# mTBI/Concussion

- Fall related TBI is high in the older population
- Symptoms: lightheadedness exacerbated by head movement and imbalance
- Thompson et al. (2006)
  - In persons aged 65 and older:
    - TBI is responsible for more than 80,000 emergency department each year
  - For the general population nonfatal TBI is 60.6 per 100,000 and for 65+ is 155.9 per 100,000
  - For older adults 51% of TBIs are from falls, 9% are from motor vehicle accidents, 1% from assault, and 21% are unknown causes

# Mild TBI/Concussion

| Physical | Cognitive | Emotional | Sleep |
|---|---|---|---|
| • Headache<br>• Nausea<br>• Vomiting<br>• Balance problems<br>• Dizziness<br>• Visual problems<br>• Fatigue<br>• Sensitivity to light<br>• Sensitivity to noise<br>• Numbness/ Tingling<br>• Dazed or stunned | • Feeling mentally "foggy"<br>• Feeling slowed down<br>• Difficulty concentrating<br>• Difficulty remembering<br>• Forgetful of recent information or conversations<br>• Confused about recent events<br>• Answers questions slowly<br>• Repeats questions | • Irritability<br>• Sadness<br>• More emotional<br>• Nervousness | • Drowsiness<br>• Sleeping less than usual<br>• Sleeping more than usual<br>• Trouble falling asleep |

Heads Up: Facts for Physicians about Mild Traumatic Brain Injury. Center for Disease Control and Prevention.

# Onset

Intermittent

# Benign Paroxysmal Positional Vertigo (BPPV)

- Symptoms:
  - Delayed onset
  - Vertigo
  - Fatigues
  - Lasts less than a minute
- BPPV is the most common otologic disorder seen in elderly patients.
  - Rate 3 times higher for older adults[1]
  - Higher recurrence rates [2,3]
  - Recurrence rate 1.7 times higher for older individuals.[2]
  - Lower effectiveness of the repositioning maneuver[3]

1(Piker & Jacobson, 2014), 2(Kao et al., 2009), 3 (Batuecas-Caletrio et al., 2013)

# Benign Paroxysmal Positional Vertigo (BPPV)

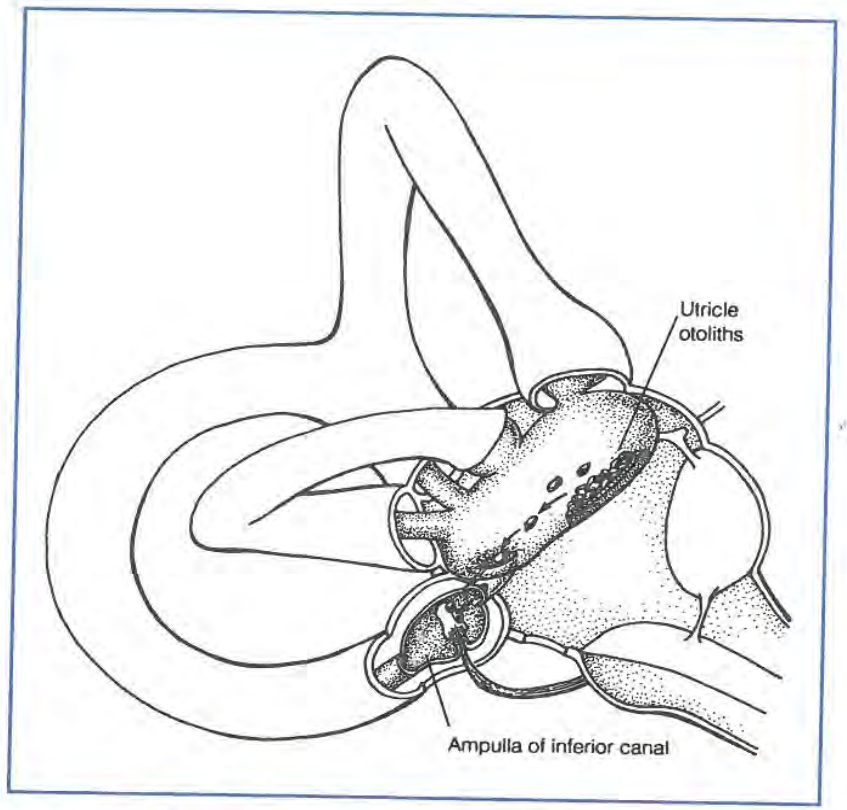



**FIGURE 6–7.** An illustration of cupulolithiasis affecting the posterior semicircular canal. (Courtesy of Daniel Pender, adapted from Pender, 1992)



McCaslin, D. (2013). Electronystagmography and Videonystagmography. Plural Publishing: San Diego, CA. Pg 115

# BPPV and Falls

- Zhang et al. (2021) found that compared to healthy individuals, those with BPPV had a more conservative gait and reduced walking stability
- Abbott et al. (2016) evaluated older adults admitted to the hospital for a fall, they found that 54% positive for BPPV
- Ganança et al. (2010) found that the number of falls reduced post BPPV treatment

