Comprehensive Review of Benign Paroxysmal Positional Vertigo for the Audiologist

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Disclosure: I have no biomedical industry relationships, including no industry-sponsored research projects.

Lecture Outline

- Nystagmus conventions
- Relevant anatomy and physiology
- BPPV by semicircular canal subtype
- Unresolved issues

Learning objectives

- Describe semicircular canal anatomy and how the canal is stimulated.
- List the different nystagmus patterns associated with each semicircular canal variant of BPPV.
- Discuss which eye (ipsilateral or contralateral) is more likely to exhibit torsional nystagmus in posterior canal BPPV? What about for superior canal BPPV?
- Be able to discuss the limitations of relying on strip recordings of nystagmus for diagnosis of BPPV.
- Demonstrate how to perform a particle repositioning maneuver to treat posterior semicircular canal BPPV.
- Describe 3 lateralizing signs to identify the affected ear in horizontal semicircular canal BPPV.

Nystagmus

- Definition = repetitive oscillation of the eyes
- Jerk nystagmus has a slow phase that alternates with a corrective fast phase. It is named after the fast phase.

Nystagmus

right-beating  down-beating  upbeating torsional
How can you improve your ability to detect nystagmus on exam?

**Suppress** the patient’s ability to visually fixate

- Frenzel lenses
- Video-oculography (VOG) goggles

Definitions

**discordant** = disagreeing
- I may use this to describe a scenario where nystagmus seen on video disagrees with the eye movement documented by strip recording.

**disconjugate** = not paired in action
- I may use this to describe nystagmus where the right and left eye movements differ

Videonystagmography (VNG) and Electronystagmography (ENG)

- Neither system can document torsional eye movements on strip recordings.
- VNG has the advantage of allowing the eye movement to be directly viewed. Strip recordings can be inaccurate.
- A binocular VNG system is better than a monocular system as vertical semicircular canal stimulation can manifest with disconjugate nystagmus (ie right and left eye movements may differ).

2-D Videonystagmography (VNG) conventions

General:
- The recording runs left to right.
- 2 channels: H = horizontal; & V = vertical.
- No torsional channel.

Vertical channel:
- Upwards deflection = upwards eye movement
- Down = down.

Horizontal channel:
- Think “people walk upright.” Upward deflection = rightwards eye movement.
- Downward deflection = leftwards eye movement.
Pay attention to the patients’ eyes during static positional and Dix-Hallpike testing.

Do not focus exclusively on the VNG strip recordings as they:
- only provide a graphic representation of nystagmus
- cannot measure torsional component of nystagmus which is present with vertical canal BPPV.

**Semicircular Canals**

Hair cells are oriented to respond to angular acceleration.
- Key structures: ampulla, crista ampullaris, cupula

Angular acceleration causes endolymph movement which deflects cupula → this bends stereocilia on hair cells → canal nerve endings get stimulated

**Endolymph flow and cupular deflection can be characterized as either:**
- **ampullopetal** (towards ampulla)
- **ampullofugal** (away from ampulla; think f=flee)
Stimulation of semicircular canals differs between the horizontal and vertical canals

<table>
<thead>
<tr>
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<th>Excitation</th>
<th>Inhibition</th>
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Vestibulo-Ocular Reflex (VOR)

The VOR generates an automatic slow-phase eye movement equal and opposite to angular acceleration to stabilize vision.

Nystagmus can occur with sustained semicircular canal stimulation due to VOR activation. The slow phase is from the VOR.

Disorders that stimulate a semicircular canal will be interpreted by the brain as angular acceleration in the plane of that canal and cause pathologic nystagmus.

- **Horizontal canal**
  - Head rotated towards that ear
  - VOR: slow phase eye movement in opposite direction
  - Horizontal nystagmus beating towards direction of angular acceleration

- **Superior canal**
  - Head down & rotated towards that ear
  - VOR: slow phase eye movement up and rotated away from the side
  - Downbeating torsional nystagmus

- **Posterior canal**
  - Head up & rotated towards that ear
  - VOR: slow phase eye movement down & rotated away from the side
  - Upbeating torsional nystagmus

Extraocular muscles

- **Rectus** muscles move the globe in a linear direction.
- **Oblique** muscles cause torsion/rotation of the globe.
Excitatory neural connections that give rise to VOR

Benign Paroxysmal Positional Vertigo (BPPV)

Why learn about BPPV?

