BPPV Evaluation and Treatment

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Program Objectives

By attending the course, clinicians will be able to:

1. Summarize the etiology of BPPV
2. Identify peripheral vestibular anatomy
3. Describe how to effectively perform a vertebral artery screen
4. Describe how to effectively perform a oculomotor screen
5. Perform a thorough physical therapy evaluation for BPPV
6. Develop an effective treatment plan for common forms of BPPV

BPPV Statistics (Bhattacharyya et al)

- A primary complaint of dizziness accounts for 5.6 million clinic visits in the United States per year and up to 42% of patients with vertigo ultimately receive a diagnosis of Benign Paroxysmal Positional Vertigo.
- There is a 2.4% life time prevalence of BPPV.
- Women are twice as likely to be diagnosed as men.
- BPPV is the most common vestibular disorder across the life span.
- Age of onset is most commonly between the 5th and 7th decades of life.
- Healthcare costs associated with BPPV approach $2 Billion dollars/year.

BPPV Statistics (Bhattacharyya et al)

- 86% of patients will suffer some interrupted daily activities and lost days at work due to BPPV.
- 68% of patients with BPPV will adjust their workload, 4% will change their job and 6% will quit their job as a result of the condition.
- It has been estimated that 9% of elderly patients undergoing a comprehensive geriatric assessment for non balance related complaints have unrecognized BPPV.
- Older patients with BPPV experience a greater incidence of falls, depression and impairments in their daily activities

Definitions

- **Vertigo**: An illusory sense of motion of either the self or the surroundings in the absence of true motion
- **Nystagmus**: A rapid, involuntary oscillatory movement of the eyeball
- **Vestibular system/apparatus**: The sensory system within the inner ear that, with the vestibular nerve and its connections in the brain, provides the fundamental input to the brain regarding balance and spatial orientation
- **Positional vertigo**: Vertigo produced by changes in the head position relative to gravity

Definitions

- **Benign paroxysmal positional vertigo (BPPV):** A disorder of the inner ear characterized by repeated episodes of positional vertigo.
- **Posterior canal BPPV**: A form of BPPV in which dislodged inner ear particles in the posterior semicircular canal abnormally influence the balance system producing vertigo, most commonly diagnosed with the Dix-Hallpike test.
- **Lateral canal BPPV**: A form of BPPV in which dislodged inner particles in the lateral semicircular canal abnormally influence the balance system producing vertigo, most commonly diagnosed with the Supine Roll test.

Definitions

- **Canalathiasis:** A theory for the pathogenesis of BPPV that proposes that there are free floating particles (otoconia) that have moved from the utricle and collect near the cupula of the affected canal, causing forces in the canal leading to abnormal stimulation of the vestibular apparatus.
- **Cupulolithiasis:** A theory for the pathogenesis of BPPV that proposes that otoconial debris attached to the cupula of the affected semicircular canal cause abnormal stimulation of the vestibular apparatus.

Definitions

- **Canal repositioning procedures (CRP's):** A group of procedures in which the patient moves through specific body positions designed to relocate dislodged particles within the inner ear for the purpose of relieving symptoms of BPPV. The specific CRP chosen relates to the type of BPPV diagnosed. These have also been termed *canalith repositioning maneuvers* or *canalith repositioning techniques*.

Common Causes of Acute Dizziness: Differential Diagnosis by Timing and Triggers Category

Acute Vestibular Syndrome

- Acute persistent continuous dizziness lasting days to weeks and usually associated with nausea, vomiting and intolerance to head motion.
  - Vestibular neuritis
  - Labyrinthitis
  - Posterior circulation stroke
  - Demyelinating diseases
  - Posttraumatic vertigo

Spontaneous Episodic Vestibular Syndrome

- Episodic dizziness that is not triggered and can last minutes to hours
  - Vestibular migraine
  - Meniere's disease
  - Posterior circulation TIA
  - Medication side effects
  - Anxiety or panic disorder

Chronic Vestibular Syndrome

- Dizziness lasting weeks to months or longer
  - Anxiety or panic disorder
  - Medication side effects
  - Posttraumatic vertigo
  - Posterior fossa mass lesions
  - Cervicogenic vertigo

Triggered Episodic Vestibular Syndrome

- Episodic dizziness triggered by specific and obligate actions, usually a change in head or body position. Episodes generally last less than one minute.
  - BPPV
  - Postural hypotension
  - Perilymph fistula
  - Superior canal dehiscence syndrome
  - Vertebrobasilar insufficiency
  - Central paroxysmal positional vertigo

Purpose of the Vestibular System

- Detects head angular velocity and linear acceleration.
- Orients the head and body to gravity.

