A Practical Approach to Assessment and Treatment of Benign Paroxysmal Positional Vertigo

Combining research and Clinical Practice

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Workshop Objectives

• Analyze normal and abnormal anatomy and physiology of the vestibular system
• Recognize signs and symptoms of BPPV and confidentially identify variants of BPPV
• Explain physiologic rationale of test procedures and results of various test for BPPV
• Utilize results of clinical examination to develop treatment plans
• Be able to identify treatment procedure
Overview

• In the USA, 1.7 million people sustain a TBI each year
• 30% and 65% of people with TBI suffer from some form of dizziness and/or have balance problems at some point during their recovery
• 28% of individuals with head trauma have BPPV
• A smaller study, of 69 patients with chronic BPPV, found a history of head or neck trauma in 81% of the cohort

Pisani et al, 2015
Iglebekk W, 2017
Definitions

• Vertigo
• Disequilibrium
• Presyncope
• Floating or rocking sensation
• Light headedness

?? DIZZY??
Anatomy and Physiology

• 3 Components
  – Peripheral sensory Apparatus
    • Motion sensors
  – Central processor
    • Vestibular nuclear complex and Cerebellum
  – Motor output
    • To ocular muscles and spinal cord
Peripheral Sensory Apparatus [Motion Sensors]

Three Semicircular Canals
  Lateral, Anterior (superior) and posterior

Two Otolith Organs
  Utricle
  Saccule
• Lateral Canal: Angled at 30°
• Anterior and Posterior canals: Oriented vertically
• Canals work in Complimentary pairs

Peripheral Sensory Apparatus

- Bony labyrinth
- Membranous Labyrinth
- **Perilymph**: Fluid between Bone and Membrane
- **Endolymph**: Fluid within membrane

(Hardy M: *Anat Rec* 59:403-418)
**Ampulla**

**Crista:** Sensory epithelium houses hair cells (Stereocillia)
Longest hair cells is called **Kinocilium**

**Cupula:** Is gelatinous mass that bridges the width of ampulla
Lateral Canal Physiology

**Head Rotation to Left** will cause the endolymph in left lateral canal to lag and pushes cupula in amullofugal direction. Which in turn causes excitatory impulse to the vestibular nerve on that side.

*Correlates with speed/amplitude of movement*
Central connections of the Vestibular System

Vestibular Afferents
• Vestibular Nucleus (4 nuclei)
• Cerebellum

From Vestibular nucleus
• Extra ocular motor neurons
• Spinal cord motor neurons
Cerebellum
Flocculonuclear lobe
Vestibular Nuclei
Cerebral cortex
Thalamus
Hypothalamus
Limbic system
Ocular muscles (III, IV and VI)
MLF
M and L vestibulo spinal tracts
Spinal Cord
Cervical Proprioception
Vestibulo Ocular Reflex (VOR)

• Produces compensatory eye movement in response to head movement in a given plane
• Helps maintain stable vision during head movement
• Angular VOR- Semicircular canals (rotation)
• Linear VOR-Otoliths (Translations)
• Head turn to L cupula deflects to R
  L tonic firing increases. These changes are transmitted via vestibular nerve.
Eye Muscles

- Medial rectus - Adducts eye
- Lateral rectus – Abducts eye
- Superior rectus - raises eye
- Inferior rectus - lowers eye
- Superior oblique - intorsion
- Inferior oblique - extorsion

- Single pair of canal connected to single pair of ocular muscles.
Vestibular System Dysfunction

Peripheral

Central

Mixed/ other
## Vestibular System Dysfunction

<table>
<thead>
<tr>
<th>Peripheral</th>
<th>Central</th>
<th>Mixed/ other</th>
</tr>
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<tbody>
<tr>
<td>• Reduced Function</td>
<td>• Traumatic Brain injury</td>
<td>• Cervicogenic</td>
</tr>
<tr>
<td>• Fluctuating Function</td>
<td>• Stroke</td>
<td>• Panic disorder</td>
</tr>
<tr>
<td>• Distorted Function (BPPV)</td>
<td>• Multiple Sclerosis</td>
<td>• Anxiety</td>
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Benign Paroxysmal Positional Vertigo (BPPV)

• Due to mechanical malfunction of the peripheral receptors
• Brief episodes of vertigo generated with change in position of head in relation to gravity

• After a period of several attacks, symptoms can become more prolonged, including dizziness and nausea lasting for hours or days.
Benign Paroxysmal Positional Vertigo (BPPV)

