiogram (with air and bone conducted stimuli) along with tympanometry and acoustic reflexes are minimally needed. The hearing assessment may also include speech testing and auditory evoked potentials. It is essential when determining if a patient has superior canal dehiscence, Menière's disease, vestibular schwannoma or perilymph fistula.

Spontaneous/Gaze Evoked Nystagmus: The presence or absence of spontaneous nystagmus should be assessed before performing the head impulse or caloric test. Spontaneous nystagmus should be assessed without fixation by either covering the eye or using the penlight cover test*. Recording of eye movement can be performed using the Impulse video only mode or VNG goggles.

**) Newman-Toker DE, Sharma P, Chowdhury M, Clemons T M, Zee D S & Della Santina C C Penlight cover test: a new bedside method to unmask nystagmus J Neurol Neurosurg Psychiatry 2009;80:900–3.*

Gaze evoked nystagmus is assessed by presenting a stimulus (center and 20-30 degrees left, right, up and down) and determining if nystagmus is present. If nystagmus is present hold the gaze position for 2 minutes to determine if periodic alternating gaze is present.

For both of these tests, a video of the eye can be recorded. The video serves as documentation and can be reviewed and compared to subsequent evaluations.



Impulse (i.e. head impulse or vHIT): The Impulse test is the only test that assesses all six semicircular canals independently and with a physiological stimulus, similar to how the patient uses the vestibular ocular reflex system in daily life. The test is essential in determining if the peripheral vestibulopathy affects the superior or inferior branch of the nerve, if the loss is unilateral vs bilateral, or only affecting the anterior, posterior or lateral canals. In combination with VEMPs, all 5 end organs for both ears can be assessed.

cVEMP: Cervical Vestibular Evoked Myogenic Potential assesses the saccule using air or bone conduction stimuli. The only test used to easily assess the saccule.

oVEMP: Ocular Vestibular Evoked Myogenic Potential assesses the utricle using air or bone conduction stimuli. The completely objective test used to easily assess the utricle.

Dix-Hallpike (i.e Hallpike – Stenger) and Lateral positioning: A dynamic positional test that positions the sitting patient with their head turned 45 degrees to the left or right and then quickly moved into a supine position with the head tilted back and slightly lower than the shoulders. The purpose of the maneuver is to provoke the canaloliths to move and stimulate the canal or cupula. This is the only test that can clearly diagnose the presence of posterior canal or anterior canal BPPV (benign paroxysmal positional vertigo). Other canals must be evaluated with the head hanging and with the head lateral positions. BPPV typically exhibits a crescendo-decrescendo nystagmus observed with a delay of about 10 seconds, with a torsional component to the undermost ear and vertical upbeat component. To diagnose lateral canal BPPV, the patient must lie on their back and turn the head to the left and then to the right.

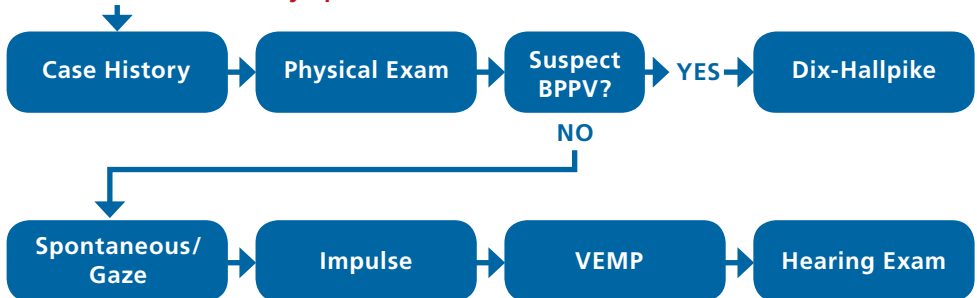


EcochG: Electrocochleography is an electrophysiology test that assists in diagnosing cochlear hydrops by comparing the ratio of the summing potential and the action potential.