Functions of the Vestibular System

- Stabilizes gaze: Stabilizes images on the fovea during head movements (Vestibular Ocular Reflex).
- Controls Posture: Keeps the body balanced, especially when the head is moving (Vestibular Spinal Reflex).
- Provides information used for spatial orientation.
- Coordinates head and body movements.

Works in conjunction with the Visual and Somatosensory Data

- Peripheral Sensory Input: Visual, Vestibular, Somatosensory
- Central Processing:
  - Primary Processor is the Vestibular Nuclear Complex
  - Adaptive Processor is the Cerebellum

Motor Output:
- Eye movements
- Position changes

Vestibular System

Peripheral Sensory Apparatus
- 3 semi-circular canals and 2 Otoliths (Utricle and Saccule)

Central Vestibular System
- Mechanism for Motor output and Sensory integration: Ascending and Descending Tracts

Central Processing of Vestibular Input

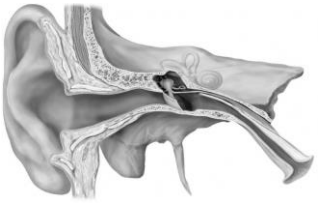
Main Targets:
- Vestibular Nuclear Complex
- Cerebellum

Other Targets:
- Motor nuclei of the extra-ocular muscles (Cranial nerves 3,4,6)

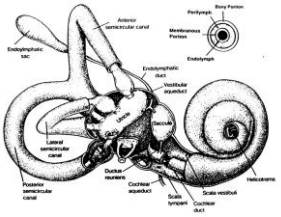
Inner Ear Anatomy

- Vestibule (Central Chamber)
- (3) Semi Circular Canals (per side)
  - Anterior
  - Posterior
  - Lateral (Horizontal)
- (2) Otoliths (per side)
  - Utricle
  - Saccule
- Cochlea

Peripheral Anatomy



Peripheral Anatomy



Semi-Circular Canals

- 3 Canals on each side
- Detect Angular Velocity
- Horizontal canals work as a pair
- Anterior canal works with posterior canal of opposite side
- Planes of canals are not directly in line with treatment plane but closer to planes of extraocular muscles
- Provide sensory input re: angular head velocity. The Vestibular Ocular Reflex generates eye movement that matches head velocity

3 SEMI-CIRCULAR CANALS Per side

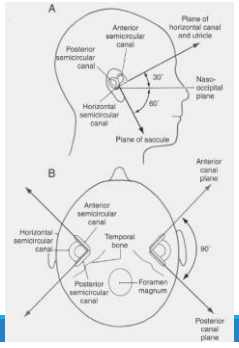
- Anterior (Superior): Nodding of the head
- Posterior (Inferior): Side bending
- Horizontal (Lateral): Rotation
- Ampulla: Articulates with Utricle

Semi Circular Canals

- Bony Labyrinth
- Membranous Labyrinth located INSIDE the bony labyrinth
- Ampulla: Widening at the base of each semicircular canal

Alignment of Canals

- Canals are aligned to the planes of the oculomotor muscles (not standard treatment planes)
- Horizontal (Lateral) canal inclined 30 degrees from horizontal plane
- Superior/posterior canals 45 degrees from sagittal plane
- All angular head movements stimulate at least 2 canals, often all 3

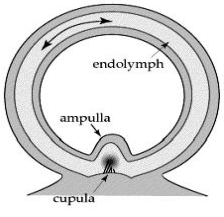


Membranous Labyrinth

- Suspended within bony labyrinth by fluid and supportive connective tissue
- Surrounded by perilymph
- Filled with endolymphatic fluid (High K: Na ratio, like intracellular fluid)
- No direct communication between endolymph and perilymph
- Endolymph is absorbed in endolymphatic sac
- Contains the sensory organs: Crista ampullaris & cupula (Inside the Semi Circular canals)

Sensory Organ of Semicircular Canals

- Located within the membranous labyrinth inside a structure known as the *ampulla*
- Crista Ampullaris: Base of the cupula
- *Cupula: Gelatinous mass*