• 28% of individuals with head trauma have BPPV
• A smaller study, of 69 patients with chronic BPPV, found a history of head or neck trauma in 81% of the cohort
• Prevalence of post-traumatic BPPV is independent of sex
• Incidence of multi-canal involvement and/or Bilateral canal involvement is higher in individuals with BPPV associated with head trauma
BPPV- Physiology

• Degeneration of the utricular macula is strongly implicated as the cause of BPPV

• Otoconia becomes dislodged and settles into the canals
BPPV Physiology

Canalithiasis
- Original position of the cupula
- Sinking otoconia cause hydrodynamic drag

Cupulolithiasis
- Heavier otoconia act as a weight on the cupula
BPPV physiology

- **Canalithiasis**
  - Detached otoconia
  - Delay in onset of symptoms (latency –typically 5-20sec)
  - Nystagmus fatigues (crescendo-decrescendo)
  - Lateral canal- Geotropic nystagmus

- **Cupulolithiasis**
  - Otoconia adherent to cupula
  - Immediate onset of symptoms
  - Nystagmus persists
  - Lateral canal- Apogeotropic nystagmus

BPPV of Vertical Canals

Dix hallpike Test (DHT)
Sidelying Test

Canalith Repositioning Maneuver (CRM/ Epley’s)
(Canalithiasis)
Liberatory Maneuver (Semonts Maneuver)
(Canalithiasis and Cupulolithiasis)
Dix Hallpike Test

• Dix-Hallpike test continues to be the “gold standard” test for diagnosing posterior canal BPPV

• Sensitivity of Dix-Hallpike test
  – Sensitivity 79%
  – Specificity 75%
Dix-Hallpike Test (DHT)

• Start patient positioned in a long sitting position
• Next the examiner rotates the head 45 degrees to the side they are testing
• The patient is quickly moved into a supine position with the neck extended 20 degrees beyond the horizontal plane.
• While in this position look for subjective complain of vertigo and/or objective finding of nystagmus
• Finally the person is returned to the long sitting position and the other side is tested
Dix-Hallpike Test (DHT)
Dix Hallpike Test

• The diagnostic criteria for BPPV – Canalithiasis are:
  – Vertigo associated with a characteristic mixed torsional and vertical nystagmus provoked by the Dix-Hallpike test
  – A *latency* between completion of the Dix-Hallpike test and the onset of vertigo and nystagmus
  – Paroxysmal nature of the provoked vertigo and nystagmus
  – *Fatigability* of nystagmus
Dix Hallpike Test

• The diagnostic criteria for BPPV – Cupulolithiasis are:
  – Vertigo associated with a characteristic mixed torsional and vertical nystagmus provoked by the Dix-Hallpike test
  – *No latency* between completion of the Dix-Hallpike test and the onset of vertigo and nystagmus
  – Paroxysmal nature of the provoked vertigo and nystagmus
  – *Persistence* of symptoms and nystagmus
Patient Education

• They should keep their eyes open
• They may experience vertigo
• The must **REMAIN** in the test position until the vertigo has stopped
• If convenient demonstrate the maneuver
Dix – Hallpike Test

• Precautions and Contraindications
  – Cervical stenosis
  – severe kyphoscoliosis
  – limited cervical range of motion
  – Down syndrome
  – severe rheumatoid arthritis
  – cervical radiculopathies
  – Paget’s disease
  – Ankylosing spondylitis
  – Low back dysfunction
  – Spinal cord injuries
  – morbid obesity
Sidelying test

The subject’s head is turned with the nose pointing 45° away from the side to be tested. Then, the subject is briskly laid on the side being tested.
## Diagnosing Vertical Canal BPPV

<table>
<thead>
<tr>
<th>Canal</th>
<th>Position</th>
<th>Direction of nystagmus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior Canal</td>
<td>DHT</td>
<td>Upbeat, torsional with top pole beating toward the down ear</td>
</tr>
<tr>
<td>Anterior Canal</td>
<td>DHT</td>
<td>Downbeat, torsional (torsional element not always visible)</td>
</tr>
</tbody>
</table>
Benign paroxysmal positional Vertigo

- 41-65% unilateral PC-BPPV
- 5-22% LC BPPV
- 20% multi-canal BPPV
- 17% AC (superior) BPPV
BPPV Treatment

Epley’s Maneuver

• 1992 Epley published his first report on the “Canalith Repositioning Procedure” (CRP).
• Epley postulated that the procedure enabled the otolithic debris to move under the influence of gravity from the posterior semicircular canal into the utricle.
BPPV Treatment

Epley’s Maneuver

1. Premedication (to help with nausea and vomiting)
2. Vibration/shaking with maneuver
3. Post maneuver instructions of keeping upright for up to 48 hours.

