



**5<sup>th</sup> Congress of the European Academy of Neurology**

**Oslo, Norway, June 29 - July 2, 2019**

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**Hands-on Course 4/8**

**Vestibular evoked myogenic potentials  
(Level 1)**

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The Author has not conflict of Interest in relation to this manuscript

## Vestibular Evoked Myogenic Potentials (VEMPs)

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## Introduction: The Vestibular System

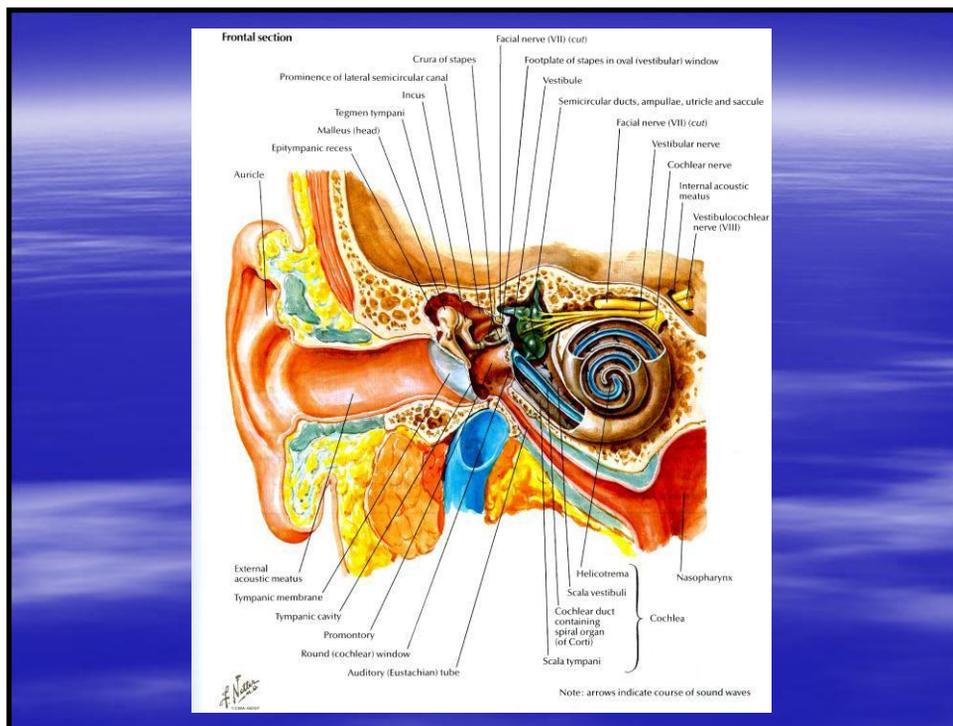
- The vestibular system is responsible for the sensation of balance.
- The end organs (receptors) of the vestibular system are located in the inner ear.
- Semicircular canals-Angular Acceleration.
- Otolith organs (saccule and utricle)-Linear acceleration.

