CLINICAL ASSESSMENT OF EQUILIBRIUM

IFOS-ASEAN ORL-HNS INTERNATIONAL –VSO CONFERENCE AND TRAINING COURSE
6TH-7TH December 2024
Ho Chi Minh City, Vietnam

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EQUILIBRIUM

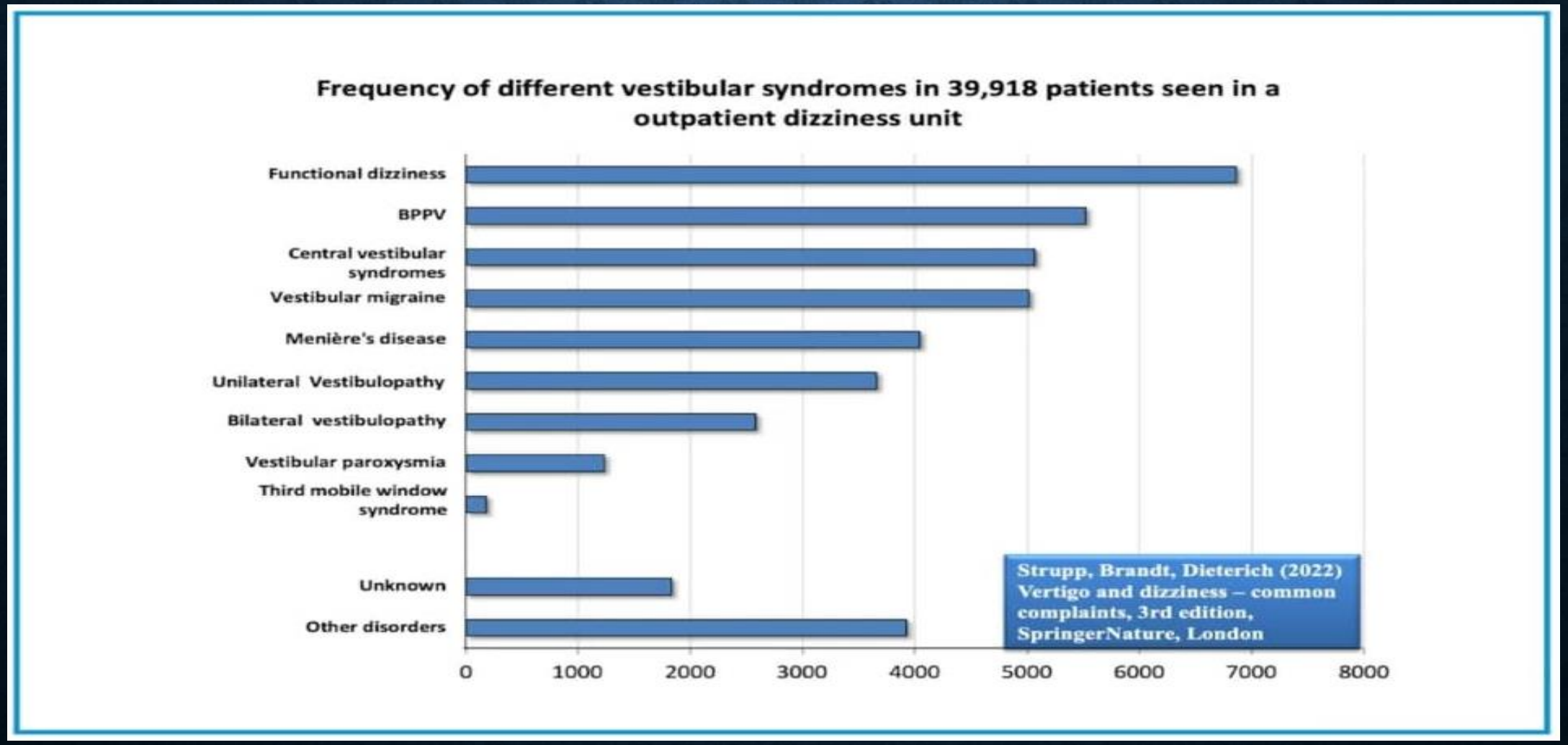
Equilibrium is the **ability** to **maintain orientation** of the **body and its parts** in relation to **external space**.

Equilibrium depends on continuous visual, labyrinthine, and proprioceptive somatosensory input and its integration in the brainstem and cerebellum.