- Most common cause of dizziness from the ear
  - Overall prevalence = 11-64 per 100,000
  - female:male = ~1.5:1

- Easy to diagnose
  - Classic history: brief spells of rotary vertigo triggered by changes in head position.
  - elderly patients may report vague symptoms

- Readily treatable with particle repositioning maneuvers (PRM)

Did Shakespeare know about BPPV?

“...turn giddy, and be [helped] by backwards turning…”
- Romeo and Juliet (Act I, Scene 2)

References:
Mechanism

Canalithiasis
- Otoconia float freely
- Latency in onset of vertigo & nystagmus
- Nystagmus has crescendo – decrescendo intensity & disappears within 60 seconds.
- common

Cupulolithiasis
- Otoconia adhere to cupula
- Immediate onset of vertigo & nystagmus
- Nystagmus persists as long as patient remains in provoking position (> 60 seconds)
- rare

BPPV by semicircular canal type

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The posterior semicircular canal (PSC) is most commonly affected in BPPV because it is the most dependent (ie lowest) canal.

The nystagmus of PSC BPPV is upbeating torsional

How can we explain this pattern of nystagmus?

Stimulation of canal afferents is interpreted as angular acceleration in the plane of the affected canal.


The nystagmus is disconjugate
Torsion is more evident in ipsilateral eye for PSC BPPV

VNG tracings are often inaccurate when compared to the eye video in PSC BPPV.

- Retrospective case series with chart review of patients diagnosed with PSC BPPV who had VNG testing.
- 3 clinicians (MD, AuD, PT) independently reviewed videos and were blinded to each others interpretation
- 100 videos of PSC BPPV with accompanying VNG tracings included in final analysis
Our VNG system is binocular and defaults to left eye to determine nystagmus trajectory.

There was no association between ear of involvement and tracing accuracy when considered alone or when accounting for globe position.

Epley Maneuver

Works by drawing the otoconia back to the utricle in an ampullofugal direction.

Success rate in randomized controlled trials is 66-89%.

Pay attention to the patient’s eyes during PRM

Some patients may develop a "liberatory" or "secondary" nystagmus during PRM.

During Epley, an ipsitorsional secondary nystagmus may be a favorable sign that suggests ampullofugal mobilization of the otoconia through the PSC.⁹

Semont’s Liberatory Maneuver

Per Cochrane Review (Hilton et al 2014), the Semont maneuver is equally effective as Epley maneuver for treatment of posterior canal BPPV.
Brandt-Daroff Exercises

Unclear mechanism

Not as effective as Epley or Semont maneuver for PSC BPPV.
- A single PRM is >10 times as effective as 1 week of Brandt-Daroff exercises done three times a day.¹

Mastoid oscillation/vibration

- Has primarily been studied in cases of posterior canal BPPV. Most studies do not distinguish between canalithiasis vs cupulolithiasis.
- Cochrane Review (2012) found no added benefit with mastoid oscillation in posterior canal BPPV.

Postmaneuver restrictions do not confer clear benefit

- Many studies differ on the type of postural and/or activity restriction used following repositioning therapy.
- 9 of 11 RCT showed no benefit with postmaneuver restrictions.

Recurrence

Once successfully treated, BPPV often recurs.
- For posterior canal BPPV, the rate of recurrence is ~12% - 15% per year.

A daily routine of either Brandt-Daroff exercises or self-PRM does not affect (1) the time to recurrence, or (2) the rate of recurrence.

Recurrent BPPV often responds to additional repositioning maneuvers.
Surgical Treatment for Refractory BPPV
Semicircular Canal Occlusion

Has been described primarily for refractory posterior semicircular canalithiasis

**Technical goal:**
- Occlude the membranous canal lumen without violating it

**How does it work?**
- Endolymph flow is restricted thereby preventing cupular deflection & stimulation of canal afferents


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Sample Case
Which video depicts correct PRM for left PSC BPPV?