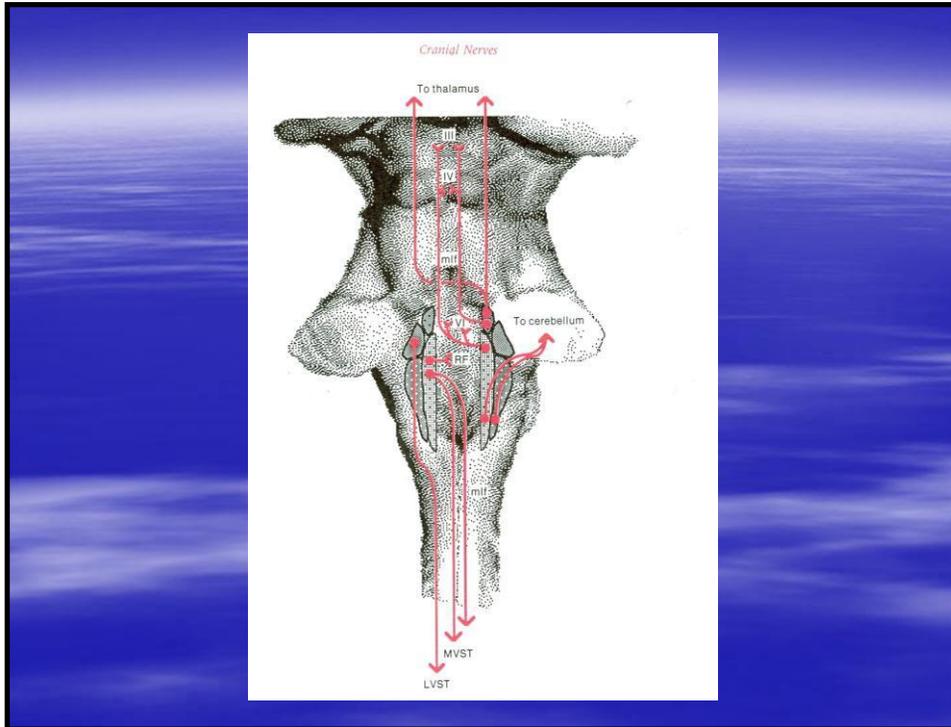
## Introduction

- Rotating chairs and head drops, that have been used in the past to stimulate the vestibular end organs to record evoked potentials have the disadvantage of having a slow rise time, a tendency not to be 100% reproducible, and not a nice experience for the patient.

## Vestibular Evoked Myogenic Potentials (VEMPs)

- Vestibular evoked myogenic potentials (VEMPs) have become an accepted test of vestibular function.
- A non-invasive method of recording function (and dysfunction) from the vestibular system
- Vestibular afferents can be activated by nonphysiological techniques such as moderate intensity (120 dB pSPL  $\approx$  90 dB nHL) sound (500 Hz tone) or vibration (mastoid, forehead stimulation, or impulsive lateral acceleration).
- Galvanic (Electrical) stimulation applied over the mastoid processes is technically difficult to perform and is now performed in only a few laboratories.

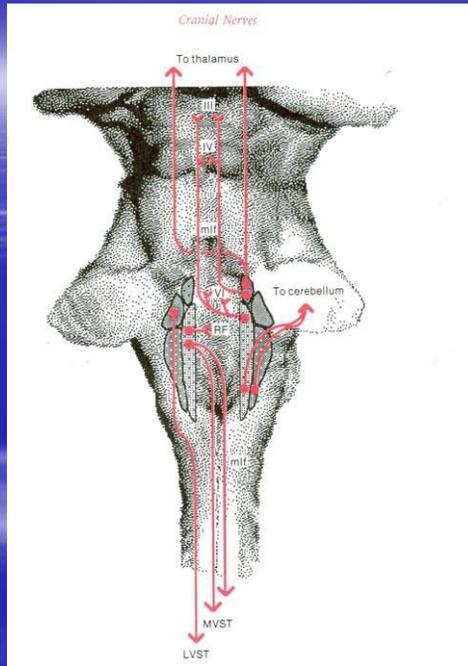
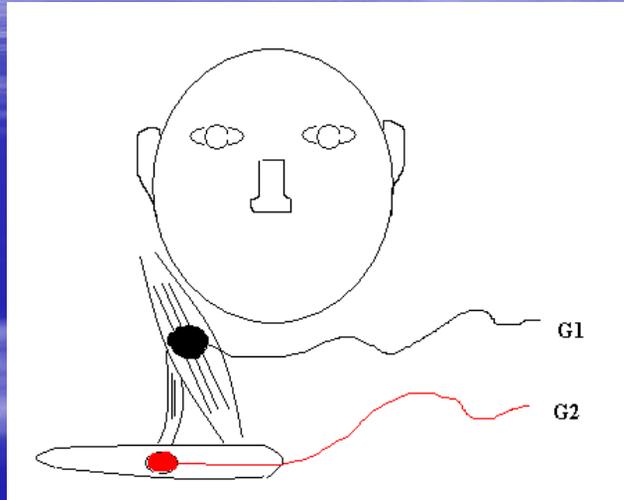