PHYSIOLOGY

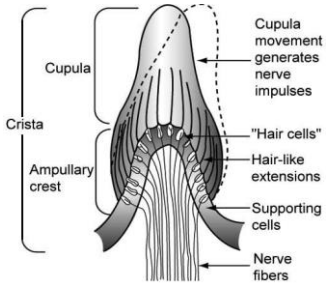
- Movement of fluid (endolymph)
- Deflection of hair cells (within the cupula)
- Each hair cell has a corresponding afferent neuron
- Action potential on what eventually becomes CN VIII

PHYSIOLOGY: Ampulla

- Two types of hair cell receptors
  - Type I: Phasic receptors
  - Type II: Tonic receptors
- Movement of head → Movement of endolymph → movement of crista ampullaris → deflection of hair cells
- Each hair cell has a corresponding afferent neuron.
- These neurons have a baseline firing rate
- When hair cells are deflected towards the utricle (toward kinocilium) →Excitation
- When hair cells are deflected away from the utricle →Inhibition

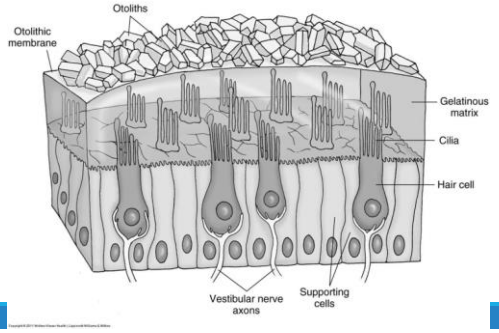
Cupula

- *Cupula: Gelatinous mass*
- Located inside the *ampulla*
- Hair Cells: *Primary receptor;* extend from the primary afferent nerve of vestibular system, through crista ampullaris into cupula

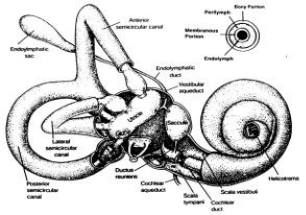


Physiology: Macula

- Cilia of hair cells embedded in otolithic membrane
- Each hair cell has a carbonate crystal on its end: otoconia
- With no head movement: Hair cells only respond to the pull of gravity → static response code
- Linear acceleration or deceleration of the head also displaces otolithic membrane



Peripheral Anatomy



Pathophysiology of BPPV

- Otoconia ("crystals")typically present in the otolith organs break free and fall into one of the semicircular canals
- During head movement, the otoconia float within the fluid filled semicircular canal
- Movement displaces endolymph causing deflection of the cupula

BPPV Canal Distribution

- Distribution of BPPV by canal has been reported as:
- 85-95% unilateral posterior canal
- 5-15% unilateral horizontal canal
- Rare variations:
  - Anterior canal
  - Multi-canal involvement (usually post trauma)

Two primary subtypes of BPPV

Canalithiasis: the debris (canalith) is free floating within the semicircular canal

- Symptoms will be short lived as the debris moves through the canal
- Symptoms will cease once the debris (canalith) settles in the most dependent portion of the canal

Cupulolithiasis: the debris may be attached/adhered to the cupula within the semicircular canal

- Symptoms of long duration
- Cupula becomes relatively heavy in the endolymph and will persist as long as the individual is in the provoking position

Canalithiasis

- Debris (otoconia) is free floating within Semicircular canal
- Will come to rest at most dependent part of the canal ~30 seconds

Characteristics of Canalithiasis

- Vertigo usually lasting <60 sec, associated with a change in head position (lying down, rolling over in bed, bending over, looking up)
- Latency of symptoms – occur 2-3 sec following head movement
- It is possible to have 2 separate incidences of vertigo/nystagmus during the Dix-Hallpike Test
- Symptoms fatigue with repeated movement into the provoking positions

Cupulolithiasis

- Debris (otoconia) is adhered to the cupula
- Will continue to stimulate cupula as long as the individual is in provocative position

Subjective Evaluation

- The "Dizzy" History can be really difficult for patients to quantify
- Important to note:
  - Onset/Circumstance
  - Quality/Intensity
  - Tempo/Temporal pattern
  - Associated symptoms
  - Contributing factors

"Dizziness"

- Non-specific term, needs to be defined

Vertigo: any sensation of movement when movement is NOT occurring
- Pathophysiology: central or peripheral insult that causes asymmetrical neural activity
- Labyrinth through pons and posterior cerebellum
- Unlikely a lesion above pons or anterior cerebellum

Unsteadiness: general or actual ataxia and possible falls
- Labyrinth disorder without vertigo

Dizziness: anything that is NOT vertigo or unsteadiness
- Light headedness, giddiness

Subjective Assessment

Dizziness Handicap Inventory
- The DHI is a 25 item self-assessment inventory designed to evaluate the self-perceived handicapping effects imposed by dizziness.

