Adult Vestibular Assessment and Treatment

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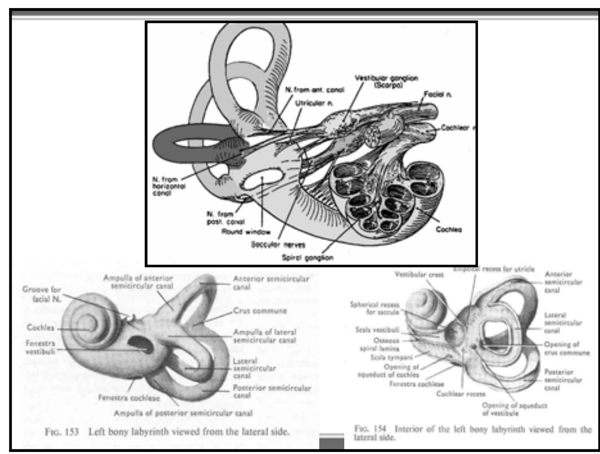
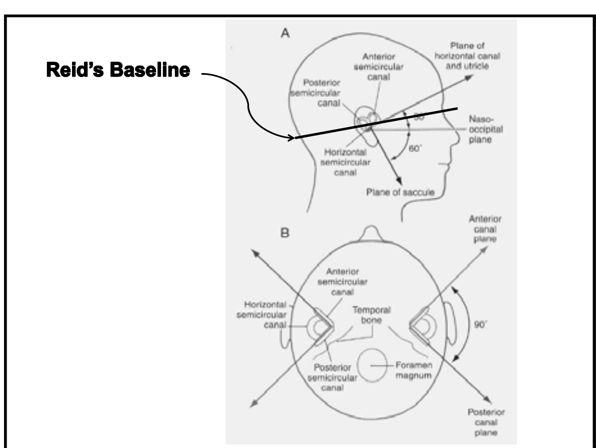
Why is it important to understand the balance system?

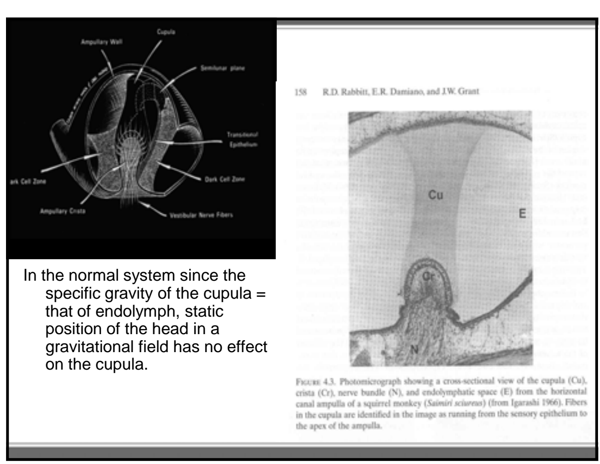
- Approximately 7 million people see their physician per year for problems with balance and dizziness
- 30% of the population will report problems with balance and dizziness before age 65
- An estimated 45% of dizziness can be attributed to a vestibular disorder
- Risk for Falls:
  - By the year 2040 20% of population 65 years or older
  - 30% people 65 years of age or older will fall, 50% repeatedly
  - Falls are the 6th leading cause of death secondary to complications from the fall

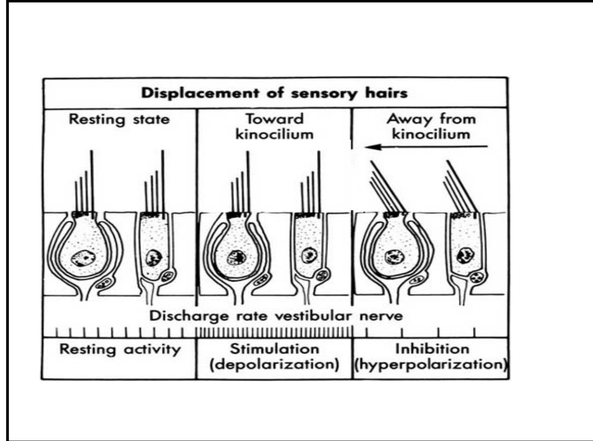
Purposes of Balance System

- Perception of orientation and movement
- Control of eye movement for clear visual imaging of the world
- Static and dynamic postural control