Caloric: Bithermal caloric test stimulates the left or right ear with warm and cool air or water causing a fluid density change in the lateral canal. By comparing the response of the left and right ear to warm and cool stimuli one can determine if there is a unilateral or bilateral weakness. Caloric testing is non-physiological stimulus and only assesses the lateral semicircular canal.



Patient with Vestibular Symptoms:



Additional Diagnostic tests:

Use dependent on results of the above tests



VEMP is not FDA approved

Benign Paroxysmal Positional Vertigo (BPPV)

What: Most common cause of vertigo as a result of canalithiasis (cupulolithiasis is rare). Otoconia detach from the utricle and enter the posterior canal (~80%), the lateral canal (~18%) or the anterior canal (<2 %).

Symptoms: Brief episodes (less than 1 minute) of vertigo caused by rapid changes of head position. Typically caused by bending the head up or down, or rolling over in bed. Vertigo lasts 30 seconds to 2 minutes. May complain of mild postural instability between attacks.

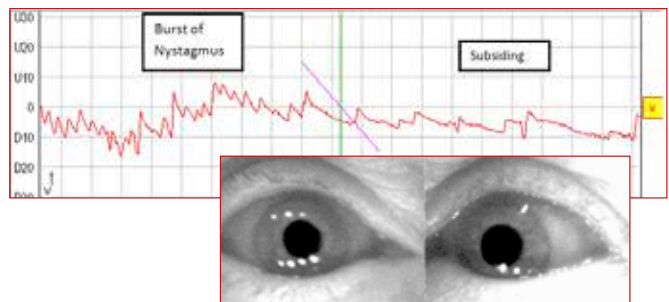
Workflow:



If Dix-Hallpike identifies burst of nystagmus (typically torsional) then subsides when testing is complete this indicates the presence of posterior canal BPPV. If Dix-Hallpike is normal (no nystagmus present), then the patient must lie on their back and turn the head to the left and then to the right. If a horizontal nystagmus in direction of the lower ear occurs (geotrophic) this is a sign for a typical lateral canal BPPV. If a horizontal nystagmus in direction of the upper ear occurs (ageotropic) this is a sign for an atypical lateral canal BPPV. If no nystagmus occurs, then continue to investigate to see if the patient may have another diagnosis.

Results: Dix Hallpike:

BPPV is a typical crescendo-decrescendo nystagmus observed with a delay of about 10 seconds and with a torsional component to the undermost ear and vertical upbeat component.



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- Baloh RW, Honrubia V, Jacobson K (1987) Benign positional vertigo: clinical and oculographic features in 240 cases. *Neurology* 37:371-8.
- Baloh RW, Jacobson K, Honrubia V (1993) Horizontal semicircular canal variant of benign positional vertigo. *Neurology* 43:2542-9.
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Vestibular Neuritis

What: Acute vestibulopathy caused by inflammation of the inner ear or vestibular nerves. This inflammation disrupts the transmission of the information from the ear to the brain. This is typically viral or degenerative. Can affect the superior or the inferior branch of the vestibular nerve.

Symptoms: Prolonged severe rotational vertigo, head movement worsens the symptoms, postural imbalance to the side of the lesion, nausea, and spontaneous horizontal/torsional nystagmus beating toward the good ear.

Workflow:



If Impulse identifies catch-up saccades and cVEMP or oVEMP is abnormal then test is complete. Catch-up saccades in the lateral or anterior canals and abnormal oVEMP indicate superior vestibular neuritis. Catch-up saccades in the posterior canals and abnormal cVEMP indicate inferior vestibular neuritis.