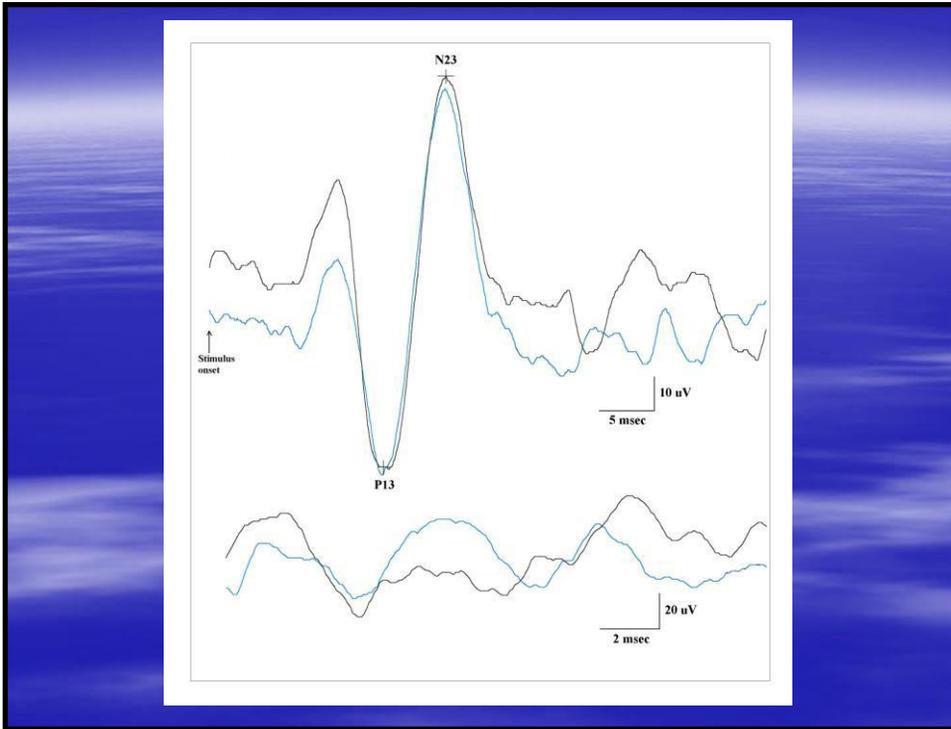


## Cervical VEMPs (cVEMPs)

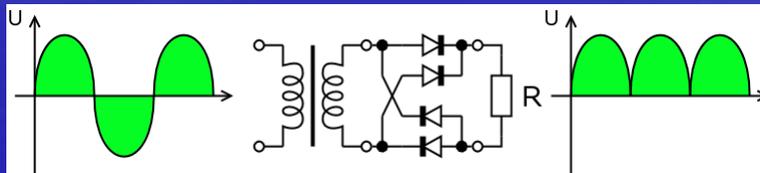
- Cervical vestibular evoked myogenic potentials (cVEMPs) are recorded from the **tonically** active ipsilateral sternocleidomastoid muscle.
- Specifically, it records function from the sacculus, **inferior** vestibular nerve, vestibular nuclear complex, medial vestibulospinal tract, motor nucleus of the sternocleidomastoid muscle and spinal accessory nerve.
- The response is mainly an inhibitory one.