We have gotten away from using #1, #2 and #3- so now the new name for the maneuver is Canalith repositioning maneuver (CRM). The maneuver however is the same.
Canalith Repositioning Procedure/ Maneuver (CRP/CRM)

Parnes LS et al. Diagnosis and management of BPPV. CMAJ 2003; 169:681-93
Canalith Repositioning Procedure/ Maneuver (CRP/CRM)

• The patient is placed in the upright position with the head turned 45° toward the affected ear (the ear that was positive on the Dix-Hallpike testing).
• The patient is rapidly laid back to the supine head-hanging 20° position, which is then maintained till patient is symptom free and additional 10-15 sec (this rule stays for all positions).
• Next, the head is turned 90° toward the other (unaffected) side (maintain neck extension)
• Following this, the head is turned a further 90° (usually necessitating the patient’s body to also move from the supine position to the lateral decubitus position) such that the patient’ head is nearly in the facedown position (about 45-50 degrees- note the neck is more in neutral position – *no longer extension*).
• Ask patient to chin tuck towards dependent shoulder. The patient is then brought into the upright sitting position, completing the maneuver.
CRM/ CRP for Right Posterior Canalithiasis
Canalith Repositioning Maneuver (CRM) for left posterior canal-canalithiasis
Liberatory Maneuver (Semont Maneuver)

• Effectiveness 70-90%
  

• Repeated maneuvers are needed to increase efficiency
  (40% after 1st maneuver and 58% with self maneuver)

  Kim JS (2014)
Liberatory Maneuver (Semont Maneuver)

• Start with the patient sitting on a table or flat surface with the head turned away from the affected side.
• Quickly put the patient into the side-lying position, toward the affected side, with the head turned up. Nystagmus will occur shortly after arriving at the side-lying position. Keep the patient in this position until at least 20 seconds after all nystagmus has ceased (some recommend up to 1-2 minutes).
• Quickly move the patient back up and through the sitting position so that he or she is in the opposite side-lying position with the head facing down (head did not turn during the position change). Keep the patient in this position for about 30 seconds (some recommend 2-10 minutes).
• At a normal or slow rate, bring the patient back up to the sitting position.
Liberatory Maneuver (Semont Maneuver)
Liberatory Maneuver (Semont Maneuver)

• Rest time between maneuvers- atleast 45 sec
• Ext angle position 1 ideally 110 degrees (atleast 90)
• Ext angle position 2 ideally 220 degrees (atleast 180)
• Maneuver velocity: ideally 135°/s (i.e., about 0.66s for the 90° movement and about 1.33s for the 180° movement)
BPPV of Lateral Canals

Roll test
Roll Maneuver
(Canalithiasis)
Guffoni Maneuver
(Canalithiasis and Cupulolithiasis)
Supine Roll Test - Lateral Canal Test
## Lateral canal BPPV

<table>
<thead>
<tr>
<th>Intensity of nystagmus</th>
<th>Apogeotropic nystagmus</th>
<th>Geotropic nystagmus</th>
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<tbody>
<tr>
<td>Stronger on left side</td>
<td>Right cupulolithiasis</td>
<td>Left canalithias</td>
</tr>
<tr>
<td>Stronger on right side</td>
<td>Left cupulolithias</td>
<td>Right canalithias</td>
</tr>
</tbody>
</table>

Parnes LS et al. Diagnosis and management of BPPV. CMAJ 2003; 169:681-93.
Canalith Repositioning Procedure/ Maneuver (CRP/CRM) for Lateral Canal- Roll Maneuver
Gufoni maneuver

A

1

2

B

1

2

3

With permission from Dr. Fife Continuum Lifelong Learning

Neurol 2012;18(5):1060–1085
Canalith Repositioning Maneuver (CRM) for right lateral canal-canalithiasis
BPPV of Anterior Canals

Deep Extension Test
Deep extension Maneuver for Anterior canal
(canalithiasis)
Liberatory Maneuver (Semont) for Anterior canal
(Canalithiasis and Cupulolithiasis)
• Orientation of vertical canal planes from sagittal plane with reference to the frontal plane bisecting the skull.
  - AC - 35°
  - PC - 51°

• Axes of rotation orthogonal to canal plane.

(Suzuki, Masukawa, Aoki, Arai, & Ueno. 2010)
Diagnostic criteria for AC-BPPV

Left Dix-Hallpike maneuver is capable of inducing left and right anterior canal BPPV but only left posterior canal BPPV.