# Normal vs. Degenerated Otoconia

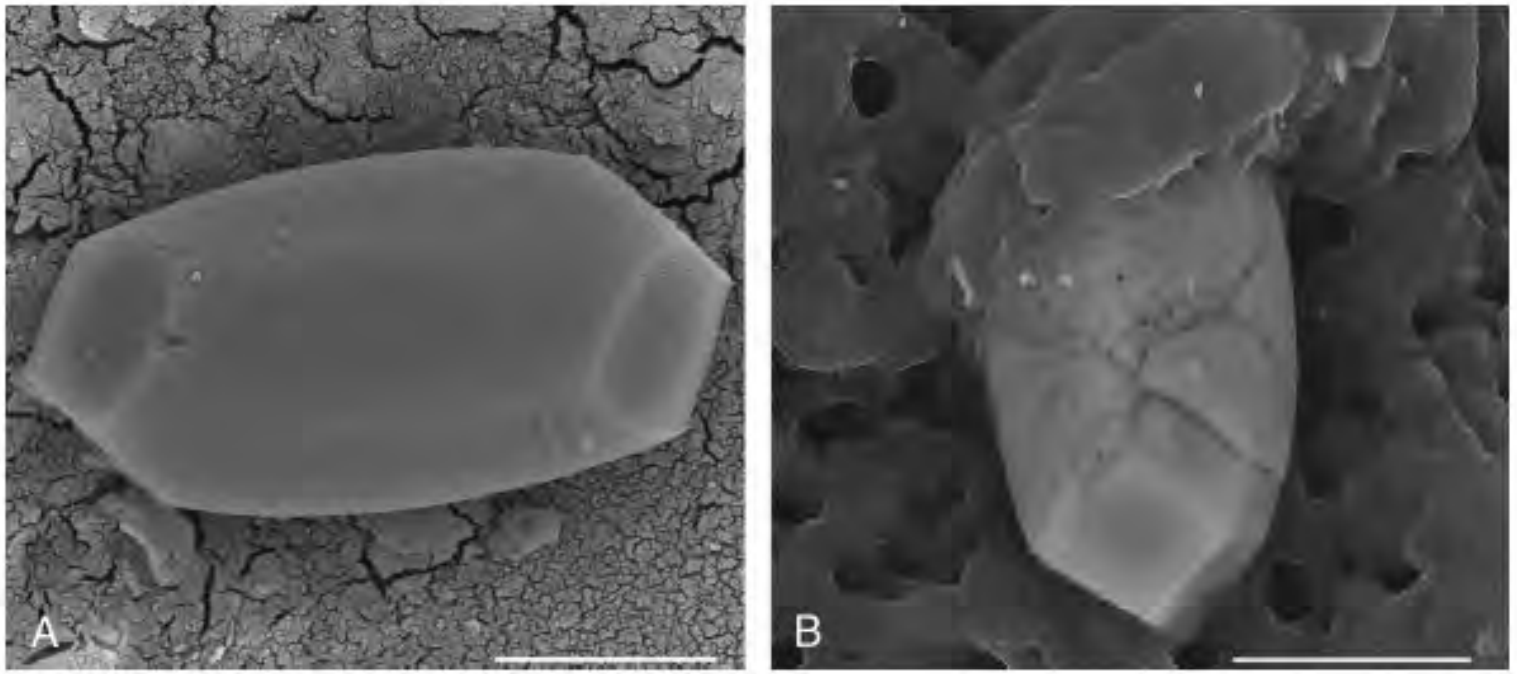



**FIG. 2.** *A*, Single intact vital human otoconium. The more regular surface structures of the rhombohedral faces differ significantly from the surface of the cylindrical body indicating different areas of the composite structures, (ESEM, HV, 15 kV, scale bar = 5 μm). *B*, Vital human otoconium affected by degeneration. Pores are deepened and fissures occur. The belly area is more affected than the rhombohedral faces, (ESEM, HV/Au, 15 kV, scale bar = 5 μm).



Walther, et al (2014)

# Diagnostic Criteria

- **Canalolithiasis of the posterior canal (pc-BPPV)**
- A. Recurrent attacks of positional vertigo or positional dizziness provoked by lying down or turning over in the supine position.
- B. Duration of attacks < 1 min
- C. Positional nystagmus elicited after a latency of one or few seconds by the Dix-Hallpike maneuver or side-lying maneuver (Semont diagnostic maneuver).
  - The nystagmus is a combination of torsional nystagmus with the upper pole of the eyes beating toward the lower ear combined with vertical nystagmus beating upward (toward the forehead) typically lasting < 1 minute.
- D. Not attributable to another disorder.

**Canalolithiasis of the horizontal canal (hc-BPPV)**

A. Recurrent attacks of positional vertigo or positional dizziness provoked by lying down or turning over in the supine position.

B. Duration of attacks < 1 min.

C. Positional nystagmus elicited after a brief latency or no latency by the supine roll test, beating horizontally toward the undermost ear with the head turned to either side (geotropic direction changing nystagmus) and lasting < 1 min.

D. Not attributable to another disorder.

**Cupulolithiasis of the horizontal canal (hc-BPPV-cu)**

A. Recurrent attacks of positional vertigo or positional dizziness provoked by lying down or turning over in the supine position.

B. Positional nystagmus elicited after a brief latency or no latency by the supine roll test, beating horizontally toward the uppermost ear with the head turned to either side (apogeotropic direction changing nystagmus), and lasting > 1 minute.

C. Not attributable to another disorder.

(von Brevern et al., 2015)