Disorders of equilibrium mainly presents with one of two clinical problems: **vertigo** or **ataxia.**

Frequency of Different Vestibular Syndromes in 39918 Patients Seen in Outpatient Dizziness Unit

STRUP M,BRANDT T, DIETERICH M. VERTIGO AND DIZZINESS-COMMON COMPLINTS, 3RD EDITION, SPRINGERNATURE, LONDON (2022)



MISCONCEPTION

- Acute vestibular syndrome (AVS) at emergency department
  - 'Peripheral vestibular diagnosis' increase risk of stroke

  - Misconception → misdiagnosis
    - 40000-70000 per year misses stroke in US

- Too much emphasis on 'type' of vertigo rather than time course

*Prof Raymon Van de Berg

VERTIGO AND DIZZINESS

Are not trivial but

1. Easy to diagnose

- 4 basic questions (**3T 1A**)
- 4 bedsides tests for the vestibular system
- 4 signs to differentiate acute peripheral from acute central vertigo
- 9 frequent disorders : 90%

2. Easy to treat

- 5 principles '**E 3P S**'
- 8 groups of drugs '**8 As**'

Look at your patient!
He/she is the primary source of information.

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https://de.depositphotos.com/457967644/stock-photo-serious-doctor-holding-cellphone-and.html

VERTIGO : PATIENT HISTORY - 4 ASPECTS
3T+1A

Time course :	**Type :**	**Triggers/modulating factors**	**Associated symptoms**
• Acute • Episodic/Recurrent • Persistent/Chronic	• Spinning, /vertigo : otonuerological causes • Postural imbalance • Light headache, vaso-vagal response, orthostatic, cardiogenic dizziness, hypercholestrolemia • Others : patient who cannot describe the sensation in details ; hyperventilation, anxiety, depression	• Changes in position; lying, sitting, standing, walking, running, eyes open/closed; changes of pressure, social situation, daytime	• Hypoacusis, tinnitus, fullness affected ear - menieres ds • Headache, hypersensitivity light/sound - migraine • Double vision, hemiparesis, hyperesthesia, ataxia – cerebellar stroke • Nausea, vomiting

TIME COURSE

1) **Episodes/recurrent**
   - Sec-min : BPPV (< 1min*), vestibular paroxysmia (<1min*), superior canal dehiscence syndrome
   - Min to hours : vestibular migraine (5min to 72 hours*), Meniere's disease (20 mins-12hours*)

2) **Acute** (onset, lasting days to weeks)
   - Acute unilateral vestibulopathy (AUVP)/vestibular neuritis, brainstem or cerebellar infarction

3) **Persistent/chronic symptoms** : months to years
   - Bilateral vestibulopathy, functional dizziness, neurodegenerative disorders (cerebellar, extrapyramidal)

*international classification of vestibular disorders

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TIME COURSE

Recurrent episodes : differential diagnosis

- Autoimmunological ear disease ; cogan syndrome
- **BPPV**
- Episodic ataxias
- **Meniere's diseases**
- **Paroxysmal brainstem attacks**
- Room tilt illusion
- Syndrome of third mobile window
- **Transient ischemic attack (TIA)**
- Tumors of the cerebellopontine angle
- Vestibular artery compression/occlusion syndrome
- Vestibular epilepsy
- **Vestibular migraine**
- **Vestibular paroxysmia**

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ACUTE VESTIBULAR SYNDROME DIFFERENTIAL DIAGNOSIS : PERIPHERAL

STRUP M,BRANDT T, DIETERICH M. VERTIGO AND DIZZINESS-COMMON COMPLAINTS, 3RD EDITION, SPRINGERNATURE, LONDON (2022)

Peripheral vestibular disorders and disease	
Infection	• Acute unilateral vestibulopathy/vestibular neuritis, most often caused by reactivation of herpes simplex virus 1 infection • Labyrinthitis : due to bacteria or viral (rarely fungus) infection • Zoster oticus
Autoimmune inner ear diseases	• Cogan syndrome and others
Vascular	• Labyrinthine infarction (AICA/labyrinthine artery)
Traumatic	• Labyrinthine contusion • Fracture of the temporal bone (transverse> longitudinal) • Post traumatic otolith dizziness/post traumatic BPPV • Syndromes of the third mobile window
Iatrogenic	• Aminoglycosides (systemic or local) • Other otolith substances (e.g amiodarone, aspirin, chemotherapy) • Surgery of inner ear

ACUTE VESTIBULAR SYNDROME DIFFERENTIAL DIAGNOSIS : CENTRAL

STRUP M,BRANDT T, DIETERICH M. VERTIGO AND DIZZINESS-COMMON COMPLINTS, 3RD EDITION, SPRINGERNATURE, LONDON (2022)