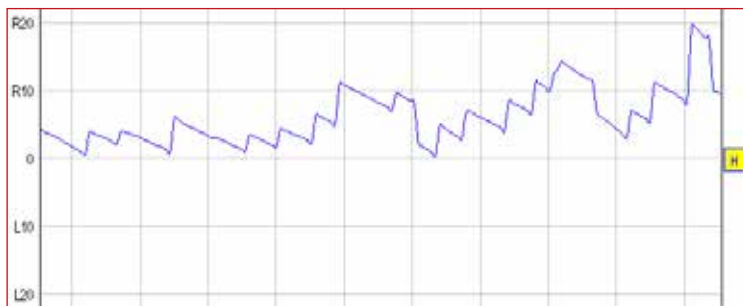
Additional test to confirm but not necessary:



If Impulse is normal, then continue to investigate to see if the patient may have another diagnosis

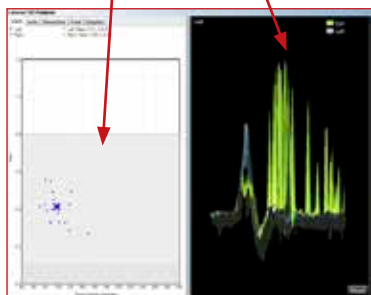
Results:

Spontaneous Nystagmus: Horizontal/torsional nystagmus beating toward the good ear.



Impulse:

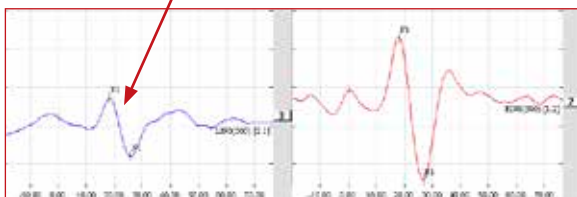
Presence of Catch-up Saccades (covert or overt) and reduced VOR gain.



cVEMP:

Reduction of amplitude on affected side.

(It should be noted that in the fields of neurology and neurophysiology convention is to have P1 (e.g. p13) as a downward deflection and N1 (i.e. n23) as an upwards deflection i.e. the reverse of what is shown below).



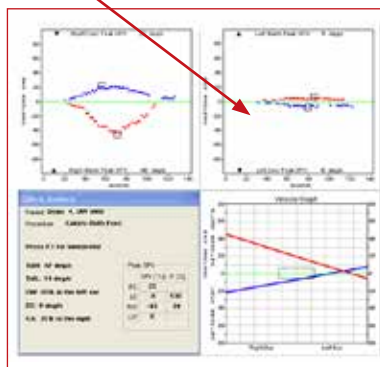
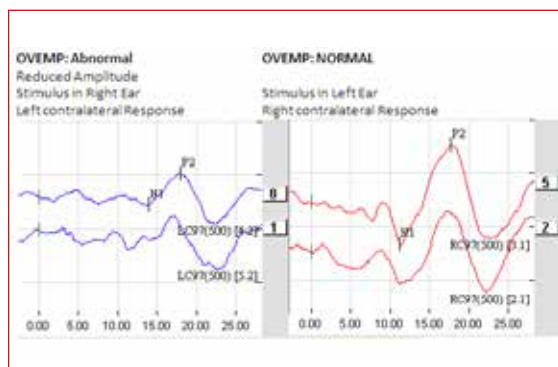
oVEMP:

Absent response contralateral to the lesion side while stimulating ipsilesional.

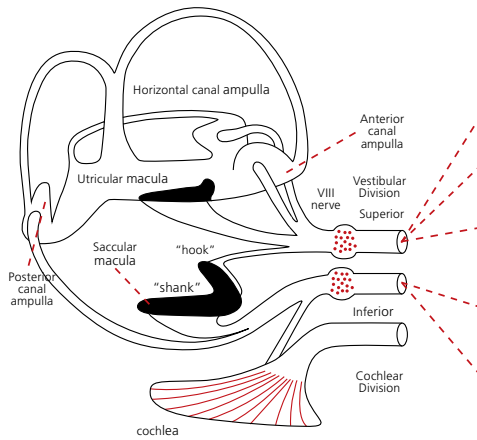
(It should be noted that in the fields of neurology and neurophysiology convention is to have N1 (e.g. n10) as a upwards deflection i.e. the reverse of what is shown below).

Caloric:

Unilateral Weakness.