## Posterior

Most common- 80-96% of BPPV

Test using Hallpike

Upward torsional nystagmus

## Horizontal

2-16% of BPPV

Tested using Roll test, not Hallpike

Horizontal nystagmus

Often times it is caused by a migration from posterior to horizontal

## Anterior

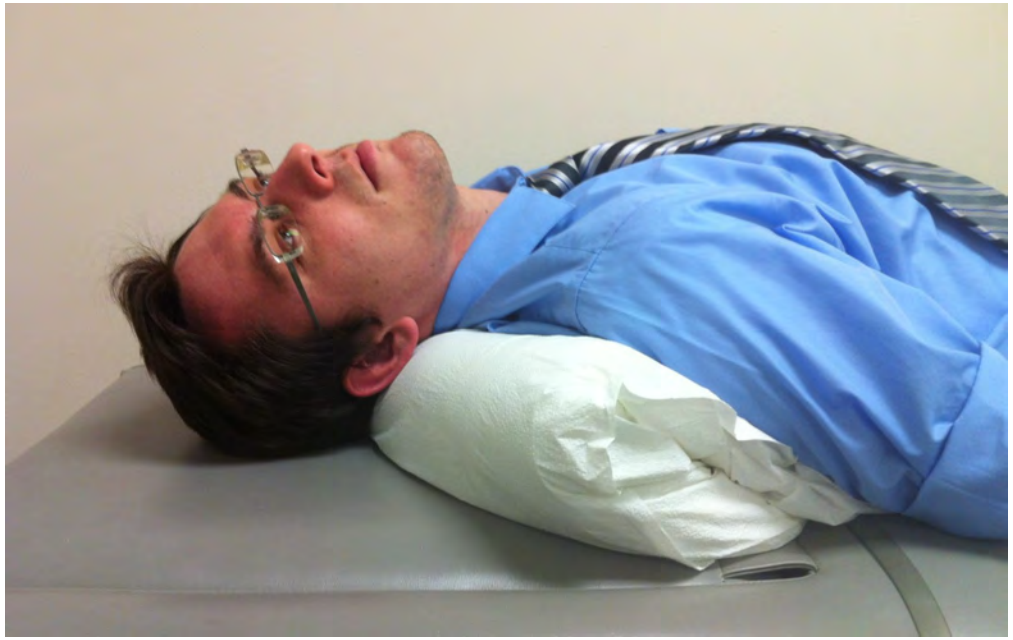
Rare 1-2% of BPPV

Tested using Hallpike

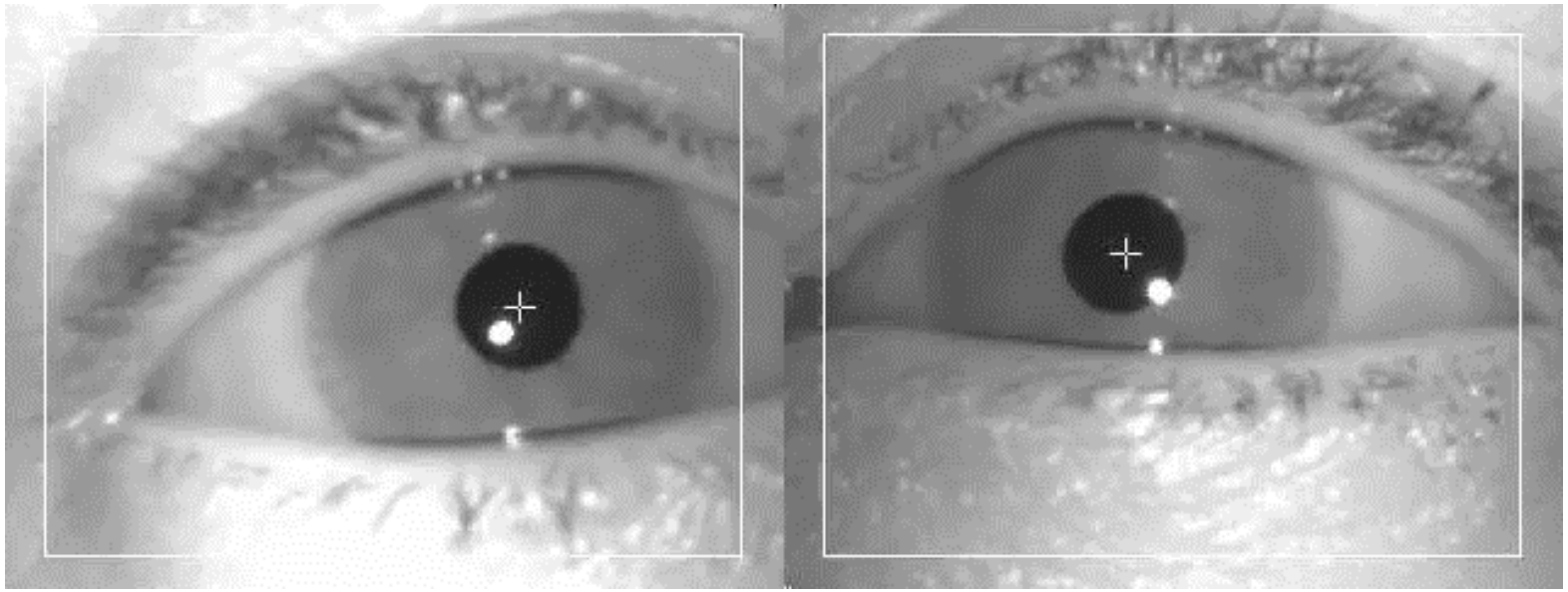
Downward torsional nystagmus (sometimes difficult to see the torsion)

# Fully Supported Hallpike

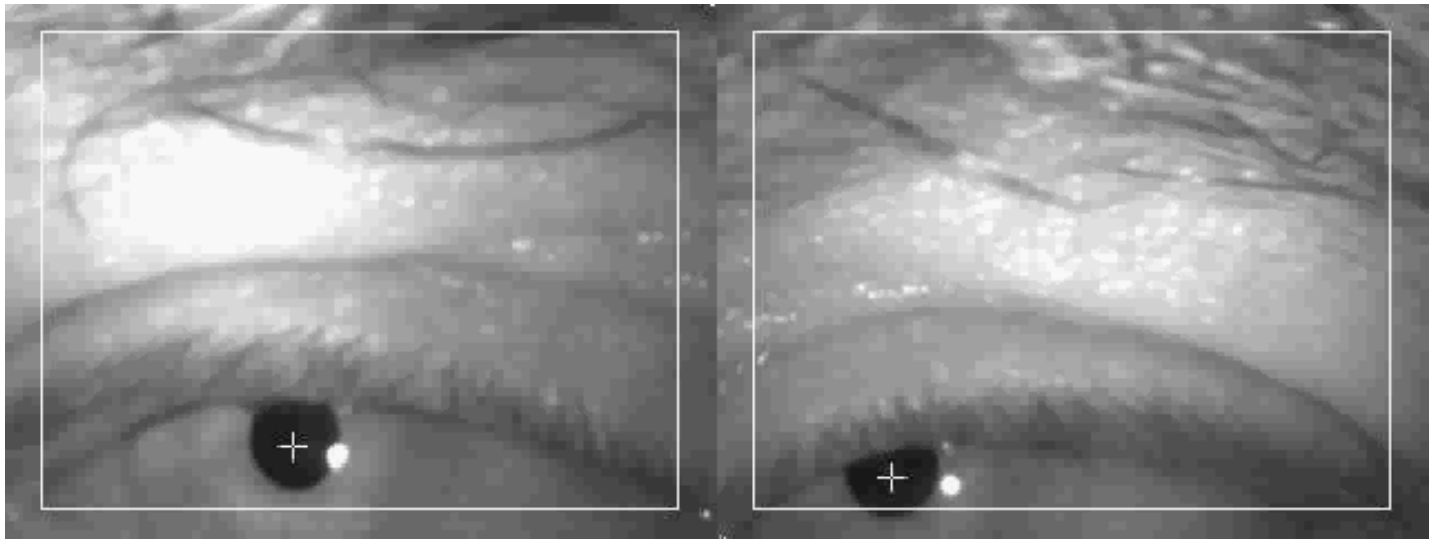
- Do not need to do head hanging
- More supportive to the patient and their neck
- Pinna mimics the PC- top of the pinna is towards the floor