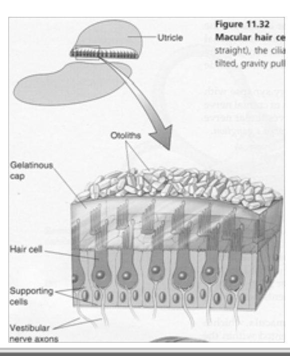

Reid's Baseline
A
Anterior semicircular canal
Posterior semicircular canal
Plane of horizontal canal and utricle
Naso-occipital plane
Horizontal semicircular canal
60°
Plane of saccule
B
Anterior canal plane
Anterior semicircular canal
Horizontal semicircular canal
Temporal bone
90°
Posterior semicircular canal
Foramen magnum
Posterior canal plane


In the normal system since the specific gravity of the cupula = that of endolymph, static position of the head in a gravitational field has no effect on the cupula.



Utricle and Saccule

- Hair cells are embedded in ***macula***
- Cilia projecting into
  - gelatinous structure that contains many small calcium crystals called ***otoconia***
  - Otoconia add weight to the otolithic membrane



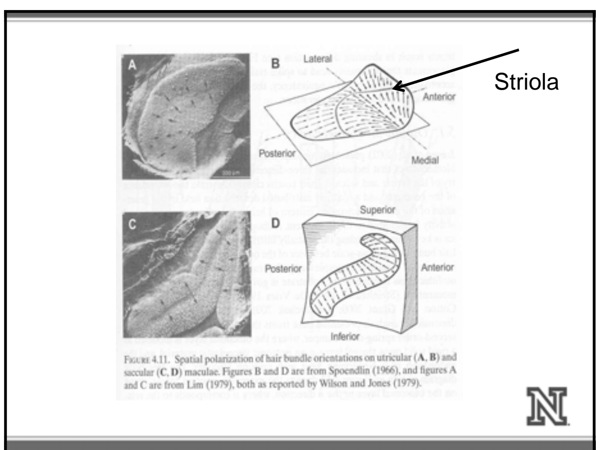
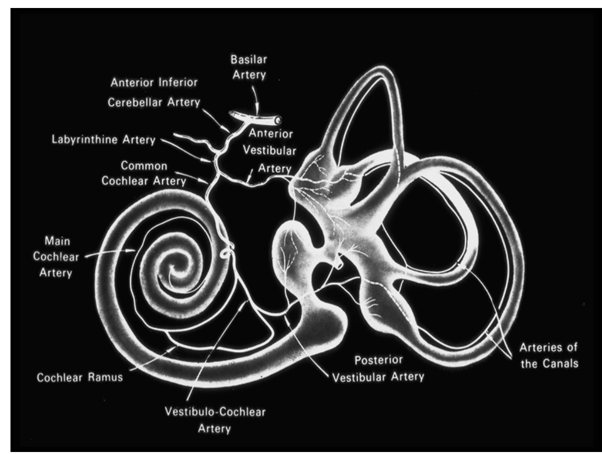
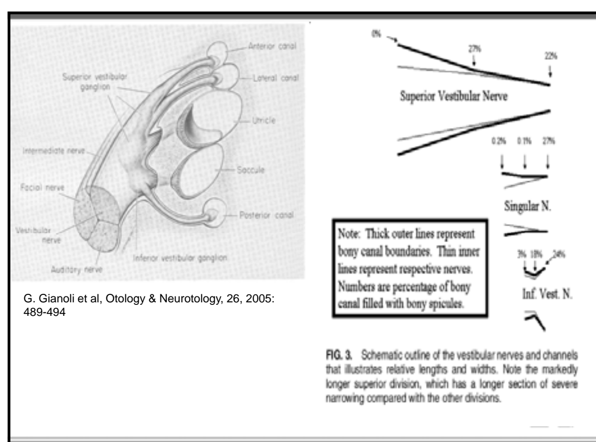


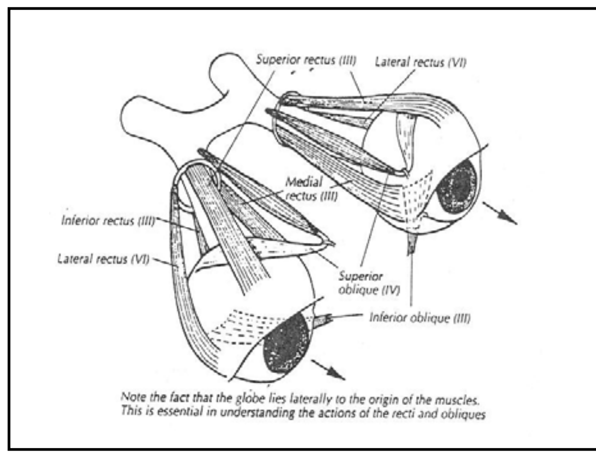
FIGURE 4.11. Spatial polarization of hair bundle orientations on utricular (**A**, **B**) and saccular (**C**, **D**) maculae. Figures B and D are from Spoendlin (1966), and figures A and C are from Lim (1979), both as reported by Wilson and Jones (1979).