Differentiating Superior and Inferior Vestibular Neuritis

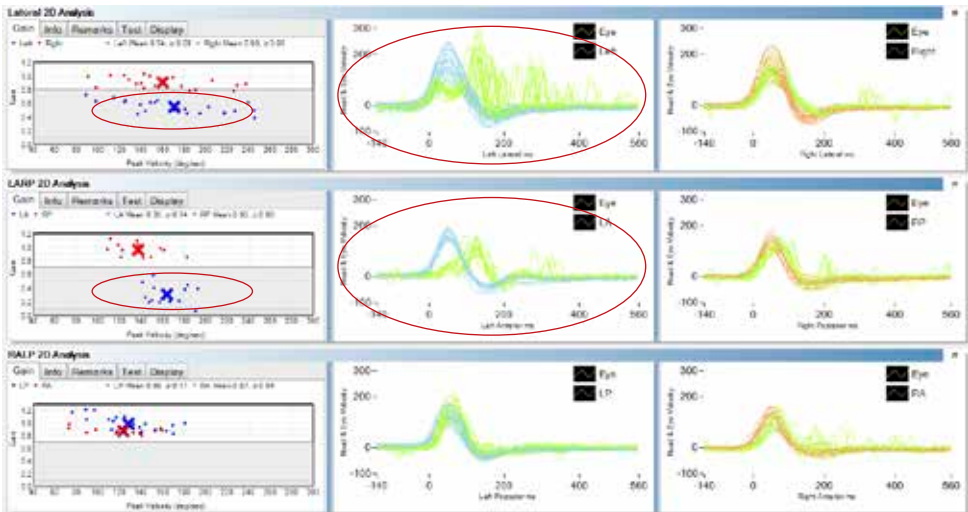


Clinical Test *	Healthy Subjects	Superior Vestibular Neuritis	Inferior Vestibular Neuritis	Unilateral Vestibular Loss
Horizontal head turn to ipsilateral horizontal canal	✓	✗	✓	✗
Pitch head impulse test in the plane of the ipsilateral anterior canal, head turn nose down - tests ipsilateral canal	✓	✗	✓	✗
cVEMP n10 beneath the contralateral eye to bone conducted vibration at Fz, or air-conducted sound of one ear - tests utricular macula of the ear opposite to the eye	✓	✗	✓	✗
cVEMP p13-n23 over ipsilateral sternocleidomastoid (SCM) muscle to bone conducted vibration at Fz, or air-conducted sound of one ear - tests saccular macula of the ear on the same side	✓	✓	✗	✗
Pitch head impulse in the plane of the ipsilateral posterior canal, head turn nose up - tests ipsilateral posterior canal	✓	✓	✗	✗

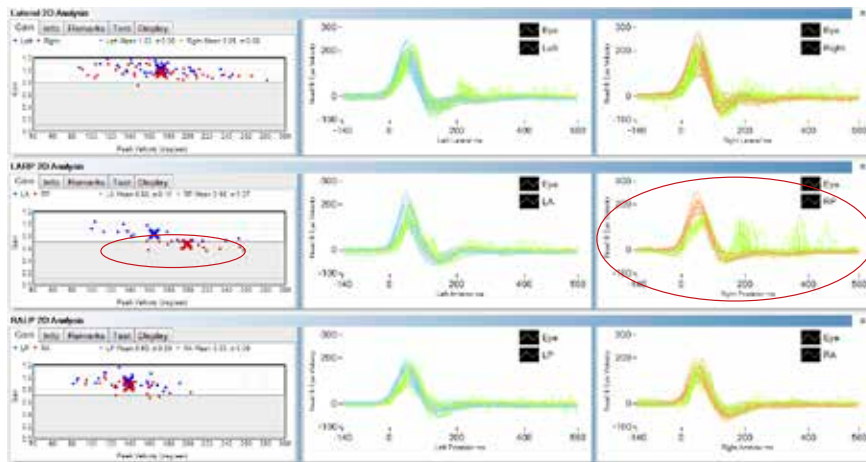
✓ = Normal Response ✗ = Abnormal Response

