

**VESTIBULAR REHABILITATION**

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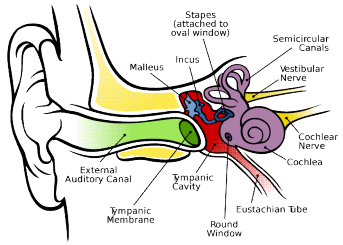
### OBJECTIVES

1. Have basic understanding of vestibular anatomy, physiology and pathology.
2. Describe what types of patients would benefit from vestibular rehabilitation.
3. Distinguish between types of vestibular diagnoses
4. Describe several vestibular rehab assessment and treatment strategies
5. Perform a Dix-Hallpike assessment



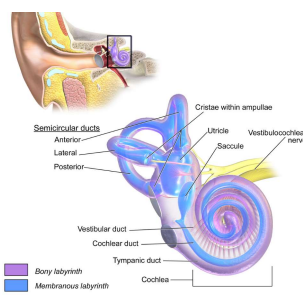
**VESTIBULAR ANATOMY**

### THE EAR

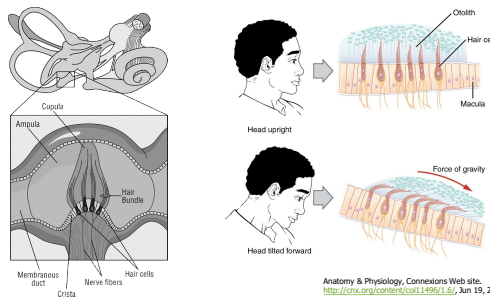


Chittka L, Brockmann A (2005) Perception Space—The Frontiers. *PLoS Biol* 3(4): e137. <https://doi.org/10.1371/journal.pbio.0030137>

### INNER EAR



### Cupula of Semicircular Canals      Macula of Utricle and Saccule



Anatomy & Physiology, Connexions Web site. <http://cnx.org/content/col11496/1.6/>, Jun 19, 2013.

### HAIR CELLS – THE SENSORY ORGAN OF THE VESTIBULAR SYSTEM

**Excitation**  
stereocilia towards kinocilium

**Inhibition**  
stereocilia away from kinocilium

### HAIR CELLS – THE SENSORY ORGAN OF THE VESTIBULAR SYSTEM

**Orientation of Hair Cells in Horizontal Canals**

left side: inhibition

right side: excitation

### SEMICIRCULAR CANALS

Three Spatial Relationships Specific to SCC:

1. Orthogonal
2. Paired
  - creates push/pull relationship
  - sensory redundancy
3. Planes of canals / planes of extraocular muscles

Diagnosis and management of benign paroxysmal positional vertigo (BPPV). Lurie S, Parnes S, Sumit K, Agrawal, Jason Atlas. CHMJ Sep 2003, 169 (7) 681-693

### SEMICIRCULAR CANAL PAIRING

Right horizontal canal ↔ Left horizontal canal

Right anterior canal ↔ Left posterior canal

Left anterior canal ↔ Right posterior canal

This allows sensory redundancy and explains compensation after unilateral vestibular loss.

### OTHOLITH ORGANS

Each ear contains one utricle and one saccule

- Utricle = sensitive to horizontal linear acceleration/deceleration
  - Example: riding in a car, quiet stance to walking
- Saccule = sensitive to vertical linear acceleration/deceleration
  - Example: elevator

Remember, otholith organs are covered by the otholith membrane with otoconia on top

### CLINICAL CORRELATION

Sometimes the otoconia break free and float into the endolymph of the semicircular canals.

Creates a change in the specific gravity of the endolymph which leads to positional vertigo, or Benign Paroxysmal Proximal Vertigo (BPPV).

## VESTIBULAR REFLEXES

### Vestibulocortical

- Vestibular nuclei → thalamus → cerebral cortex
- = Conscious awareness of body orientation

### Vestibulocerebellar

- Vestibular nuclei → cerebellum → medial vestibular nucleus
- = Coordination of eye and head movement

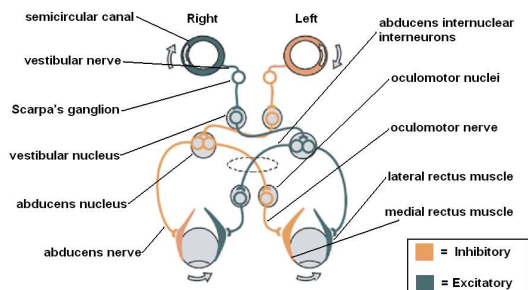
### Vestibulospinal

- Vestibular nuclei → lateral and medial vestibular tracts and reticulospinal tract
- = Antigravity response

### Vestibuloocular (VOR)\*\*

- Enables clear vision through gaze stabilization by coordinating eye movement with movement of the head

## HORIZONTAL VOR – HEAD ROTATION RIGHT



## CLINICAL CORRELATION

VOR is combination of direct *and* indirect pathways

Commissural connections are also present between the right and left vestibular nuclei in the brainstem

After a unilateral loss of vestibular function, the commissural connections become important because they provide a possible mechanism for the intact vestibular organs to control the vestibular nuclei bilaterally.