Central vestibular disorders	
Vascular	• AICA infarction • PICA infarction • Hemorrhage in the area of brainstem or cerebellum
Autoimmune	• MS • Autoimmune encephalitis/cerebellitis • Vasculitis
Infection	• Brainstem encephalitis • Cerebellitis
Traumatic	• Brainstem concussion • Dissection of the vertebral artery (indirectly via ischemia)

COMBINATION OF VESTIBULAR AND AUDIOLOGICAL SYMPTOMS

Cerebellopontine angle tumor e.g, vestibular schwannoma

Cholesteatoma

Cogan syndrome or other autoimmune disease

Ear/head trauma (labyrinthine concussion)

Inner ear malformation

Labyrinthine infarct (anterior inferior cerebellar artery, labyrinthine artery)

Meniere's disease

Neurolabyrinthitis

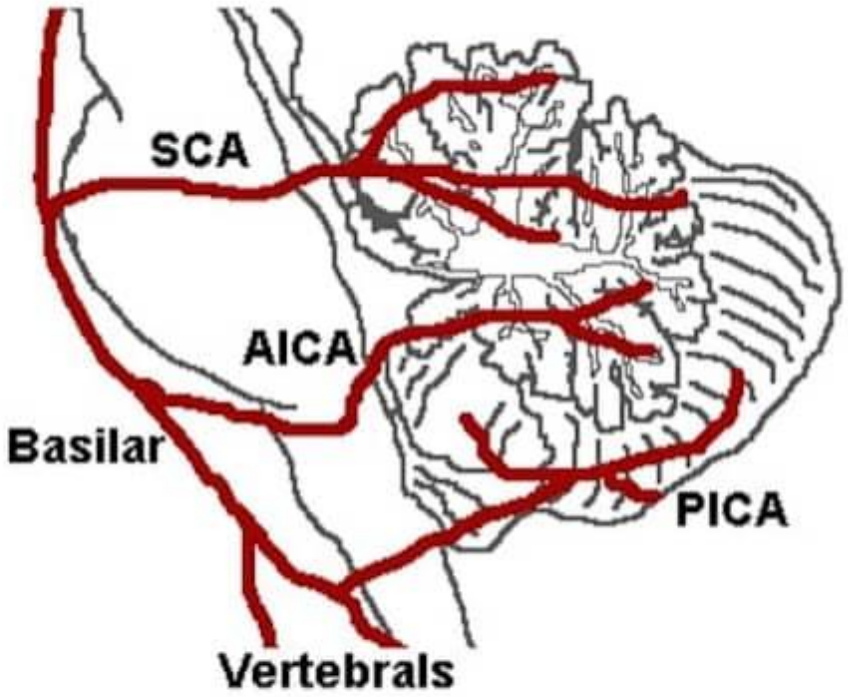
Otosclerosis

Ponto-medullary brainstem infarction (AICA) or MS plaque

Syndrome of third mobile window

Vestibular paroxysmia

Zoster oticus



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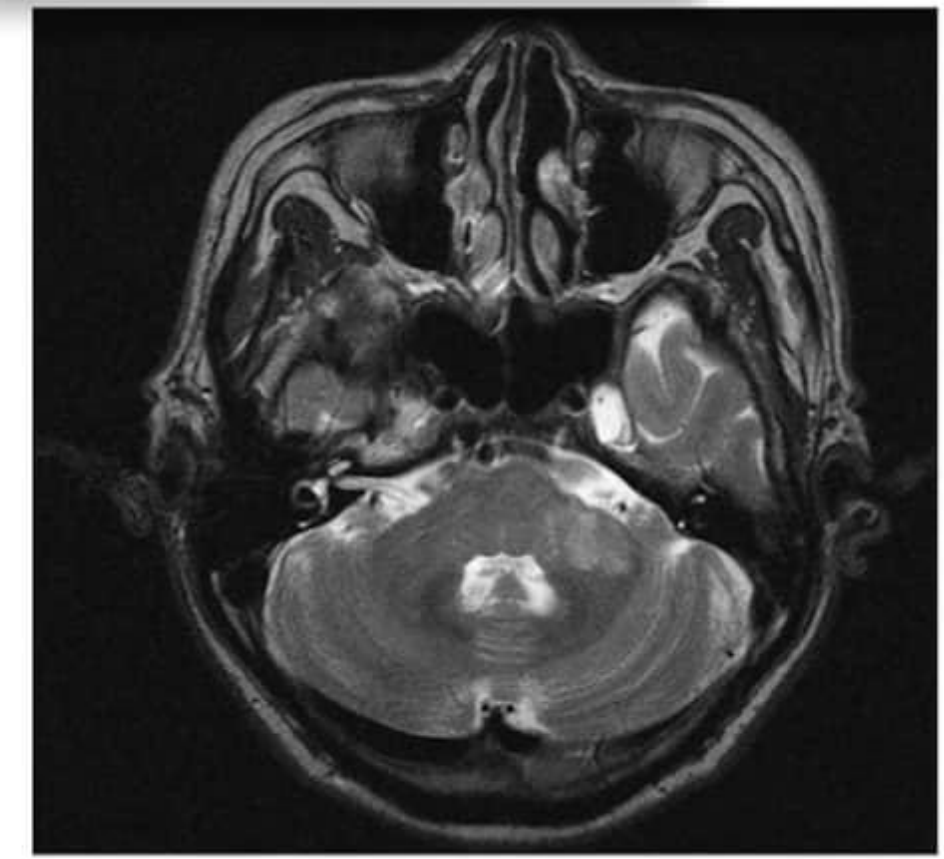