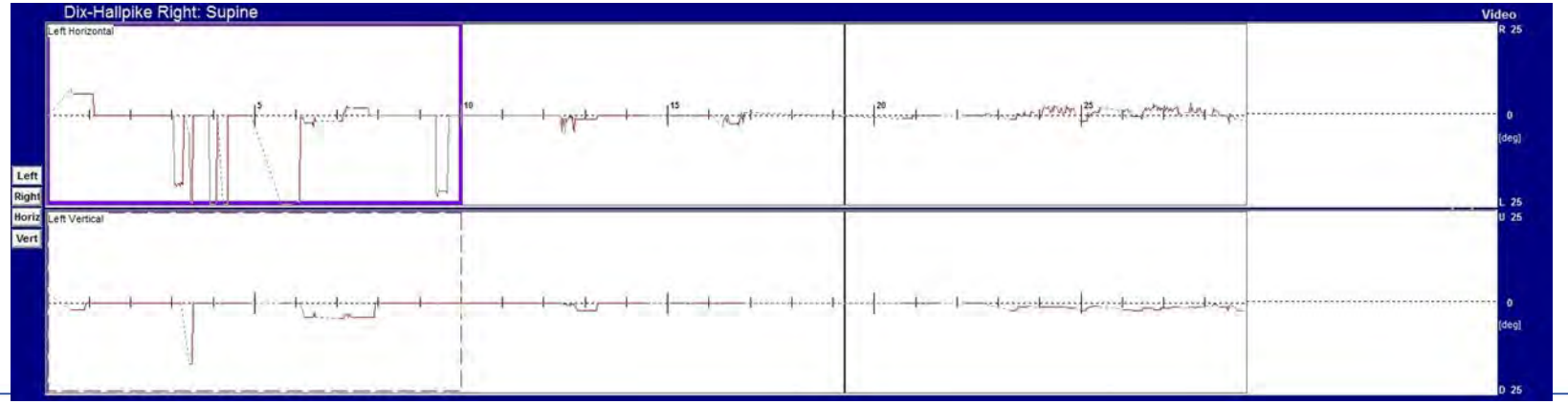


# Posterior Canal-BPPV

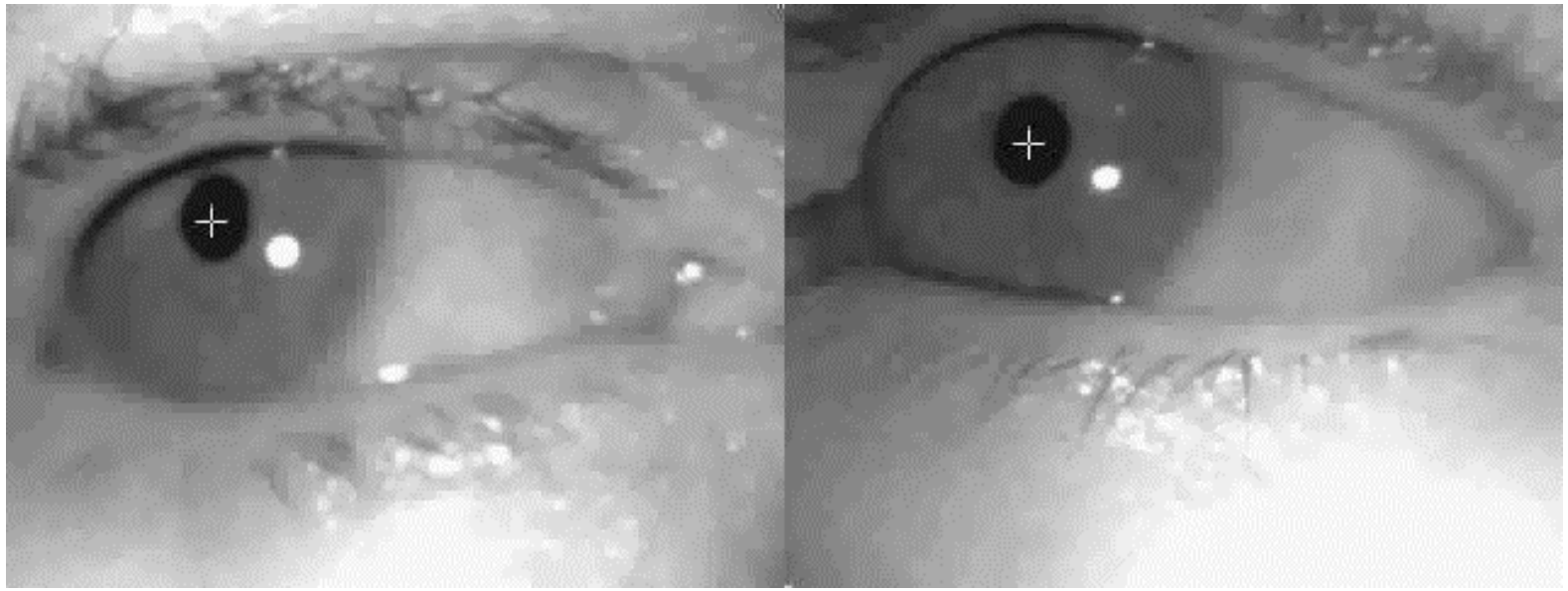


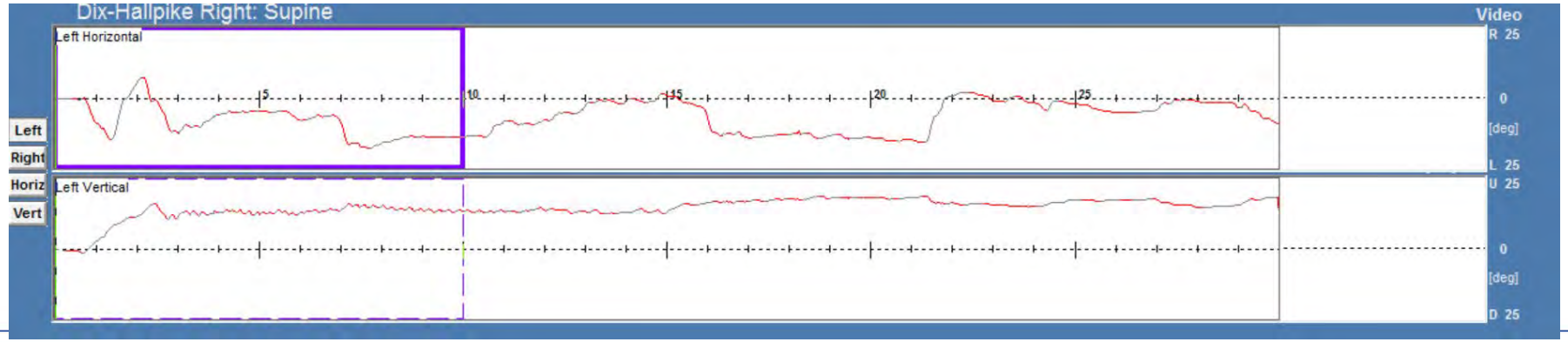
# Pt: Mk right PC-BPPV





# PC-BPPV




Dix-Hallpike Right: Supine
Video
Left Horizontal
Left Vertical
Left
Right
Horiz
Vert
R 25
0
[deg]
L 25
U 25
0
[deg]
D 25

# Treatment of BPPV

| | |
|---|---|
| PC | Epley/Canalith Repositioning Maneuver, Semont Liberatory Maneuver, Gans Repositioning Maneuver |
| HC | Lempert (BBQ or Log Roll), Casani, Gufoni |
| AC | Yacovino maneuver, reverse Epley |

# Calcium and Vitamin D

- There is various literature related to the relationship between calcium and vitamin D levels with patients with BPPV
- A recent meta-analysis by Jeong et al. (2022) reveals there is a benefit of high-dose vitamin D with/without calcium in reducing BPPV