Therefore, it is possible to regain a functional VOR.

## SEMICIRCULAR CANALS AND RELATED EYE MUSCLES IN THE VOR

### Semicircular Canals

### Eye Muscles

Horizontal Canals

Medial and Lateral Rectus

Left Anterior/Right Posterior Canals

Left Superior and Inferior Rectus  
Right Superior and Inferior Oblique

Right Anterior/Left Posterior Canals

Right Superior and Inferior Rectus  
Left Superior and Inferior Oblique

## COMMON VESTIBULAR DIAGNOSES WE SEE

## BENIGN PAROXYSMAL POSITIONAL VERTIGO (BPPV)

Most cases are idiopathic

- 11 to 64 per 100,000 per year
- Increases approximately 38% per decade of life

- 17% are the result of head trauma
- 15% are a result of vestibular neuritis

Two Types

- Canalithiasis
- Cupulolithiasis

Symptoms

- Positional vertigo
- Vertigo is brief
- No changes in hearing

## UNILATERAL VESTIBULAR HYPOFUNCTION (UVH)

Decreased or loss of vestibular input from one of the paired SCC

### Several Causes:

- Vestibular Neuritis
- Labyrinthitis
- Labyrinthine Fistula
- Head Trauma

## UNILATERAL VESTIBULAR HYPOFUNCTION (UVH)

### Vestibular Neuritis

- 2<sup>nd</sup> most common cause of vertigo
- Viral infection affecting superior portion of the vestibular nerve (horizontal SCC paresis)
  - Accompanied by upper respiratory infection or GI infection
- Sx: acute vertigo, nausea/vomiting, imbalance; lasts 1-3 days

### Labyrinthitis

- Infection of membranous labyrinth (viral or bacterial)
- Sx: acute hearing loss and vertigo, nausea/vomiting; can last up to 3-4 days
- May have residual hearing loss, sensitivity to head movements and imbalance

### Labyrinthine Fistula

- Abnormal connection between fluid filled inner ear and surrounding air-filled structures
- Oval and round window vulnerable
- Sx: may hear "pop," hearing loss, vertigo, and tinnitus

### Head Trauma

## TRAUMATIC BRAIN INJURY (TBI)

Vestibular dysfunction occurs in 30-60% of patients with TBI during their course of recovery

### Symptoms:

- Vertigo
- Decreased gaze stabilization and ocular control
- Disequilibrium
- Gait ataxia

### Causes

- BPPV
- Labyrinthine concussion
- Temporal bone fracture
- Increased ICP
- Central vestibular lesions

## CERVICOGENIC DIZZINESS

Abnormal afferent input to vestibular nuclei from damaged joint receptors in upper cervical spine

- Diagnosis of exclusion
  - R/O all other causes of dizziness

Frequently seen in our population due to whiplash injuries

**Symptoms:** unsteadiness associated with neck pain, limited cervical range of motion, dizziness and headaches.

- Complaints of neck pain *must be present* to receive this diagnosis

Episodic vertigo provoked with certain neck positions

Can be differentiated from BPPV by absence of symptoms when the positions of the head and neck are changed together (e.g., bending forward or turning in bed without movement of cervical spine facet joints)

## MENIERE'S DISEASE

### Symptoms:

- Episodes are recurrent
- Spontaneous event >20 minutes < 24 hours
- Fluctuating hearing loss
- Tinnitus and fullness of ear
- No CNS indicators

### Classic Treatment

- Vestibular suppressant during episode
- Diet (low salt, limited caffeine/nicotine/ alcohol)
- Surgery (last resort)
  - VR beneficial after surgery, but not prior

## WHAT IS VESTIBULAR REHAB?

Exercise approach used to manage persistent vertigo and dysequilibrium in patients with vestibular pathology.

Useful in:

- Decreasing vertigo and visual symptoms
- Decrease risk of falls
- Improving postural stability
- Increasing general activity levels



### WHAT IS THE ROLE OF PHYSICAL THERAPY IN VESTIBULAR REHAB?

1. Evaluation to determine the impairment
2. Develop a program of exercise with emphasis on proper gait and balance plus activities to decrease dizziness symptoms

### HOW DOES VESTIBULAR REHAB (VR) WORK?

Goal of VR is the "retrain" the brain to more effectively process sensory information in order to improve balance

VR helps the brain to recognize and process signals from the vestibular system in coordination with information from vision and proprioception.