Canalith Repositioning Maneuver (CRM) for anterior canal-canalithiasis
Clinical Practice Guideline: Benign Paroxysmal Positional Vertigo (Update)

Neil Bhattacharyya, MD¹, Samuel P. Gubbels, MD², Seth R. Schwartz, MD, MPH³, Jonathan A. Edlow, MD⁴, Hussam El-Kashlan, MD⁵, Terry Fife, MD⁶, Janene M. Holmberg, PT, DPT, NCS⁷, Kathryn Mahoney⁸, Deena B. Hollingsworth, MSN, FNP-BC⁹, Richard Roberts, PhD¹⁰, Michael D. Seidman, MD¹¹, Robert W. Prasaad Steiner, MD, PhD¹², Betty Tsai Do, MD¹³, Courtney C. J. Voelker, MD, PhD¹⁴, Richard W. Waguespack, MD¹⁵, and Maureen D. Corrigan¹⁶
Canalith Repositioning Procedure/ Maneuver (CRP/CRM)

• No specific post maneuver instructions

• Remember- BPPV can recover spontaneously in approximately 20% of patients by 1 month of follow-up and up to 50% at 3 months
OBSERVATION AS INITIAL THERAPY: Clinicians may offer observation with follow-up as initial management for patients with BPPV

- If there are contraindications to performing a CRM
- From history of adverse consequences from previous treatments for BPPV
Atypical BPPV

Subjective BPPV
Type II BPPV
Downbeat Nystagmus with Posterior canal BPPV
Direction and Characteristics of Nystagmus
Suggest Location of Debris Within Canal (Illustrated for Right Ear Involved)

Typical or geotropic PC-BPPV
- Canalithiasis – ampullary arm.
- **Excitatory response of CN VIII**
- Excitation ipsilateral SO and contralateral IR (slow phase component).
- **UB with torsion towards involved ear** – fast phase (red arrows)-ny named for fast phase.

Atypical or apogeotropic PC-BPPV
- Canalithiasis – non-ampullary arm.
- **Inhibitory response of CN VIII**
- Inhibition of ipsilateral IO and contralateral SR (slow phase component).
- **DB with strong torsion towards uninolved ear** – fast phase (blue arrows)

Helinski et al. IVRC 2018. Peripheral downbeat positional nystagmus apogeotropic posterior canal or anterior canal BPPV: a case series. JNPT April 2019
Sitting-up vertigo and trunk retropulsion in patients with benign positional vertigo but without positional nystagmus

Béla Büki¹, László Simon², Sándor Garab², Yunxia W. Lundberg³, Heinz Jünger¹, and Dominik Straumann⁴
Subjective BPPV (sBPPV)

Type 2 BPPV?

(1) Subjective report of short episode of vertigo when bending forward, lying down, sitting up or turning over in bed

(2) Objective: No nystagmus during either Dix–Hallpike positioning or supine roll test to the left and right

(3) A short episode of vertigo during and immediately after sitting up from the a Dix–Hallpike position

Buki et al. 2011
Advances in Treatment of BPPV
Advances in treatment of BPPV

Epley Omniax
BPPV and TBI

• Ahn et al studied the characteristic of BPPV after a TBI
• BPPV after TBI group required significantly increased treatment session than the group with idiopathic BPPV
• Patient with BPPV after TBI were younger and had multi canal involvement compared to the other group
• No difference in the reoccurrence rate between the 2 groups

Brandt Daroff Exercises

- Rotate head 45° to the unaffected side and quickly lie down on the affected side. Remain in position for 30 sec. Or until vertigo stops plus additional 30 seconds
- Repeat to opposite side
- One cycle = once to both sides
- Perform 10-15 cycles, 3 times per day or until symptom free for 2 days
There is NO evidence to suggest that medications are effective as a primary treatment or as a substitute for a repositioning maneuver

Cawthrone-Cooksey and Brandt-Daroff exs are NOT repositioning maneuvers
Case discussion

• 49 year old male with TBI Sept 2017. Patient referred for vestibular rehab. Patient has symptoms of dizziness, lightheadedness and reports occasional spinning. However is unable to distinguish clearly between the three
Case discussion

• Oculomotor exam – non significant

• Postural assessment- mCTSIB- mode sway in Condition II and III. LOB with condition IV in 7 sec

• Positional test
  • DHT to right- negative. Patient reports light headed feeling and reports spinning when sitting up. No nystagmus seen
  • DHT to left- positive. Down beat nystagmus (no torsion) with 3 sec latency and 8 sec duration. After 8 sec the nystagmus changed to upbeat left torsional nystagmus
Case Discussion

• Treatment:??
Thank you for your Attention!
References


Additional reference available on request.