H. Lee, J Clin Neurol 2009;5:65-73

Acute Severe Spinning Vertigo & Acute Complete Hearing Loss- AICA Infarction

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PERSISTENT DIZZINESS, POSTURAL IMBALANCE : DIFFERENTIAL DIAGNOSIS

Peripheral vestibular disorders

Bilateral vestibulopathy

Unilateral vestibulopathy

Prebyvestibulopathy

Functional disorders

Persistent postural-perceptual dizziness (PPPD), phobic postural dizziness, visual induced dizziness, mal de embarquement syndrome, functional gait disorders

Central disorders

Cerebellar disorders/cerebellar dizziness; > 40 spinocerebellar ataxias (SCA), multiple systems atrophy (MSA), cerebellar ataxia with neuronopathy and vestibular areflexia (CANVAS), downbeat nystagmus syndrom

Movement disorders (basal ganglia); progressive supranuclear palsy (PSP), Parkinson disease, Lewy body dementia

Brainstem/cerebellar Stroke, multiple sclerosis, encephalitis

Orthostatic tremor

Chronic intoxication

Normal pressure hydrocephalus

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2 BASIC QUESTIONS SHOULD ASK YOURSELF

1. Is there a deficit/dysfunction ?
   - Just **4 tests** for the **vestibular systems**

2. Is it peripheral or central ?
   - The big **4 central signs**!

BEDSIDE EXAMINATIONS OF THE VESTIBULAR SYSTEMS – JUST 4 TESTS !

M glasses/frenzel glass : peripheral vestibular spontaneous vs central **fixation nystagmus**

Head impulse test (HIT) : Vestibulo-Ocular Reflex function

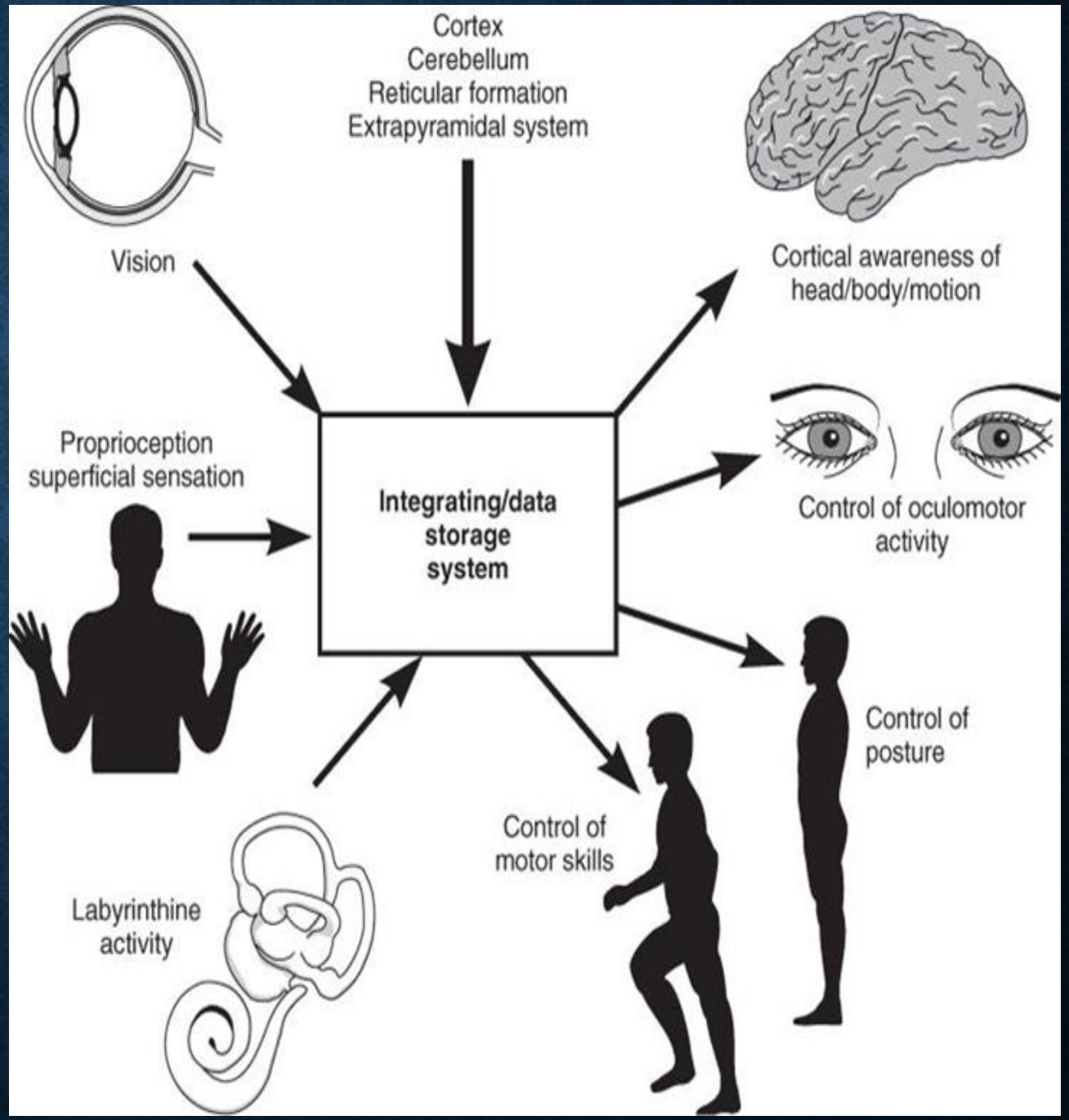
Positioning maneuvers : Positional nystagmus