# cVEMPs





## EMG Rectification



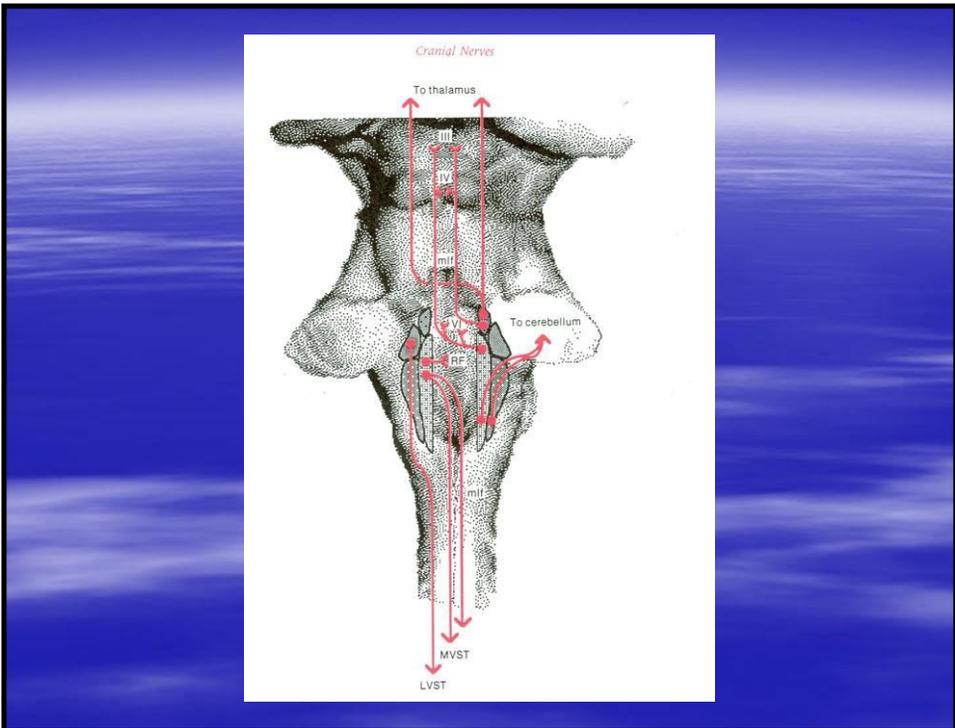
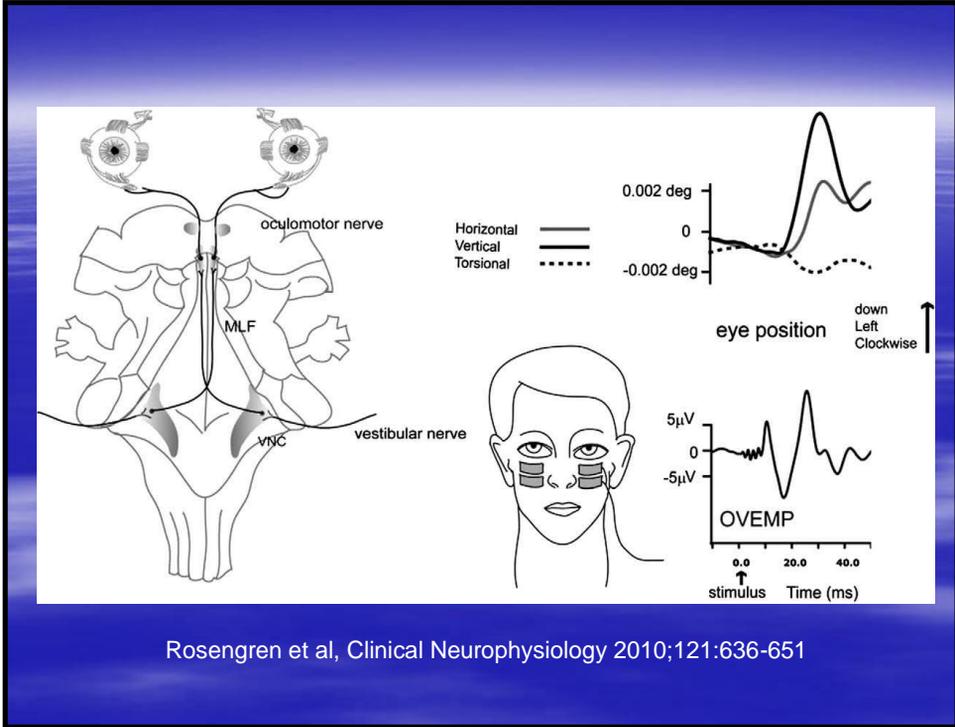
## cVEMPs