A B

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Any questions on PSC BPPV?

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Horizontal Semicircular Canal BPPV

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These terms have a botanical origin

from Charles Darwin's The Power of Movement in Plants (1869)

The dilemma with horizontal canal BPPV

If nystagmus is present in both the right and left ear down positions, then which ear is affected?

There are several lateralizing signs that can be used to identify the affected side:

1) Nystagmus intensity during supine roll test
2) Sit-to-supine test
3) Pseudo-spontaneous nystagmus

**Lateralizing sign #1**

Compare nystagmus intensity during supine roll test

When nystagmus intensity is the greatest it beats towards the affected side.

With **geotropic** HSC BPPV, the affected ear is undermost when nystagmus intensity is greatest.

With **apogeotropic** variant, the affected ear will be up when nystagmus intensity is the greatest.

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**What is the basis for this lateralizing sign?**

**Ewald’s 2nd Law**

The response to an excitatory stimulus is always more intense than that of an inhibitory stimulus.

- *J.R. Ewald, 1892*

Geotropic HSC BPPV is due to canalithiasis where the otoconial debris resides far away from the ampullated end of the canal.

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**Sample case: What does this patient have?**

Apogeotropic HSC BPPV

Can be due to two possible mechanisms: (1) cupulolithiasis, or (2) canalithiasis, where the otoconia reside close to the ampullated end of the canal.
What do you think is going on with this patient?

**Lateralizing sign #2:**
Sit-to-supine test

When the patient is brought from a seated to supine position, they often develop a horizontal nystagmus which beats...

- **towards** the affected ear in apogeotropic HSC BPPV
- **away** from the affected ear in geotropic HSC BPPV

**Lateralizing sign #3**
Pseudo-spontaneous nystagmus

In a series of 293 pts with HSC BPPV, 76% exhibited a pseudo-spontaneous nystagmus. This beats:

- towards the affected ear in apogeotropic HSC BPPV
- towards healthy ear in geotropic HSC BPPV

It is a pseudo-spontaneous nystagmus b/c it can be extinguished by tilting head forward 30° which brings HSC into neutral plane.

- It's direction can be inverted with bending head forward >30° (B).
- It will be restored back to its initial direction with leaning head backwards (C)

Video of Pseudo-spontaneous nystagmus for right apogeotropic HSC BPPV

Video courtesy of G. Asprella-Libonati, MD

My philosophy for eliciting lateralizing signs for HSC BPPV

To be efficient with my time, I look for the 2 most sensitive lateralizing signs:
1st: Sit-to-supine test, then go straight into the...
2nd: Supine roll test

Treatment of HSC BPPV

The key is to correctly identify the affected side.
Treat with repositioning maneuvers.
- These differ from those used to address PSC BPPV.
- Confusing nomenclature
If patient fails to improve consider other potential causes (central).
Surgery is controversial given the potential to operate on the wrong side.

BBQ Roll for geotropic HSC BPPV

The literature for BBQ roll varies regarding whether this should be a 270° or 360° roll.
For right geotropic HSC BPPV, roll the patient to their left.
Gufoni Manuever for geotropic HSC BPPV

In the sitting position, the otoconial debris is located in the posterior arm of the HSC.

How to do it:
- Bring the patient to a side-lying position on the healthy side. This moves the otoconia posteriorly in the canal.
- Head is rotated to the ground, causing otoconia to fall into the utricle.
- Patient is returned to upright position.

Treatment of left ear is shown. Each position is maintained for 2 min.


Modified Gufoni Maneuver for apogeotropic HSC BPPV

In the sitting position, the otoconial debris is adherent to the cupula or in the anterior portion of the HSC.

How to do it:
- Bring the patient to a side-lying position on the affected side. This moves the otoconia posteriorly in the canal.
- Head is rotated to the ceiling, causing otoconia to move posteriorly through the canal & into the vestibule.
- Patient is returned to upright position.