Activities-Specific Balance Confidence Scale
- The ABC Scale is a self-report measure of balance confidence in performing various activities without losing balance or experiencing a sense of unsteadiness.

Examination

Seated Vertebrobasilar Artery Screen

- Signs and symptoms of Vertebral Artery Involvement:

1. Dizziness, lightheadedness, nausea, giddiness, tinnitus, headache, blurred vision, diplopia, facial or tongue paresthesias. Presenting sign of dissecting Vertebral Artery may be neck pain!
2. Manual Therapy Mantra: Any of these symptoms reported requires further investigation into vertebrobasilar artery insufficiency.

- First look at active/passive cervical range of motion
- Procedure: hold each of the following for 10 seconds:
  - Active range of motion in sitting: extension, rotation each direction: Look for nystagmus and symptoms of VBI insufficiency.

Oculomotor Screen

- Spontaneous Nystagmus
- Smooth Pursuits
- Gaze-Evoked Nystagmus
- Saccadic Eye movements
- Vestibular-Ocular Reflex (VOR)
- VOR cancellation
- Head Impulse Test
- Dynamic Visual Acuity Test

Video of Vertebrobasilar artery screen and Oculomotor screen



Evaluation of BPPV

- Posterior Canal/Anterior Canal
- Horizontal Canals

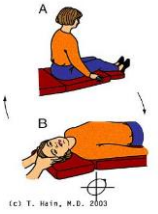
Posterior Canal involvement

- 85 - 95% of cases
- Up-beating ipsitorsional nystagmus
- Typically short duration
- Bending down, looking up, getting in/out of bed
- Stimulation of the Posterior Canal → Slow Downward and Contratorsional eye movement due to stimulation of the VOR
- After that slow Downward and Contratorsional eye movement, the eye must reset itself… and generates:
- UPWARD and IPSITORSIONAL fast phase
- Nystagmus is named for the fast phase
- Posterior Canal BPPV → Upward and Ipsitorsional Nystagmus

Positional Testing for Posterior Canal BPPV

Goal – To place the canal of interest in its most provocative position to induce movement of the otoconia within the canal

Dix-Hallpike Test: The gold standard test position for the Posterior Canal



Dix-Hallpike Test

- Patient begins in long sitting
- Head is rotated 45° TOWARDS the side being tested
- Patient is assisted to supine with neck extended 20-30°beyond horizon
- Hold position x 30-60 seconds
- Observe eyes for nystagmus
- Reliability: **Excellent** inter-rater reliability
- (Kappa = 0.92; 95% CI: 0.87-0.98)
- (Burston et al 2012)
- Highly Recommended for assessment of BPPV (V-EDGE 2013)

Canalithiasis vs Cupulolithiasis

- Duration of the nystagmus will guide you
  - Short Duration (~<60 seconds) = Canalithiasis
  - Long Duration (>60 seconds) = Cupulolithiasis
- Determining canalithiasis vs. cupulolithiasis will guide your treatment

Posterior Canal BPPV

- Positional Test: Dix-Hallpike
- Positive Test: Upbeating, Ipsitorsional Nystagmus
- Duration of nystagmus/symptoms will tell you canalithiasis vs cupulolithiasis
- Short duration – canalithiasis
- Long duration – cupulolithiasis

Canal	Right Dix-Hallpike	Left Dix-Hallpike
Posterior	Up-beating, right torsional	Up-beating, left torsional

Video of Posterior canal nystagmus

https://www.youtube.com/watch?v=jrp8iPfvP4Y

Modifications to Test Positions

- Factors that can influence test:
  - C-spine: pain, ROM restrictions, HALO
  - Lumbar pain
- Test relies on the position of the inner ear in space
- Can modify test position in any manner to assess inner ear
- Side-lying position, tilt table, elevate table, hospital bed (Trendelenberg)

Side-lying Test Maneuver

- This is an alternative to the Dix-Hallpike test.
- The patient begins seated at side of an examination table. The head is turned 45 degrees away from side being tested to align the posterior semicircular canals with the plane of movement; patient is quickly laid onto the table onto the side being tested. The clinician observes the patient's eyes for one minute.