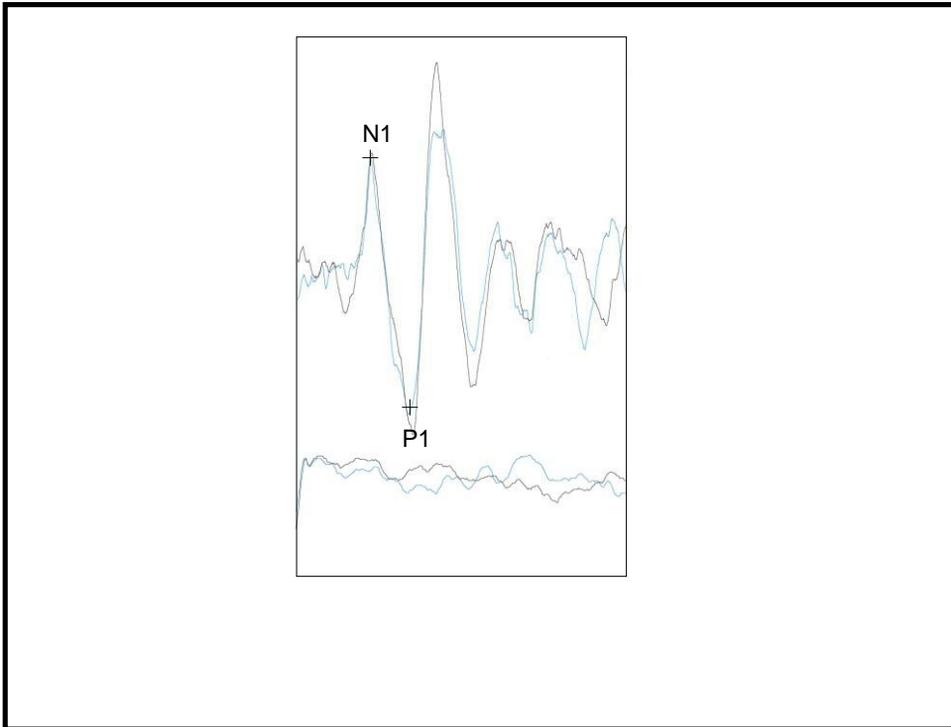
(can be performed on any neurophysiology system that normally does BAEPs)

- Recording Parameters:
  - Bandwidth 10 Hz – 2 kHz
  - Sensitivity 10  $\mu$ V/Div
  - Sweep 10 msec/Div.
  - Speaker On.
  - Rejection Off.
- **Gain between 2,500 and 5,000** depending on system (Hands-on will use 2,000 based on experience of own recording system)
  - (Biotronics/VikingSelect= Amplifier Sensitivity (SNS) of 500  $\mu$ V).
- Stimulation Parameters:
  - Tone frequency of 500 Hz.
  - Stimulation rate of presentation of 5 Hz.
  - Rise/Fall of 1 cycle
  - Duration of 3.5 cycles (7 msec)
  - Stimulus polarity does not appear to be critical (unpublished data).
  - Contralateral masking noise of 30 dB less than stimulation intensity.
  - Stimulation intensity of 90 dB nHL (120 dB pSPL).

## Ocular VEMPs (oVEMPs)

- The oVEMP is recorded from the tonically active *contralateral* inferior oblique muscle.
- Specifically, it records function from the utricle, superior vestibular nerve, vestibular nuclear complex, medial longitudinal fasciculus, oculomotor nucleus, III CN, inferior oblique muscle.
- The response is mainly an excitatory one.





## oVEMPs

- Recording Parameters:
  - Bandwidth 5 Hz – 1 kHz
  - Sensitivity 2 uV/Div
  - Sweep 5 msec/Div.
  - Speaker On
  - Rejection Off.
  - **Gain between 2,500 and 5,000** depending on system (Hands-on will use 5,000 based on experience of own recording system). (Stepping).
  - (Biotronics/VikingSelect= Amplifier Sensitivity (SNS) of 200 uV).
- Stimulation Parameters:
  - Tone frequency of 500 Hz.
  - Stimulation rate of presentation of 5 Hz.
  - Rise/Fall of 1 cycle
  - Duration of 2 msec
  - Rarefaction
  - Contralateral masking noise of 30 dB less than stimulation intensity.
  - Stimulation intensity of 90 dB nHL (120 dB pSPL).

## Meniere's Disease

- A clinical syndrome that consists of episodes of spontaneous vertigo usually associated with unilateral fluctuating sensorineural hearing loss, tinnitus and aural fullness.
- Associated with the accumulation of endolymph in the cochlear duct and the vestibular organs in histopathological studies.

## Vestibular Migraine

- Also is associated with episodes of vertigo with or without migraine.
- However, this usually coexists with separate episodes of migraine without vertigo.
- The cause of this clinical entity is unclear, as there is evidence for both central and peripheral causes.
- One study has shown the presence of endolymphatic hydrops in both ears in patients with VM.