G. Gianoli et al, Otology & Neurotology, 26, 2005: 489-494

FIG. 3. Schematic outline of the vestibular nerves and channels that illustrates relative lengths and widths. Note the markedly longer superior division, which has a longer section of severe narrowing compared with the other divisions.

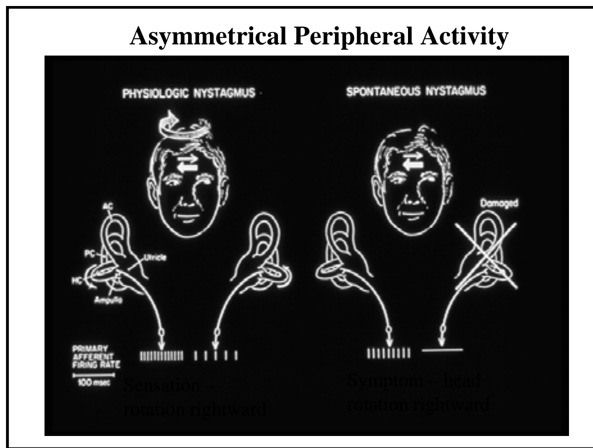


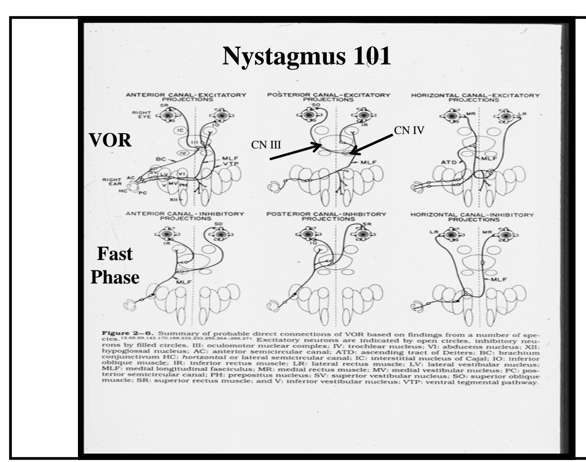
Note the fact that the globe lies laterally to the origin of the muscles. This is essential in understanding the actions of the recti and obliques

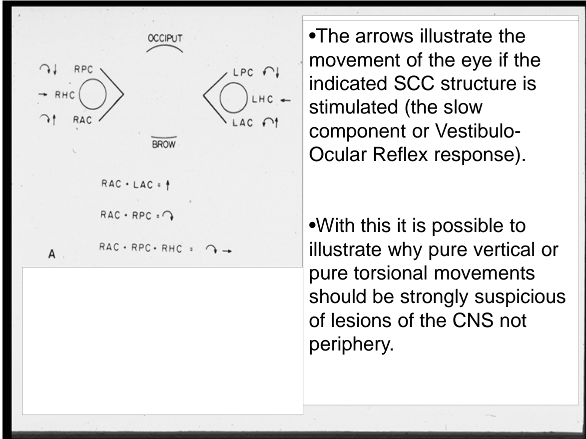
The Physiology of the Vestibulo-Ocular Reflex (VOR)

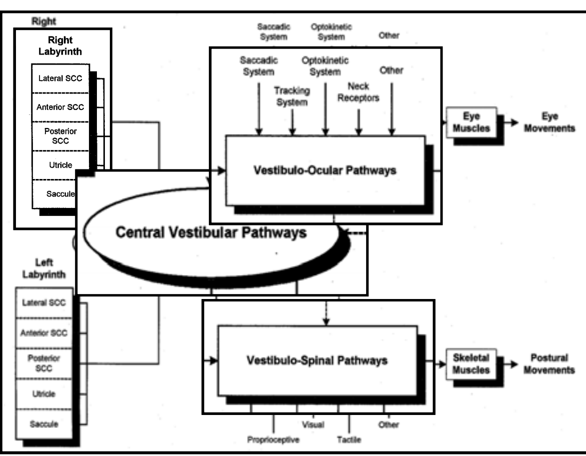
- Keeps image on the fovea
- Provides for a clear image during head movement
- Bilateral labyrinthine ablation causes bobbing oscillopsia