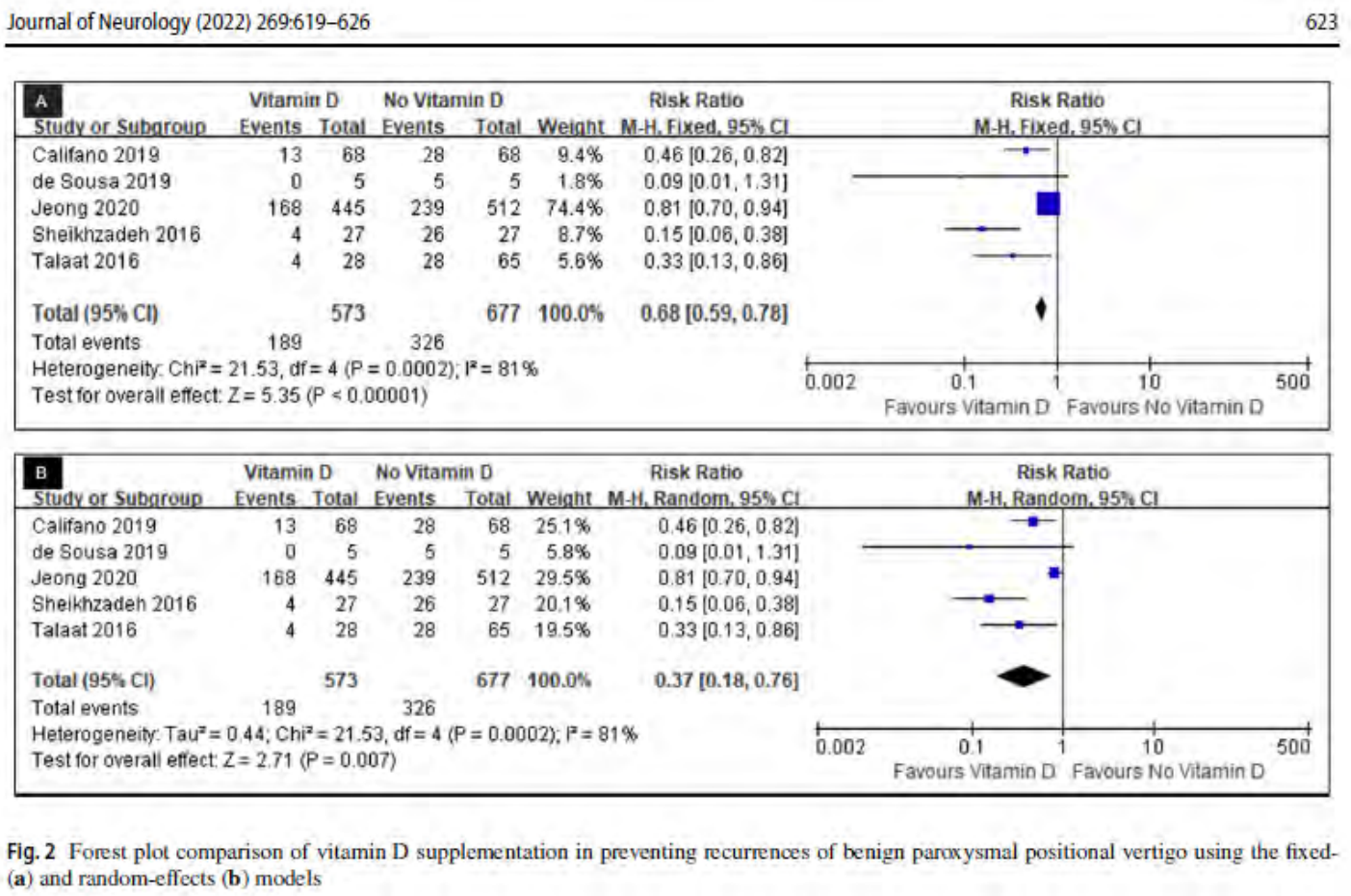
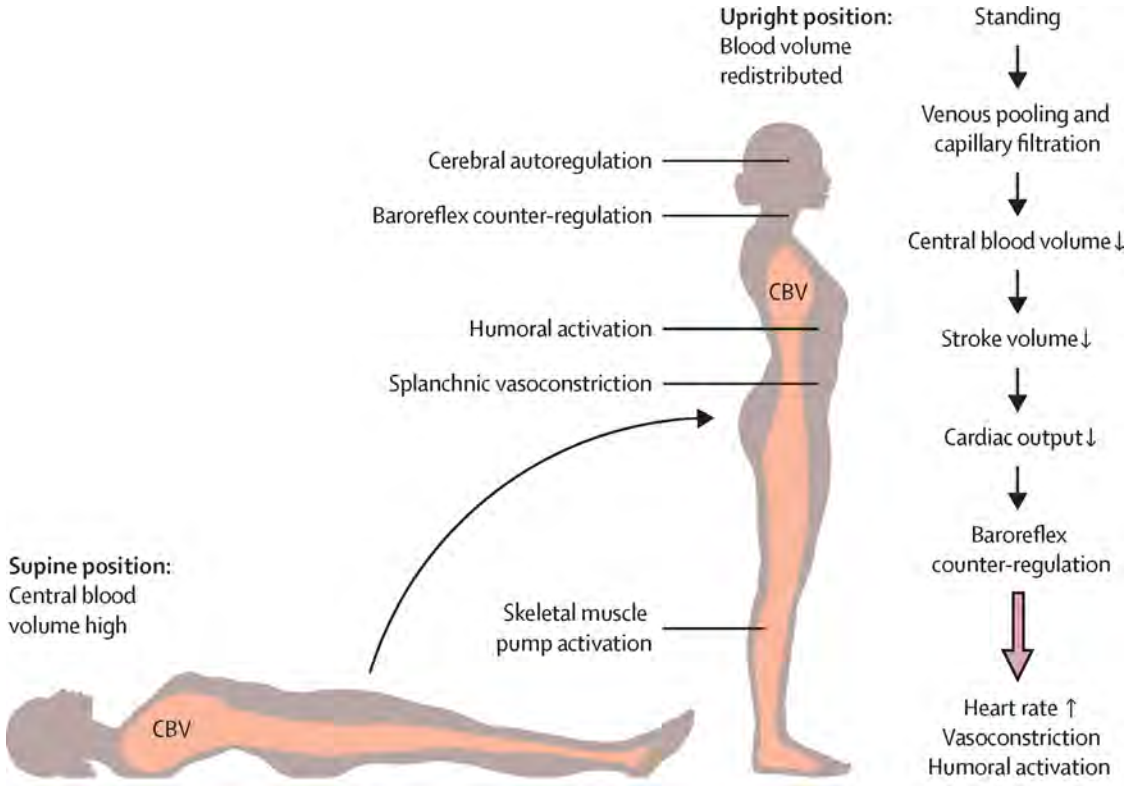



**Fig. 2** Forest plot comparison of vitamin D supplementation in preventing recurrences of benign paroxysmal positional vertigo using the fixed- (**a**) and random-effects (**b**) models

# Orthostatic Hypotension

- Symptoms- short episodes of lightheadedness or vertigo
- Drop in blood pressure that occurs when moving from a laying down (supine) position to a standing (upright) position
- Gravity causes blood to collect in the legs and belly.
  - Blood pressure drops because there's less blood flowing back to the heart.
- Causes: dehydration, heart problems, endocrine problems, nervous system disorders, eating meals
- Risk factors: age, medications, certain diseases, heat exposure, bed rest, alcohol




https://www.thelancet.com/cms/attachment/f395b8d2-b0e6-42b4-831a-894abf3af961/gr1_lrg.jpg

# Hemodynamic Orthostatic Dizziness

- 4.1. Hemodynamic orthostatic dizziness/vertigo
  - Criteria A-C should be fulfilled to make the diagnosis of hemodynamic orthostatic dizziness/vertigo.

A. Five or more episodes of dizziness, unsteadiness or vertigo triggered by arising (i.e. a change of body posture from lying to sitting/standing or sitting to standing), or present during upright position, which subsides by sitting or lying down

B. OH, POTS or syncope documented on standing or during head-up tilt test

C. Not better accounted for by another disease or disorder

- 4.2. Probable hemodynamic orthostatic dizziness/vertigo
  - A. Five or more episodes of dizziness, unsteadiness or vertigo triggered by arising (i.e. a change of body posture from lying to sitting/standing or sitting to standing), or present during upright position, which subsides by sitting or lying down
  - B. At least one of the following accompanying symptoms
  - – generalized weakness or tiredness
  - – difficulty in thinking or concentrating
  - – blurred vision
  - – tachycardia or palpitations
  - C. Not better accounted for by another disease or disorder

(Kim et al., 2019)