## Meniere's Disease vs Vestibular Migraine.

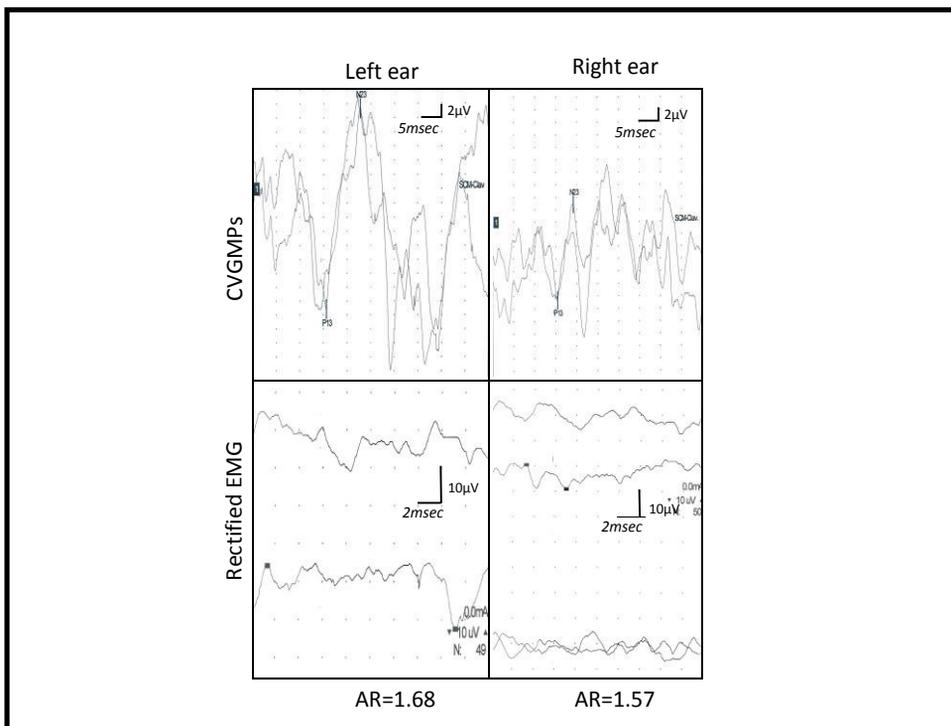
- Although the characteristic of Meniere's disease is tinnitus with aural fullness, vestibular migraine can show this also.
- Also, meniere's disease, as well as other vestibular disorders, can also present with migraine.
- Sometimes, a patient can have both Meniere's disease and Vestibular Migraine.

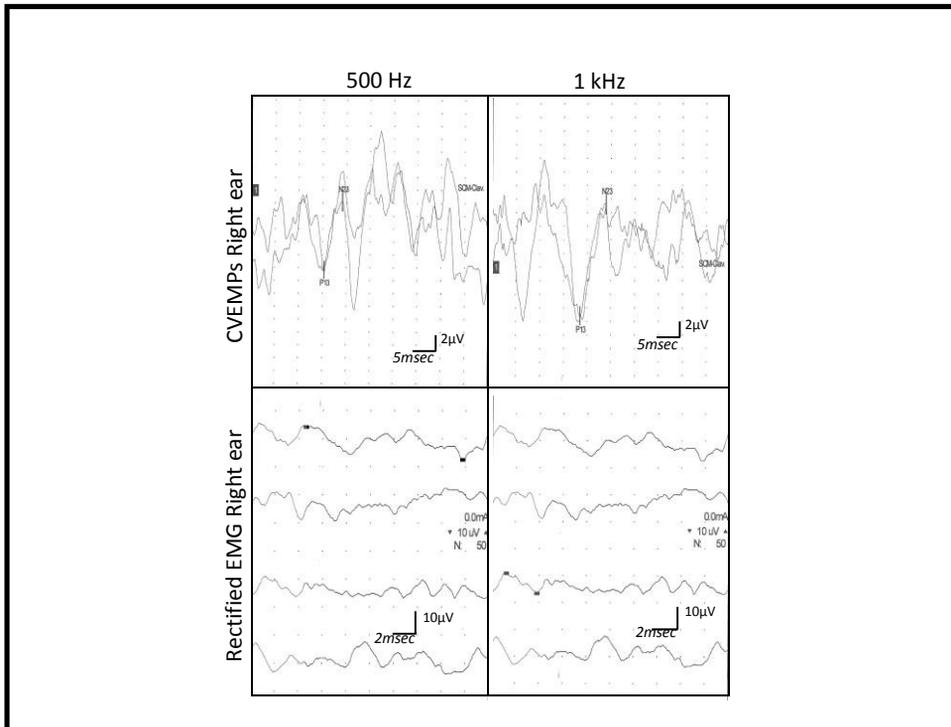
## Modification of VEMP protocol dependent on differential diagnosis