It may include training the balance system to be less sensitive to movements that provoke symptoms

### ASSESSMENT

Taking a History

- Symptoms
- PMH
- Medications
- Function
- Patient goals

A complete history is the most important component in correctly diagnosing the patient with the complaint of dizziness

### ASSESSMENT

Medications:

- Usually prescribed to decrease sensation of vertigo, assist in restoring balance, and prevent vomiting

Beware of ototoxic meds, meds that cause dizziness, and vestibular suppressants

### ASSESSMENT

Oculomotor Exam

- Purpose: allows clinician to examine the interaction between the patient's visual and vestibular system by having patient perform a variety of head and eye movements
- May assist in differential diagnosing of vestibular disorders
- May assist in determining part of the treatment plan

## ASSESSMENT

### Oculomotor Exam

- Visual-Vestibular interaction:
  - 3 visual systems work together to maintain gaze:
    - Saccade system
    - Smooth Pursuit System
    - Optokinetic System

## ASSESSMENT

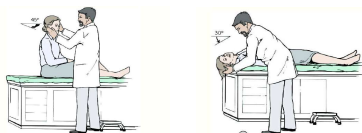
### Oculomotor Exam

- Screen alar ligaments and vertebral artery
- Spontaneous Nystagmus
- Gaze-holding nystagmus
- Smooth pursuit
- Saccadic eye movement
- VOR to slow head movements
- VOR to fast head movements (head thrusts)
- VOR Cancellation
- Optokinetic nystagmus
- Static and Dynamic visual acuity
- Dix-Hallpike Maneuver

## ASSESSMENT

### Dix-Hallpike Maneuver

- To identify canalithiasis or cupulolithiasis of posterior or anterior semicircular canal

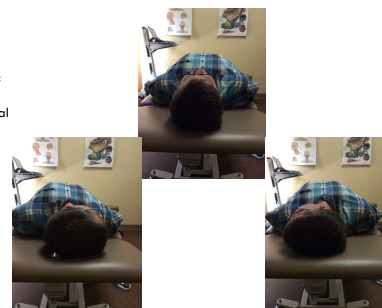


Diagnosis and management of benign paroxysmal positional vertigo (BPPV). Lamee S, Parnes S, Sumit K, Agrawal, Jason Atlas. *CMJ* Sep 2003; 169 (7): 681-693

## ASSESSMENT

### Roll Test

- To identify canalithiasis or cupulolithiasis of the horizontal semicircular canal



## ASSESSMENT

### Torsional Nystagmus

- Upbeating = posterior canal
- Downbeating = anterior canal

### Duration of nystagmus

- <60 seconds = canalithiasis
- >60 seconds = cupulolithiasis

### Horizontal nystagmus

- Geotropic = horizontal canalithiasis
- Ageotropic = horizontal cupulolithiasis

## ASSESSMENT

Torsional nystagmus

Geotropic nystagmus

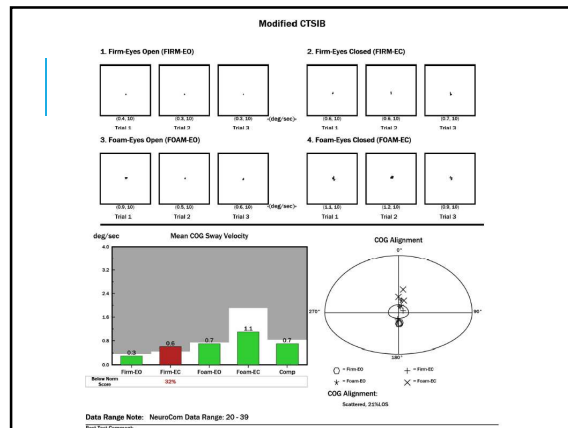
## ASSESSMENT

### Clinical Test for Sensory Interaction on Balance (CTSIB)

- 30 second trials of each condition are performed with timing stopped if the patient reaches, steps or falls.
- Used to determine if patient is surface or visually dependent and to develop an HEP

### NeuroCom Balance Manager m-CTSIB

- Objectively determines sway velocity and COG with each condition



## ASSESSMENT

### Other standardized balance tests

- Berg Balance Scale
- Tinetti Assessment tool
- Single leg, Romberg, and tandem stances
- Dynamic Gait Index
- Functional Gait Assessment
- Fukuda Step Test
- Motion Sensitivity Test