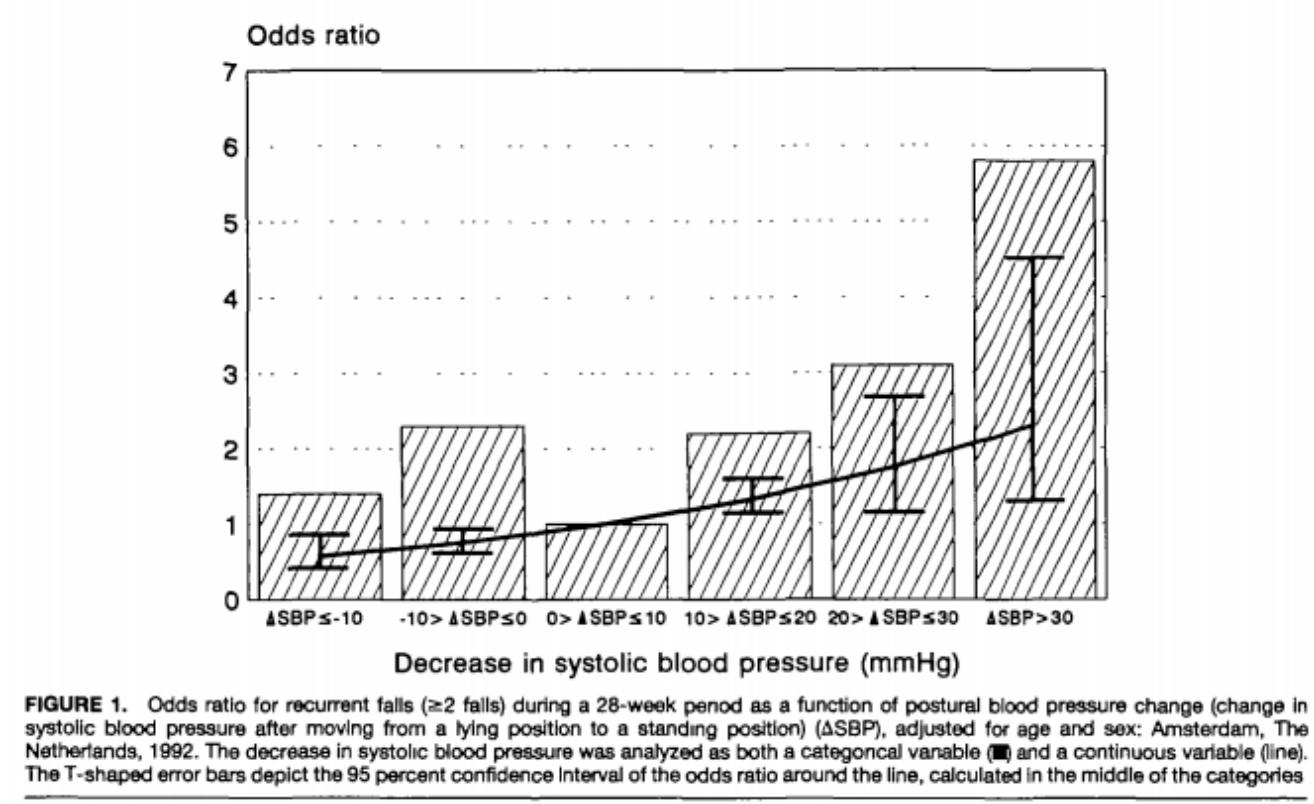



**FIGURE 1.** Odds ratio for recurrent falls (≥2 falls) during a 28-week period as a function of postural blood pressure change (change in systolic blood pressure after moving from a lying position to a standing position) (ΔSBP), adjusted for age and sex: Amsterdam, The Netherlands, 1992. The decrease in systolic blood pressure was analyzed as both a categorical variable (■) and a continuous variable (line). The T-shaped error bars depict the 95 percent confidence interval of the odds ratio around the line, calculated in the middle of the categories

(Graafmans et al., 1996)

# Orthostatic hypotension vs. fall

- Those with OH have had 2.7 times greater risk of an in-hospital fall (Beretta et al., 2023)

# Onset

Gradual/Constant

# Presbyvestibulopathy

- It is estimated that in people 60+  approximately 50% have some form of vestibular physiologic loss (Agrawal et al., 2019).
- This term is meant to include mild or incomplete vestibular losses related to normative aging and consistent with other age-related sensory losses such as presbycusis and presbyopia.
- Other terms: presbyvertigo and disequilibrium of aging

# Presbyvestibulopathy Diagnostic Criteria

- Barany society published their diagnostic criteria (Agrawal et al., 2019)
- Each of the criteria A through D have to be fulfilled
    - A. Chronic vestibular syndrome (at least 3 months duration) with at least 2 of the following symptoms:
        - 1. Postural imbalance or unsteadiness
        - 2. Gait disturbance
        - 3. Chronic dizziness
        - 4. Recurrent falls
    - B. Mild bilateral peripheral vestibular hypofunction documented by at least 1 of the following:
        - 1. VOR gain measured by video-HIT between 0.6 and 0.83 bilaterally
        - 2. VOR gain between 0.1 and 0.3 upon sinusoidal stimulation on a rotatory chair (0.1 Hz, Vmax = 50–60◦/sec)
        - 3. Reduced caloric response (sum of bithermal maximum peak SPV on each side between 6 and 25◦/sec)
    - C. Age ≥ 60 years
    - D. Not better accounted for by another disease or disorder



(Agrawal et al., 2019)

# Presbyvestibulopathy

- Soto-Varela et al. (2020)
  - Most patients with presbyvestibulopathy have a high reported rates of disability via the Dizziness Handicap Inventory
  - This perception is substantially higher in women than in men.
  - The most influential factors are difficulties in walking, fear of falling, and obesity

- Vestibular testing can help verify bilateral weakness
- Bilateral weakness patients at high risk of falls
- Presbyvestibulopathy patients at even high risk of falls
  - Vision, vestibular, somatosensory

# Polypharmacy

- Many definitions depending on the source, but can include:
  - Two or more drugs for 240 days+
  - Concurrent use of two or more drugs
  - Use of four+ medications
  - Use of five+ medications