*) Ian S. Curthoys, PhD
The Interpretation of Clinical Tests of Peripheral Vestibular Function
The Laryngoscope: Volume 122, Issue 6, pages 1342–1352, June 2012

Superior Vestibular Neuritis (affects the lateral and anterior canal)



Inferior Vestibular Neuritis (affects the posterior canal)

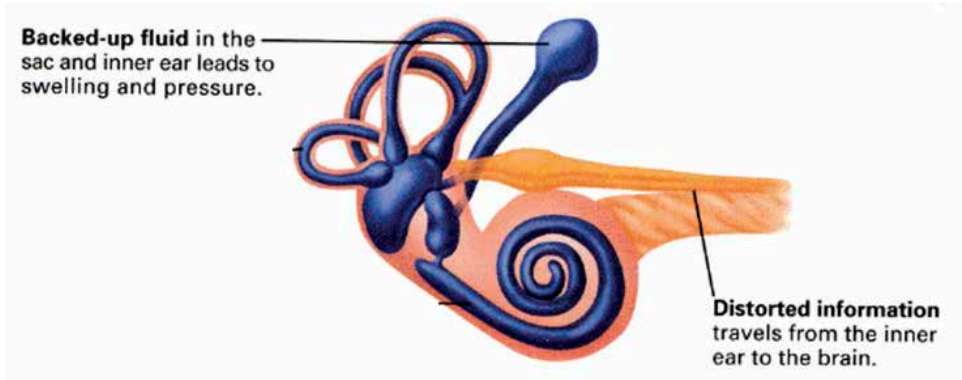


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Menière's Disease

What: Due to the presence of inner ear hydrops. Can be due to cochlear hydrops (causing hearing loss) or vestibular hydrops (causing vestibular symptoms).



Symptoms: According to the American Academy of Otolaryngology, Menière's disease describes a set of episodic symptoms including vertigo (attacks of a spinning sensation), hearing loss, tinnitus (a roaring, buzzing, or ringing sound in the ear), and a sensation of fullness in the affected ear. Episodes typically last from 20 minutes up to 4 hours. Hearing loss is often intermittent, occurring mainly at the time of the attacks of vertigo. Loud sounds may seem distorted and cause discomfort. Usually, the hearing loss involves mainly the lower pitches, but over time this often affects tones of all pitches. After months or years of the disease, hearing loss often becomes permanent. Tinnitus and fullness of the ear may come and go with changes in hearing, occur during or just before attacks, or be constant.

Workflow:



If Impulse is abnormal with increased gain and cVEMP has reduced amplitude then test complete.

Additional tests to confirm:



If Impulse is normal, then continue to investigate to see if the patient may have another diagnosis.

Results:

Audiogram: Ipsilateral sensorineural hearing loss with involvement in the low frequencies

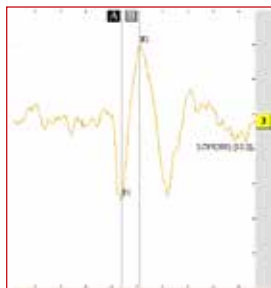
Impulse: Increased gain during attack



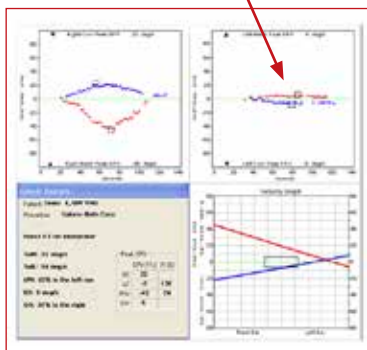
cVEMP: reduction of amplitude on affected side



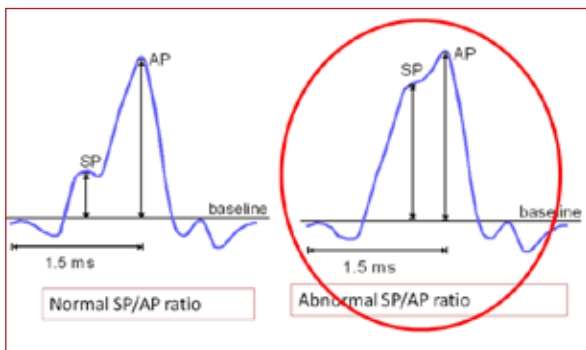
oVEMP: Increased amplitude as compared to normals (about 5–6 μ V).