Asymmetrical Peripheral Activity









History

- Majority of patients with acute balance disorders or dizziness tend to recover spontaneously (***vestibular compensation***) with only treatment needed for their symptoms
- It would be rare for these individuals to receive balance function testing
  - May be referred if complaining of auditory symptoms or possible abnormal ocular-motor findings

Vestibular Compensation

- Injury to the peripheral or central vestibular system = considerable disability
  - Spontaneous functional recovery --known as vestibular compensation
    - Goal is to achieve stability of gaze and postural control under static and dynamic conditions
  - Failure to recover may be due to:
    - continued dysfunction in the vestibular end organs
    - or of the central vestibular compensation

In the Chronic Dizzy Patient – Why are symptoms continuing? Why has the Natural Compensation process not worked?

- The patient has an UNSTABLE lesion
  - ie, the locus of the lesion is changing over time.
- The historical hallmark is spontaneous events
- More likely to be assisted with medicine or surgery

- The patient has a STABLE lesion yet uncompensated by the central process
- The historical hallmark is symptoms are provoked by something
- More likely to be served with VBRT

Surgical Management of the Dizzy patient

- Reparative
  - Middle ear procedures for erosive process
  - Perilymphatic fistula both the controversial form at OW or RW & Superior SCC dehiscence
  - Sac decompression or endolymphatic shunt

- Ablative procedures
  - Labyrinthectomy
  - Vestibular nerve section
  - Canal plugging procedures
  - Chemical destruction
    - not necessarily complete ablation

Rationale for Ablative Procedures

- Compensation process difficult if not impossible with fluctuating lesion
- If lesion site is confined to the labyrinth
  - then partial or full destruction of this site produces a stable peripheral lesion
- Thus changing the patient to a group where compensation is possible

Medical & Dietary Control of the Dizzy Patient

- Medical
  - Control of an underlining metabolic or hormonal disorder
  - Steroid sensitive disorder
  - Migraines
  - Destructive or degenerative disorders
  - Symptom control
- Dietary
  - Low sodium diet
    - 1.5 to 2 grams daily
  - migraine control

Difficulty with use of Rx Medications

- As a group they produce a sedentary effect with CNS depression that can possibly prevent or slow down the compensation process
- There are patients that will need the medications to cut the edge off the symptoms in order to get active enough to drive compensation
  - judicious use is the order of the day

Common Disorders in Group 1

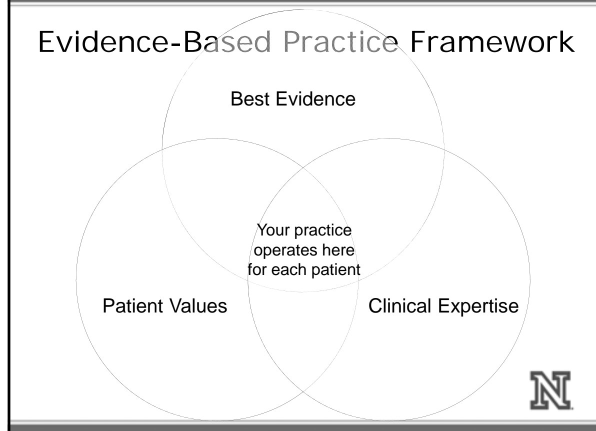
- In general these are 'unstable' lesions - changing over time:
  - Meniere's
  - Migraine
  - Anxiety (and other psychological) disorders
  - Degenerative CNS disorders
    - SCA, Parkinsonism (PSP), MS, Cerebellar paraneoplastic
  - Cardiovascular disorders / orthostatic hypotension
  - Mass lesions of the CPA
    - Schwanoma, meningioma
      - respond very well to therapy
  - Autoimmune inner ear disorder

Common Disorders of Group 2

- Vestibular and Balance Rehabilitation - Primary
  - BPPV
  - Uncompensated Stable Peripheral, eg
    - Vestibular neuritis
    - Labyrinthitis
    - Ablative surgery
  - Dysequilibrium of aging
  - Stable central lesions
  - Mild Anxiety
  - Bilateral peripheral paresis
- Vestibular and Balance Rehabilitation - Adjunctive
  - Migraine
  - More severe anxiety and other psychological disorders
  - Head trauma
  - Aspects of Meniere's disease
  - Aspects of Degenerative CNS