- Meniere's Disease vs Vestibular Migraine
  - Perform the cVEMP study not only at 500 Hz but also at 1 kHz (Frequency tuning).
  - An amplitude assymetry in the cVEMP response becomes more sensitive and specific to MD when combined with an abnormal asymmetric caloric test and responses that are best obtained at 1 kHz compared to 500 Hz (0.5/1 kHz frequency ratio) (Taylor et al., 2011).

## History

- 41-year-old female with vertigo/imbalance for 2 weeks. History of epilepsy.
- Negative Dix-Hallpike maneuver.
- VPA, Stemetil, Betaserc.
- Rule out Vestibular Migraine.
- PTA was within normal limits bilaterally.





## Other Paramedical Examinations

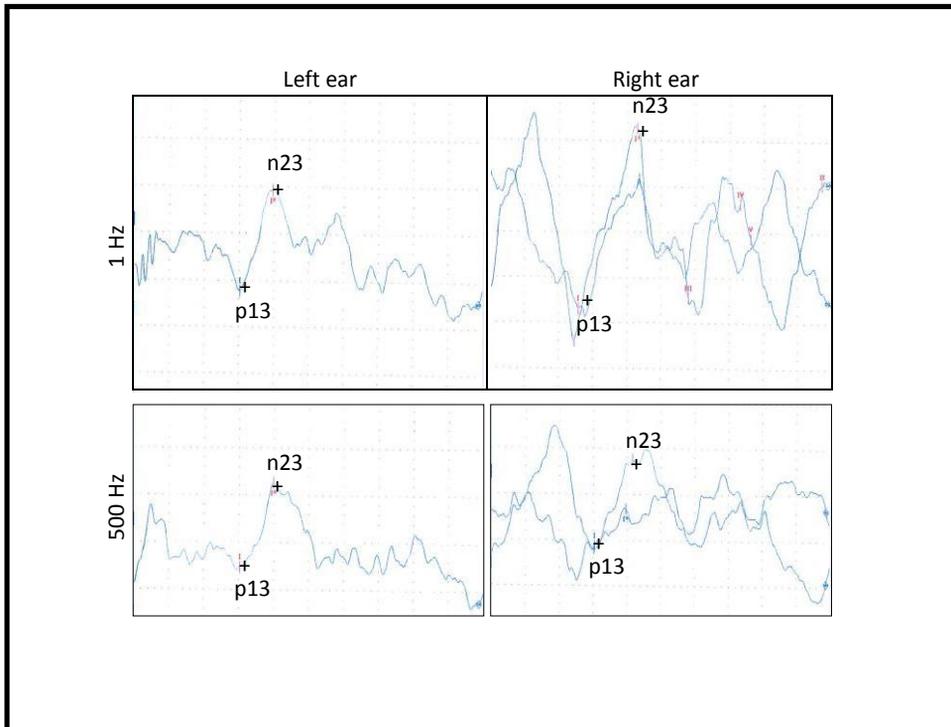
- Audiogram is within normal limits (tends to rule out Meniere's disease or endolymphatic hydrops involving the cochlea)
- The caloric test has not been done yet at the time of writing (but has been recommended).
- Impression: Probable endolymphatic hydrops involving the right ear (left ear was not examined at 1 kHz).

## Impression

- In the presence of a normal audiogram, this may be a case of Recurrent Peripheral Vestibulopathy (endolymphatic hydrops involving the vestibular labyrinth alone).
- Calorics were recommended to be performed.

## History

- 56-year-old female with probable Meniere's disease.
- Pure tone audiometry was reported by the patient as showing low frequency hearing loss for the left ear.



## Endolymphatic hydrops

- It appears in this case that the EH is affecting predominantly:
  - The cochlea on the left (abnormal PTA).
  - The saccule on the right (frequency tuning of cVEMP).

## Case by Case Evaluation

- Assistance with future cases and advice on when to perform VEMPs and if it will be useful:
  - [neurophy@cing.ac.cy](mailto:neurophy@cing.ac.cy)