Caloric: Unilateral Weakness



Electocochleography: SP/AP ratio abnormal



References:

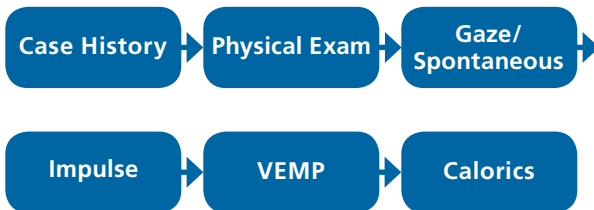
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Vestibular Migraine

What: Episodic vertigo or dizziness with or without migraineous headaches or migraineous symptoms in patients with a diagnosed migraine (according to the criteria of the International Headache Society). Exclusion of other disease. Common in children and adults.

Symptoms: Vertigo (often positional) or dizziness associated with migraineous symptoms as phonophobia (intolerance of sound), photophobia (intolerance of light), migraineous aura (scintillating scotoma, aphasia, etc.), motion sensitivity, tinnitus (high pitched). Migraineous headache might be present (in about 30% of patients no headaches). High comorbidity of anxiety and depression. Sometimes central oculomotor or vestibular signs.

Workflow: This is an exclusion diagnosis



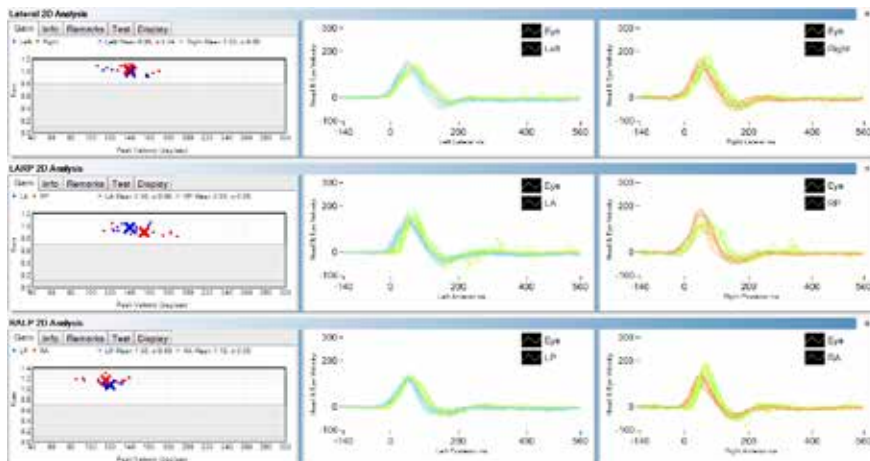
If all other diagnoses have been ruled out, spontaneous nystagmus or gaze nystagmus exists with and without fixation, Impulse may be normal or exhibit peripheral vestibular deficits. VEMP will typically be normal.

If Gaze is normal or VEMP is abnormal, then continue to investigate to see if the patient may have another diagnosis.

Results:

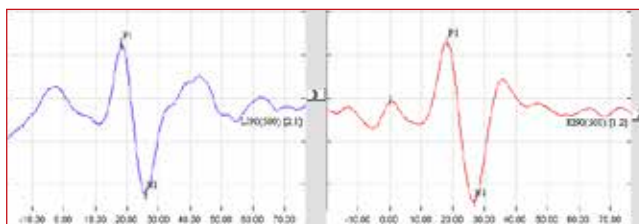
Gaze Evoked/Spontaneous: A central nystagmus, e.g. Gaze-evoked, Upbeat or Downbeat nystagmus, or a central positional nystagmus. Often saccadic pursuit is observed.