# Polypharmacy

- Falls are more commonly associated with polypharmacy for older adults
- Symptoms: constant, possibly wax/wane, lightheaded
- Maarsingh et al. (2010): 33% of the dizzy patients used more than 5 drugs
- Dizziness is a common side effect from medications
- Can have an additive effect

**Table 1**
**Medications that often cause dizziness in older adults**

| Class of Medication | Possible Mechanism |
|---|---|
| $\alpha_1$-Adrenergic antagonists | Orthostatic hypotension |
| Alcohol | Hypotension, osmotic effects |
| Aminoglycosides | Ototoxicity |
| Anticonvulsants | Orthostatic hypotension, cerebellar dysfunction |
| Antidepressants | Orthostatic hypotension |
| Anti-Parkinson medication | Orthostatic hypotension |
| Antipsychotics | Orthostatic hypotension |
| β-Blockers | Hypotension or bradycardia |
| Calcium channel blockers | Hypotension, vasodilation |
| Class 1a antiarrhythmics | Torsades de pointes |
| Digitalis glycosides | Hypotension |
| Diuretics | Volume contraction, vasodilation |
| Narcotics | CNS depression, torsades de pointes |
| Oral sulfonylurea | Hypoglycemia |
| Vasodilators | Hypotension, vasodilation |
| Anticoagulants | Bleeding complications |
| Antidementia agents | Bradycardia, syncope |
| Antihistamines: sedating | Torsades de pointes |
| Antirheumatic agents | Vestibular disturbance |
| Anti-infectives: anti-influenza agents, antifungals (oral), quinolones | Torsades de pointes |
| Antithyroid agents | Bone marrow toxicity |
| Anxiolytics | CNS depression |
| Attention-deficit/hyperactivity disorder agents | Cardiac arrhythmias |
| Cholesterol-lowering agents | Hypotension |
| Bronchodilators | Hypotension |
| Skeletal muscle relaxants | Central anticholinergic effects |
| Urinary and gastrointestinal antispasmodics | Central anticholinergic effects |

*Data from* Refs.[19,28,29]



(Shoair et al., 2011)

# Ototoxic medications

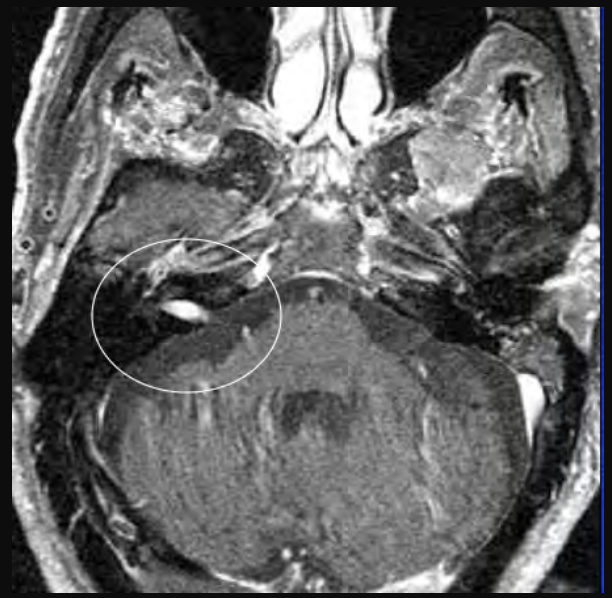
- Can differently attack the end organ- cochleotoxic vs vestibulotoxic
  - Gentamicin – more vestibulotoxic
  - Amikacin- more cochleotoxic
- Generally causes bilateral dysfunction
  - Exception is chemical ablation- Meniere's disease
- Symptoms are more lightheaded than vertigo and unsteadiness

# Ototoxic medications

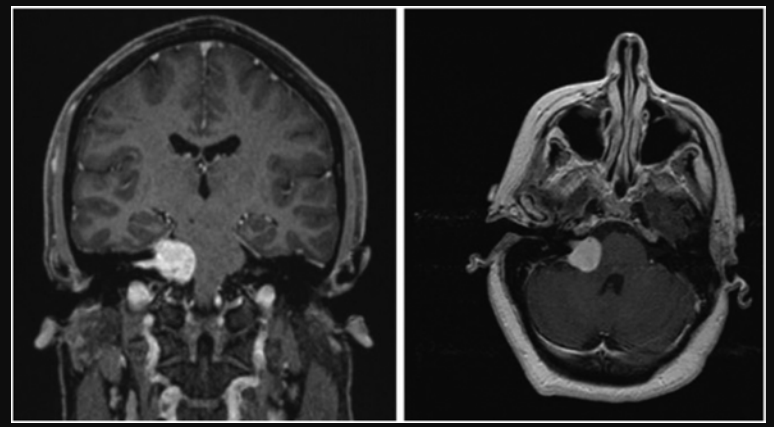
- Aminoglycosides:
  - Amikacin
  - Gentamicin
  - Kanamycin
  - Neomycin
  - Netilmicin
  - Streptomycin
  - Tobramycin
  - Vancomycin
- Chemotherapy
  - Cisplatin
  - Carboplatin
- Loop diuretics
  - Bumetanide
  - Ethacrynic acide
  - Furosemide
  - Torsemide
- Other
  - Quinine
  - Salicylates
  - Environmental chemicals

# Vestibular Schwannoma

- Onset is gradual- lightheaded, vague dizziness
  - Can also report gradual unsteadiness
- Associated with unilateral tinnitus and hearing loss
- Wang et al. (2023)- of 2191 patients, 14% were elderly
  - Older adults reported more gait uncertainty and facial palsy compared to younger adults
- Need:
  - MRI
  - Audiogram
  - Vestibular assessment



https://canadianaudiologist.ca/vestibular-schwannomas-or-acoustic-neuromas-by-another-name/



# Multifactorial Dizziness

- Older adults may have dizziness from several etiologies
- More complex to diagnose
- More complex to treat

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