EBP approach to "Best Practice"

- Developing "Best Practice"
- Evidence-Based Practice- "the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients…" (Dollaghan, 2004, J of Com Dis 37; Sackett, Rosenberg, Gray, Haynes & Richardson, 1996 Evidence-based medicine: what it is and what it isn't, British Medical Journal, 312: 71-72)
  - Clinical Decision Analysis/Rules/Critical Appraisals – Mathematical & non-math techniques for evaluating the performance and clinical utility of tests of a diagnostic nature/treatment, prevention, prognosis, harm, etiology & economics/reviews of literature and other information



Clinical Decision Analysis Tools

- CDA provides a systematic way to make decisions in an environment where uncertainty is the operative word
- There are multiple tools that can be used in the decision process. The use of these tools can be divided into 2 camps.
  - Those evaluation tools that provide useful information about the performance of a single test to ID or screen for a particular condition
  - Used to compare to compare the test as its parameters or criterion for interpretation are changed.
  - Those tools that can be used to compare and rank order tests to select the optimum test to ID or screen for a disorder.

Evidence-Based Practice – Framework

- **Steps in the application of EBP help to make the use of EBP manageable (Sackett, et al, 2001 – presentation London, UK)**
- FRAPA (**FRAP from Goss et al, Mosby 2001**
  - **Formulating EBP questions**
  - **Retrieving relevant evidence**
  - **Appraising and evaluating the quality and appropriateness of evidence (literature)**
  - **Patient centered care and Personal expertise**
  - **Audit – evaluate the effectiveness of the recommendations**

35 yr old Male - Confirmatory

- On vacation - mild URI - sudden onset of true vertigo with n/v slowly improving over 3 days - no auditory symptoms
- Resolved in mild hd mov provoked vertigo lasting seconds that have now continued for 6 months - comes with nml Audio and hd MRI
- Hx and bedside exam strongly positive for severe L peripheral - uncompensated by spont nyst - Dx uncomp L unilateral Hypo function from VN
- ENG - 76% L RVR - Right spont / Pos all - Ocular nml - CDP nml - Chair inc Phase

44 year old Female- Altered Management

- Spontaneous spells of lightheadedness and imbalance without true vertigo - hours - 2/mo ongoing for > 4 years now more frequent
- Negative for hearing loss - mild unilateral tinnitus - MRI neg
- Negative for Migraine - remainder of Hx Neg
- Dx by history and office exam - mild atypical peripheral vest - ? Developing Meniere's type
- ENG / Ocular / Chair / CDP SOT - NML
- MCT & PERs abn pattern for demylination

Ideal Laboratory Studies

- Would be a single test
- Results of which would:
  - Render the Diagnosis
  - Allow for determination of site(s)-of-lesion
  - Allow for determination of patient functionality & and level of disability
  - Determine the correct management path
- Currently only study that does the above = History

Case History

Peripheral	Central or non-vestibular sx
– Sudden onset – True vertigo – Spontaneous < 24 hours – Head mov't provoked sx – Vestibular crisis – Auditory involvement	– Slow onset imbalance – Sudden onset of sx with complaints of diplopia, dysphasia, dysarthia, dysmetria – Slow vertigo lasting 24/7 – Vague sx of any character

Balance Function Testing

- Purpose encompasses 4 major goals
- 1. Site of lesion localization
- 2. Assessment of patients functional ability to use systems inputs & outputs appropriately
- 3. Indications for status of compensation
- 4. Determine if patient may be candidate for vestibular rehabilitation

Balance Function Testing

- Diagnostic balance function tests
  - ENG/VNG
  - Rotational Chair
  - Sway Platform Posturography
- Key to managing the chronic balance disorder patient is to select balance testing that completes the clinical picture outlined in the case history!

Purposes for Laboratory Assessment

Site-of-Lesion Localization:

- ENG / VNG
  - Ocular motor tests – Cerebellar/Brainstem involvement
    - Saccades – rapidly move eyes/refixate on a target
    - Smooth pursuit – ability to track target
    - Gaze stability – ability to hold eyes steady
  - Spontaneous / positional nystagmus – non-localizing
    - Sitting, supine, lateral right & left, pre-caloric positions
    - Fixation removed
  - Caloric – localization to right or left periphery
    - Open loop
    - horizontal canal/low frequency/COWS
  - Hallpike Maneuver – BPPV – canal involved based on eye mov'ts
    - 2D recordings cannot be used to determine BPPV and localize it to the side involved this requires direct observation of the eye!