Impulse: Typically the response will be normal but peripheral vestibular deficits may be observed and result in the presence of Catch-up Saccades (covert or overt).

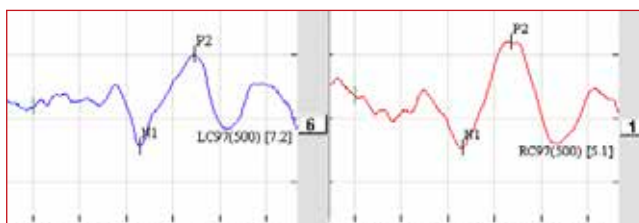


VEMP: within normal limits (some literature has reported a reduction in amplitude).

cVEMP



oVEMP



References:

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Superior Canal Dehiscence (third window pathology)

What: Sound and/or pressure-induced vertigo due to dehiscence (thinning) of bone overlying the superior semicircular canal

Symptoms: Chronic dysequilibrium, oscillopsia (sensation that objects are moving), conductive hyperacusis, sound and/or pressure induced eye movements

Workflow:

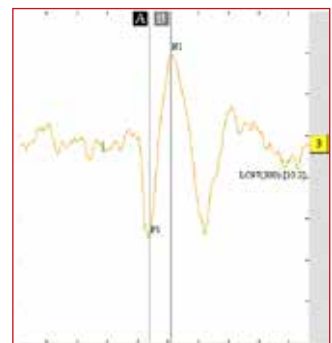
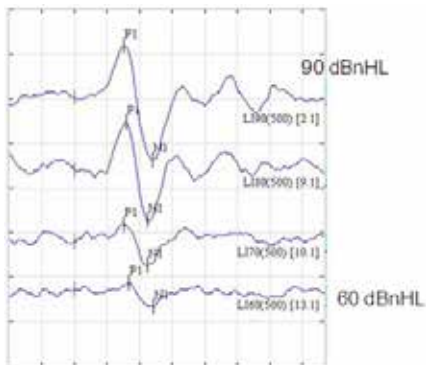


If cVEMP has abnormally low threshold in involved ear (< 80 dB), if oVEMP has increased amplitude and abnormally low threshold in the involved ear then test is complete and a CAT scan should be performed to confirm existence of superior canal dehiscence. If VEMP is normal, then continue to investigate to see if the patient may have another diagnosis.

Results:

Hearing Exam: Bone thresholds better than air thresholds and acoustic reflexes are present.

cVEMP: Abnormally low threshold in involved ear (< 80 dB)



oVEMP: Increased amplitude as compared to normals and reduced threshold response contralateral to the lesion side while stimulating ipsilesional.

References:

Chien WW, Carey JP & Minor LB Canal dehiscence 2011, 24:25-31.

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This educational booklet was developed in collaboration with:

Jill Craig M.A.
GN Otometrics Business Manager/Audiologist for the
Evoked Potential product line

Wendy Crumley-Welsh M.S., CCC-A
GN Otometrics Business Manager/Audiologist for the
Vestibular product line

Dr Jorge Kattah, MD, Neuro-Ophthalmologist
INI Balance Center
Peoria, IL, USA

Dr Leonardo Manzari
Sapienza Università di Roma
Cassino, Italy

Dr. Nicolás Pérez
Consultor Clínico
Director del Departamento de Otorrinolaringología
CLINICA UNIVERSITARIA DE NAVARRA
Pamplona Spain

Priv.-Doz. Dr. med. Holger Rambold
Head of the Vestibular and Oculomotor laboratory
Community Hospital Altötting, Dept. of Neurology
Altötting, Germany

Prof. Dr. med. Frank Schmäl
Director Balance Department
ENT Center Münsterland
Greven Germany

Dr. med. Konrad P. Weber
Interdisciplinary Center for Vertigo and Balance Disorders
University Hospital Zürich
Zürich, Switzerland

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GN Otometrics, Europe.

+45 45 75 55 55. info@gnotometrics.dk

GN Otometrics, North America.

1-800-289-2150. sales@gnotometrics.com

www.otometrics.com

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