BPPV- Anterior Canal

- Stimulation of the Anterior Canal → Slow Upward and Contratorsional eye movement due to stimulation of the VOR
- After that slow Upward and Contratorsional eye movement, the eye must reset itself… and generates:
- DOWNWARD and IPSITORSIONAL fast phase
- Nystagmus is named for the fast phase
- Anterior Canal BPPV → Downward and Ipsitorsional Nystagmus

Positional Testing for Anterior Canal

- Anterior canals on both sides are provoked with Dix-Hallpike
- The direction of the torsional component of the nystagmus will tell you the side of involvement
- Torsion can be difficult to visualize in anterior canal

Anterior Canal BPPV

- Positional Test: Dix-Hallpike
- Positive Test: Downbeating, Ipsitorsional Nystagmus
- Duration of nystagmus/symptoms will tell you canalithiasis vs cupulolithiasis
- Short duration – canalithiasis
- Long duration – cupulolithiasis

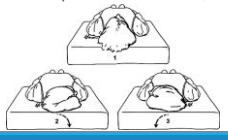
Canal	Right Dix-Hallpike	Left Dix-Hallpike
Anterior	Down-beating, right torsional	Down-beating, left torsional

BPPV – Horizontal Canals

- Horizontal Canals are paired
- Both canals are provoked during head turns
- Right Head turn → Excite R/Inhibit L
- Left Head turn → Excite L/ Inhibit R
- Otoconia in the Horizontal Canal may be displaced with the Dix-Hallpike Maneuver but are not maximally provoked
- Pagnini-McClure maneuver/ "Roll Test" places the Horizontal Canals in most provocative position

Roll Test (Pagnini-McClure)

- Begin with patient supine
- Turn Head to the RIGHT, Hold and Observe for Nystagmus
- Return to Center
- Turn Head to the LEFT, Hold and Observe for Nystagmus



Roll Test Results

- Both Horizontal Canals are provoked during each Roll – challenging to differentiate the involved canal
- Identify the direction of the nystagmus WITH RESPECT TO GRAVITY
- Geotropic - "with gravity"
- Apogeotropic– "against gravity"

Roll Test – Canalithiasis vs Cupulolithiasis

Canalithiasis – Geotropic nystagmus

Right Roll → Right Beating Nystagmus (short duration)

Left Roll → Left Beating Nystagmus (short duration)

Assume involved side is the side that causes MORE symptoms/ stronger nystagmus

Cupulolithiasis – Apogeotropic nystagmus

Right Roll →Left Beating Nystagmus (Long duration)

Left Roll→ Right Beating Nystagmus (Long duration)

Assume involved side is the side that causes FEWER symptoms/ weaker nystagmus

Nomenclature of the Horizontal Canal

- Named for the direction of the nystagmus with respect to gravity
- In Right Roll:
  - Right Beating Nystagmus = Geotropic
  - Left Beating Nystagmus = Apogeotropic
- In Left Roll:
  - Right Beating Nystagmus = Apogeotropic
  - Left Beating Nystagmus = Geotropic

Horizontal Canal – Determining Side of Involvement

- Often times intensity of nystagmus and/or symptoms are similar during R and L rolls
- The Bow and Lean test (Choung's test) was developed to assist with determining side of involvement for horizontal canal BPPV

Video of Lateral canal nystagmus

Reference: https://www.youtube.com/watch?v=5eWcwgbgibM

Bow and Lean Interpretation

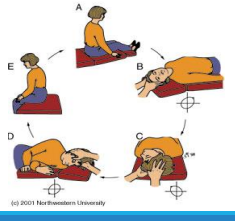
Test	Geotropic direction changing positional nystagmus	Apogeotropic direction changing positional nystagmus
Supine Roll	Side of greater intensity = involved side	Side of lesser intensity = involved side
Bow	Nystagmus in direction of involved side	Nystagmus in direction opposite of involved side
Lean	Nystagmus in direction opposite of involved side	Nystagmus in direction of involved side

Treatment options

Posterior/Anterior Canal
- Canalithiasis - Modified Epley
- Cupulolithiasis – Semont