Treatment of left ear is shown. Positions (b) through (d) are maintained for 2 minutes.


Vannucci-Asprella Maneuver for geotropic or apogeotropic HSC BPPV

Fig. 2. Vannucci-Asprella maneuver for HSC-BPPV. A. Patient lies in supine position. B. Head is slightly turned 90° towards the healthy ear. C. While keeping head turned, patient is returned to the seated position. D. Head is slowly brought back in axial with body. A. Patient is returned to the supine position. This sequence of movements is repeated twice or more, if necessary, as long as no help or vertigo appears.


Sample Case
What happened?

Canal Switch:
A potential complication of repositioning therapy

The risk of converting posterior to horizontal or superior canal BPPV following Epley is 6-16%.


Any questions on HSC BPPV?

Superior Semicircular Canal BPPV

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Can you differentiate the nystagmus of superior vs. posterior canal BPPV?

The torsional component is more pronounced in the contralateral eye in superior canal BPPV

Treatment of Superior Canal BPPV

- No large series exist
- These maneuvers have been described:
  - Epley
  - Yacovino
- If tx of SSC BPPV fails, referral to neurology should be considered to exclude central pathology.

Any questions on SSC BPPV?
BPPV by semicircular canal type

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Posterior canal BPPV may be more complex than we initially thought ...

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<th>Posterior (apogeotropic)</th>
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</tr>
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<tr>
<td>Diagnostic maneuver</td>
<td>Dix-Hallpike</td>
<td>Dix-Hallpike (ipsi- or contra-)</td>
<td>Supine roll test</td>
<td>Head hanging supine or Dix-Hallpike</td>
</tr>
<tr>
<td>Nystagmus pattern</td>
<td>Upbeating torsional rotating towards ear (geotropic)</td>
<td>Downbeating torsional rotating away from ear (apogeotropic)</td>
<td>Horizontal (geotropic vs apogeotropic)</td>
<td>Downbeating (may see torsional towards ear)</td>
</tr>
</tbody>
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Other features of apogeotropic posterior canal BPPV *:
- Nystagmus often last > 2-minutes
- Does not fatigue
- Does not reverse with sitting up.


Apogeotropic Posterior Semicircular Canal BPPV

Background:
- Some patients with presumed superior canal BPPV exhibit nystagmus associated with contralateral posterior canal BPPV following repositioning therapy.

Mechanism:
- Otoconia present in the non-ampullated arm of posterior canal
- Dix-Hallpike position causes ampullopetal migration & triggers an inhibitory nystagmus.

Inhibition of the posterior canal manifests with the same nystagmus as excitation of its co-planar pair (contralateral superior canal):
- Downbeating torsional rotating away from affected ear (apogeotropic)

Repositioning maneuvers for apogeotropic posterior canal BPPV

Quick Liberatory Maneuver demi Semont 45º Forced Prolong Positioning

- Tx for left apoge o PSC BPPV shown.
- Move from a → b in 1-sec, and remain in 45º nose down healthy side for 3-minutes.

Figure source: Califano L, et al. Anterior canal BPPV and apogeotropic posterior canal BPPV: two rare forms of vertical canalithiasis. Acta Oto labyrinthologica Italiana 2014;34:189-197.

Unresolved Issues

Residual Dizziness after successful repositioning maneuvers

Prospective, controlled study:
- control = normal volunteer
- 82 pts with PSC-BPPV, 53 with HSC-BPPV (Apogeo:Geo = 19:34).
- Seen 5-7 days after successful repositioning maneuver

Results:
- Improvement in DHI seen with tx of BPPV, but post-Epley scores do not reach level of controls.

Residual Dizziness (continued)

Prospective cohort study (N=46).
- If RD was present 3 days after successful tx, pts were monitored every 3 days until it resolved.
- 63% had RD. This resolved in 55% by 6 days.

Residual Dizziness after Successful Repositioning Treatment in Patients with Benign Paroxysmal Positional Vertigo

- N = 40 patients
- Mean RD duration: 16 days
I do not authorize use of my slides or lecture handout without my written consent.