Diagnosing BPPV

Posterior/ Anterior Semicircular Canal BPPV

	Right Torsion	Left Torsion
Up Beat	Right Posterior Canal	Left Posterior Canal
Down Beat	Right Anterior Canal	Left Anterior Canal

Horizontal Semicircular Canal BPPV Diagnosed by: Roll Test

	Head Right	Head Left
Canalathiasis (geotropic)	Pure Horizontal Right Beat	Pure Horizontal Left Beat
Cupulolithiasis (ageotropic)	Pure Horizontal Left Beat	Pure Horizontal Right Beat

Purposes for Laboratory Assessment

Site-of-Lesion Localization:

- Rotational Chair –
  - Expands the investigation of the peripheral vestibular system
    - Indications for peripheral involvement – time constant
    - Suggestions for Right / Left localization – asymmetries steps/sine testing
    - Specific protocol for Cerebellar Nodulus involvement

Purposes for Laboratory Assessment

Functional performance

- Computerized Dynamic Posturography
  - Quantitative method for assessing upright balance function under a variety of tasks that effectively simulate the conditions encountered in everyday life
    - Vision
    - Vestibular
    - Somatosensory
      - » Sensory Organization Test

What are indicators of Compensation?

- Physiologic compensation re eye movements
  - Static compensation
    - Nystagmus with fixation
    - Nystagmus without fixation
    - Significant positional nystagmus
  - Dynamic compensation
    - Significant directional preponderance
    - Asymmetry from rotary chair
    - Symptoms with head movements
    - Post head shake nystagmus

What are indicators of Compensation?

- Functional compensation re quiet stance
  - Sensory Organization Testing (of Computerized Dynamic Posturography) or Clinical Test of Sensory Interaction and Balance (CTSIB) normal

Management of Balance & Dizzy Patient

- Needed for Management decisions
  - Full Neurotologic History
  - Physical / Bedside Exam
  - Auditory Testing
- Adjunctive for Management decisions (less likely to alter management – NOT a statement on priorities or when testing should be done)
  - Laboratory Vestibular Tests
  - Blood studies / Neuro-radiographics

18 Yr Female

- Head and visual motion provoked vertigo and general lightheadedness – occasional spontaneous events of vertigo lasting several hours
- Denies otologic sx and PMH is otherwise negative except strong history of active migraines
- Direct exam and laboratory studies were all negative except for the following eye movement examination that was seen during ocular motor portion of the ENG

18 Yr Female

- What do the eye movements show and indicate?
- Gaze evoked nystagmus – left on left and right on right with associated down beat
- Indication would be for brainstem area involvement
- Recommendation: MRI with enhancement of posterior fossa

18 Yr Female

- MRI – negative results
- On further questioning – born with significant ocular misalignment – treated with prisms and medications up to age 14 – treatment stopped at that time
- Final diagnosis: Migraine associated vertigo with the ocular signs secondary to congenital nystagmus from ocular misalignment

Use of Balance Function Tests - summary

- Never returns a Diagnosis
- Most often as a confirmatory means for that suspected from Hx, audio and direct exam
- Drives management when results:
  - Not what is expected based on other information
  - Are used as part of a triage process for chronic patients with specific central or peripheral findings
- In Decision process during treatment
  - Termination of Gent treatment for Meniere's
  - To go on for specialty studies eg. SSCC dehiscence
  - Determination of CPA mass point of origin – VEMPs w/ calorics

Purposes for Laboratory Assessment

- Together with Symptoms: Indications, prognosis & design for Vestibular Rehab.
  - VBRT – primarily a sx driven indication some testing can add to that determination
    - SOT – to help design and monitor
    - DVA – to help design and monitor
    - Caloric asymmetries and Chair time constant abnormalities – to a limited extent indicate abnormal VOR – indication for a type of therapy (Adaptation) if sx appropriate for tx

Who is appropriate for VBRT?

- Appropriate
  - Head visual motion provoked
  - Continuous with motion exacerbation
  - Functional balance or gait dysfunction
  - Stable peripheral or central lesion
  - Any age
- Inappropriate
  - Only spontaneous events or too freq. (unstable/progressive periph.)
  - No provocative activity or balance dysfunction
  - Progressive Central lesion (balance/gait)