Horizontal Canal
- Canalithiasis
  - Lempert Roll (BBQ Roll)
  - Gufoni maneuver for geotropic nystagmus
- Cupulolithiasis
  - Gufoni maneuver for apogeotropic nystagmus
  - Rapid Head Shaking

Modified Epley Maneuver



Modified Epley Maneuver (Part 1)

- Begin Long sitting
- Rotate Head 45 deg to INVOLVED SIDE
- Assist patient into supine head-hanging position with 20-30 deg extension
- Maintain this position for duration of symptoms PLUS additional 30 seconds

Modified Epley Maneuver (Part 2)

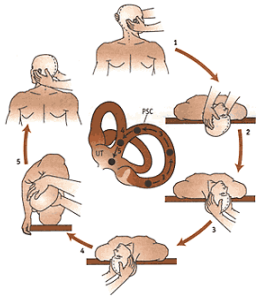
- Turn Head 45 deg cervical rotation to UNINVOLVED SIDE while maintaining Cervical extension
- Maintain this position for duration of symptoms PLUS additional 30 seconds

Modified Epley Maneuver (Part 3)

- Assist the patient to roll onto the UNINVOLVED side with chin tucked into shoulder and nose directed toward the floor
- Maintain this position for duration of symptoms PLUS additional 30 seconds

Modified Epley Maneuver (Part 4)

- While maintaining cervical rotation, assist patient back to seated position
- The patient may become very symptomatic during this movement, be near patient and able to guard them

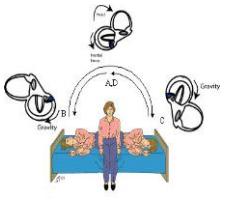


Criteria for a successful Canal Repositioning Maneuver

- A 180°turn of the head is required to effectively clear the debris (positions 2 and 3) (Rajguru, Ifediba et al., 2004).
- The head must be slightly elevated from the supporting surface in position 3 and the patient must return to sitting from lying on the uninvolved side to prevent canal conversion to the AC. (Rajguru, Ifediba et al., 2004).
- Each position must be held a minimum of 30 seconds to allow particles to settle (Hain et al, 2004).

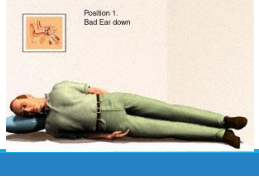
Semont Maneuver – Posterior Canal

- Begin with C-spine rotated 45 deg AWAY from involved side
- Lower patient into side lying position on involved side with C-spine extended – Hold 1-2 minutes
- Rapidly Bring patient to opposite side of mat table while maintaining C-spine rotation Rapid rotation… Rapid deceleration at end point
- Maintain this position for 2 minutes



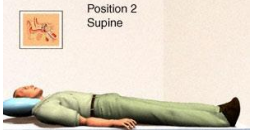
Lemperts Roll (BBQ Roll Part 1)

- Begin with Head Rotation TOWARD involved ear
- Maintain this position for duration of symptoms PLUS additional 30 seconds



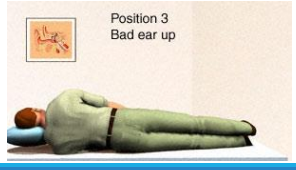
Lemperts Roll (BBQ Roll Part 2)

- Roll to supine position
- Maintain this position for duration of symptoms PLUS additional 30 seconds



Lemperts Roll (BBQ Roll Part 3)

- Roll Patient toward UNINVOLVED ear
- Maintain this position for duration of symptoms PLUS additional 30 seconds



Lemperts Roll (BBQ Roll Part 4)

- Assist patient to roll into prone position, may prop onto elbows keeping C-spine tucked
- Maintain this position for duration of symptoms PLUS additional 30 seconds



Lemperts Roll (BBQ Roll Part 5)

Can assist patient to seated position directly from the nose-down position, or complete a final roll back to the start position and then return to sit

Gufoni Maneuver for geotropic nystagmus

- The patient is taken from the sitting position to the straight side lying position on the **UNAFFECTED** side for about 30 seconds
- Then the patient's head is quickly turned toward the ground 45-60 degrees and held in this position for 1-2 minutes
- The patient then sits up again with the head held toward the downward shoulder until fully upright and then may be straightened

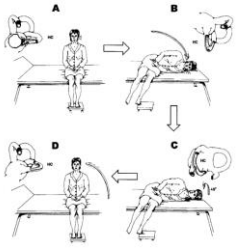
Gufoni Maneuver for apogeotropic nystagmus (variation 1)