### MOTION SENSITIVITY TEST

Position Change	Intensity (0-5) 0=No symptoms 5=severe symptoms	Symptom Duration (seconds) 5-10 sec = 1 point 11-30 sec = 2 points >30 sec = 3 points	Score (1-10)
<b>Baseline Symptoms</b>			
1. Sitting to Supine			
2. Supine to Left side			
3. Supine to Right side			
4. Supine to sitting			
5. Left Hallpike-Dix			
6. Return to sit from left Hallpike-Dix			
7. Right Hallpike-Dix			
8. Return to sit from right Hallpike-Dix			
9. Sitting, head tipped to left knee			
10. Head up from left knee			
11. Sitting, head tipped to right knee			
12. Head up from right knee			
13. Sitting, turn head horizontally 5 times			
14. Sitting, move head vertically 5 times			
15. Standing, turn 180 degrees to right			
16. Standing, turn 180 degrees to left			
<b>Total Score</b>			
Key: 0-10 = mild; 11-30 = moderate; 31-100 = severe (reference: Abbott)			<b>MSQ</b> =(#Positions with symptoms x Total Score) / 20.48

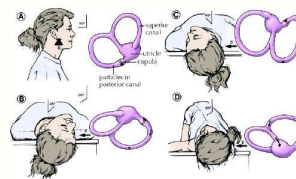
## TREATMENT APPROACHES

### BPPV

- Ant/ Post Canal Canalithiasis
  - Repositioning Maneuver
- Horizontal Canal Canalithiasis
  - Log Roll
- Ant/ Post Canal Cupulolithiasis
  - Liberatory Maneuver
- Horizontal Canal Cupulolithiasis
  - Modified Liberatory Maneuver-Appiani

## TREATMENT APPROACHES

### Repositioning Maneuver/ Epley Maneuver



Diagnosis and management of benign paroxysmal positional vertigo (BPPV). Lorne S. Paines, Sumit K. Agrawal, Jason Atlas. CMAJ Sep 2005; 169 (7):681-693

### TREATMENT APPROACHES

Log Roll

### TREATMENT APPROACHES

Liberatory Maneuver for Ant/Post Cupulolithiasis

Diagnosis and management of benign paroxysmal positional vertigo (BPPV). Lorne S. Parnes, Sumit K. Agrawal, Jason Atlas. CMAJ Sep 2003; 169 (7): 981-993

### TREATMENT APPROACHES

Modified Liberatory Maneuver- Appiani

### TREATMENT APPROACHES

Habituation

- The repetitive exposure to a noxious stimulus (usually movement) to gradually inhibit the patient's response to that stimulus
- Usually given for central vestibular diagnoses or maintenance for BPPV (Brandt-Daroff)

### TREATMENT APPROACHES

Brandt-Daroff

- Usually performed for those who cannot tolerate the Canalith Repositioning Treatment or those who need maintenance

### TREATMENT APPROACHES

Adaptation

- The ability to make long term changes in the neuronal response to head movement. The stimulus used to induce change is an error signal called retinal slip.
- Retinal slip- When the VOR is not working, the eyes cannot stabilize on an image, so images move across the retina
- Usually used for unilateral loss



## TREATMENT APPROACHES

### Adaptation Principles

1. Adaptation exercises should incorporate head movement
2. Adaptation is context-specific
3. The brain needs time to resolve the error signal
4. Voluntary motor control has an influence on vestibular function
5. Patients should work at their highest level of ability

## TREATMENT APPROACHES

### Example of Adaptation

- Gaze Stabilization exercises



## TREATMENT APPROACHES

### Substitution

- Used when there is complete bilateral loss of vestibular function, and there is no expectation of vestibular return
- Enhance visual and somatosensory stimuli to compensate

## COMPONENTS OF A TREATMENT PROGRAM

- Education
- Adaptation
- Habituation
- Substitution
- Balance Retraining
- Conditioning Program

## BARRIERS TO RECOVERY

- Restricts head movement
- Visual input is minimized
- Use of Vestibular suppressant medications
- Presence of other disorders (esp. CNS disorders)
- Normal age related declines in sensory and adaptive capabilities

## SPECIFIC CHALLENGES WITH TBI POPULATION

- Orthopedic injuries
- Psychological state
- Visual system deficits
- Impulsivity
- Decreased processing speed
- Memory
- Decreased ability to follow directions

## TREATMENT EXPECTATIONS

Should notice an improvement in symptoms 4-6 weeks after initiating therapy

If no change is noted, a review of the exercise program is essential to make modifications

Majority of patients return to their previous level of functioning



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