- The patient is taken from the sitting position to the straight side lying position on the **AFFECTED** side for about 30 seconds
- The patient's head is then quickly turned toward the ground 45-60 degrees and held in position for 1-2 minutes, which would free the debris from the utricle side of the cupula
- The patient then sits up again with the head held toward the downward shoulder until fully upright, and then may be straightened

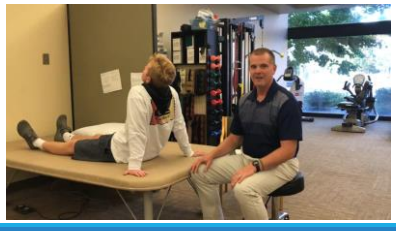
Gufoni Maneuver for apogeotropic nystagmus (variation 2)

- The patient is taken from the sitting position to the straight side lying position on the **AFFECTED** side for about 30 seconds
- The patient's head is then quickly turned away from the ground 45-60 degrees and held in position for 1-2 minutes, which would free the debris from the canal side of the cupula (or from being lodged in the anterior arm of the lateral semicircular canal)
- The patient then sits up again with the head held toward the upward shoulder until fully upright, and then may be straightened

Gufoni Maneuver



Video of Testing/Treatments



Rapid Head Shaking

- Patient begins seated at edge of mat table
- Head is rapidly shaken (Left – Right) for 30-60 seconds
- Goal is to displace otoconia from cupula

Treatment Considerations

- Vibration
- Repeat Maneuvers during session
- Treatment position modifications
- Post Treatment Precautions

Conservative Post-Treatment Precautions

- Sleep 45 degrees from horizontal (2-7 days)
- Avoid bending/ tipping head
- Cervical Collar
- Considerations: yoga, sleep position, etc.

- The latest research states that you do not generally need to give any post-treatment precautions

BPPV Recurrence

- Hain, 2000
- 25% experience recurrence within one year
- 44% experience recurrence within two years
- Teach self-CRM?

Subjective BPPV

- Balatsouras 2012 – subjective reports of BPPV with negative positional testing respond to treatment with Canal Repositioning maneuvers

Questions?



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Bibliography

1. Bhattacharyya, N et al. Clinical practice guideline: Benign paroxysmal positional vertigo (Update): Otolaryngology-Head and Neck Surgery 2017; Vol. 156 S1-S47.
2. Fife, T et al. Practice Parameter: Therapies for benign paroxysmal positional vertigo (an evidence-based review): Neurology 2008; 70: 2017.
3. Moore, B. Clinical decision-making to address poor outcomes in persistent horizontal semicircular canal benign paroxysmal positional vertigo: a case study: Physiotherapy Theory and Practice May 2017: 33(5) 429-438.
4. Rethorn, Z et al. Differential Diagnosis of a patient referred to physical therapy for dizziness: a case report: Physiotherapy Theory and Practice March 2017. 33(3) 254-259.

Bibliography Continued

5. Jung, J et al. Comparison between objective and subjective benign paroxysmal positional vertigo: clinical features and outcomes: Acta Oto-Laryngologica December 2016. 136(12), 1267-1272.

6. Hilton, M and Pinder, D. The Epley maneuver for benign paroxysmal positional vertigo: Cochrane Database of Systematic Reviews 2015 Issue one.

7. Helminski, J. Effectiveness of the Canalith Repositioning Procedure in the Treatment of Benign Paroxysmal Positional Vertigo: Physical Therapy 2014, Volume 94, Number 10.

8. Califano, L et al. Anterior canal BPPV and apogeotropic posterior canal BPPV: two rare forms of vertical canalithiasis: Acta Othorinolaryngol Ital 2014; 34: 189-197.

Bibliography continued

9. Foster, C et al. Canal Conversion and Reentry: A Risk of Dix- Hallpike During Canalith Repositioning Procedures: Otology and Neurology 2011.

10. Casani, A et al. Horizontal Semicircular Canal Benign Paroxysmal Positional Vertigo: Effectiveness of Two Different Methods of Treatment: Audiology and Neurology 2011; 16: 175-184.

11. Balatsouras, D et al. Subjective Benign Paroxysmal Vertigo: Otolaryngology-Head and Neck Surgery 2011.

12. Kerber K. and Helmchen, C. Benign Paroxysmal Positional Vertigo, New opportunities but still old challenges: Neurology 2012; 78:1.