Romberg test/Fukuda test : Sensory deficit

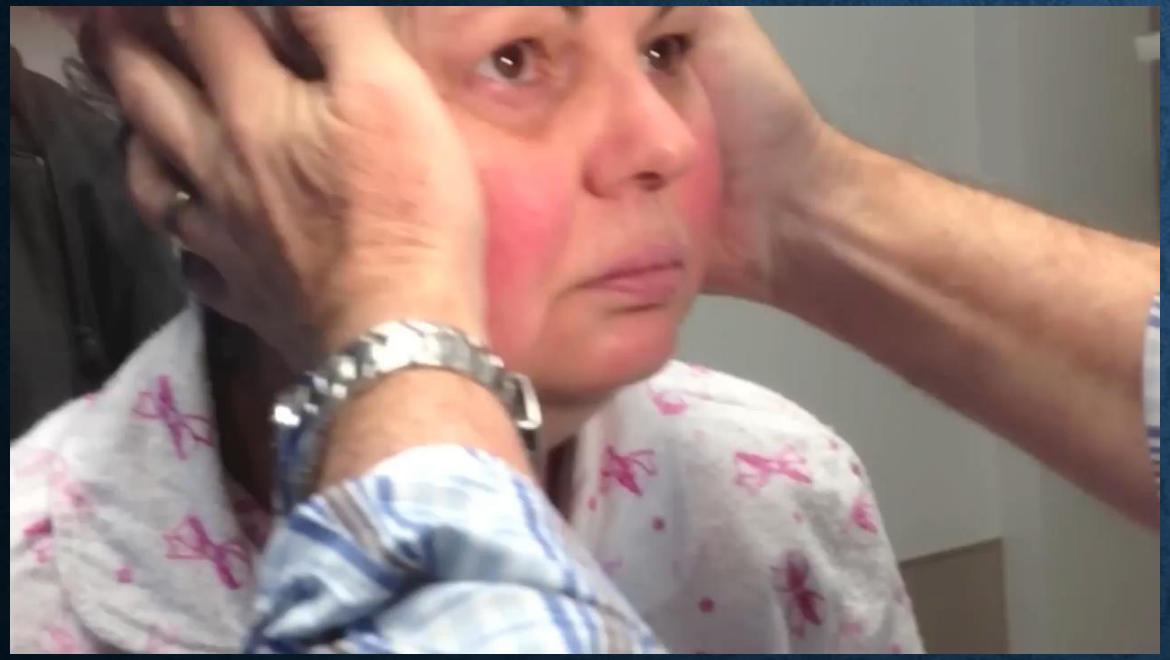
MECHANISM OF SUB-SERVING EQUILIBRIUM LUXON, 1997

Vestibular-ocular reflex (VOR)

Vestibulocollic reflex (VCR)



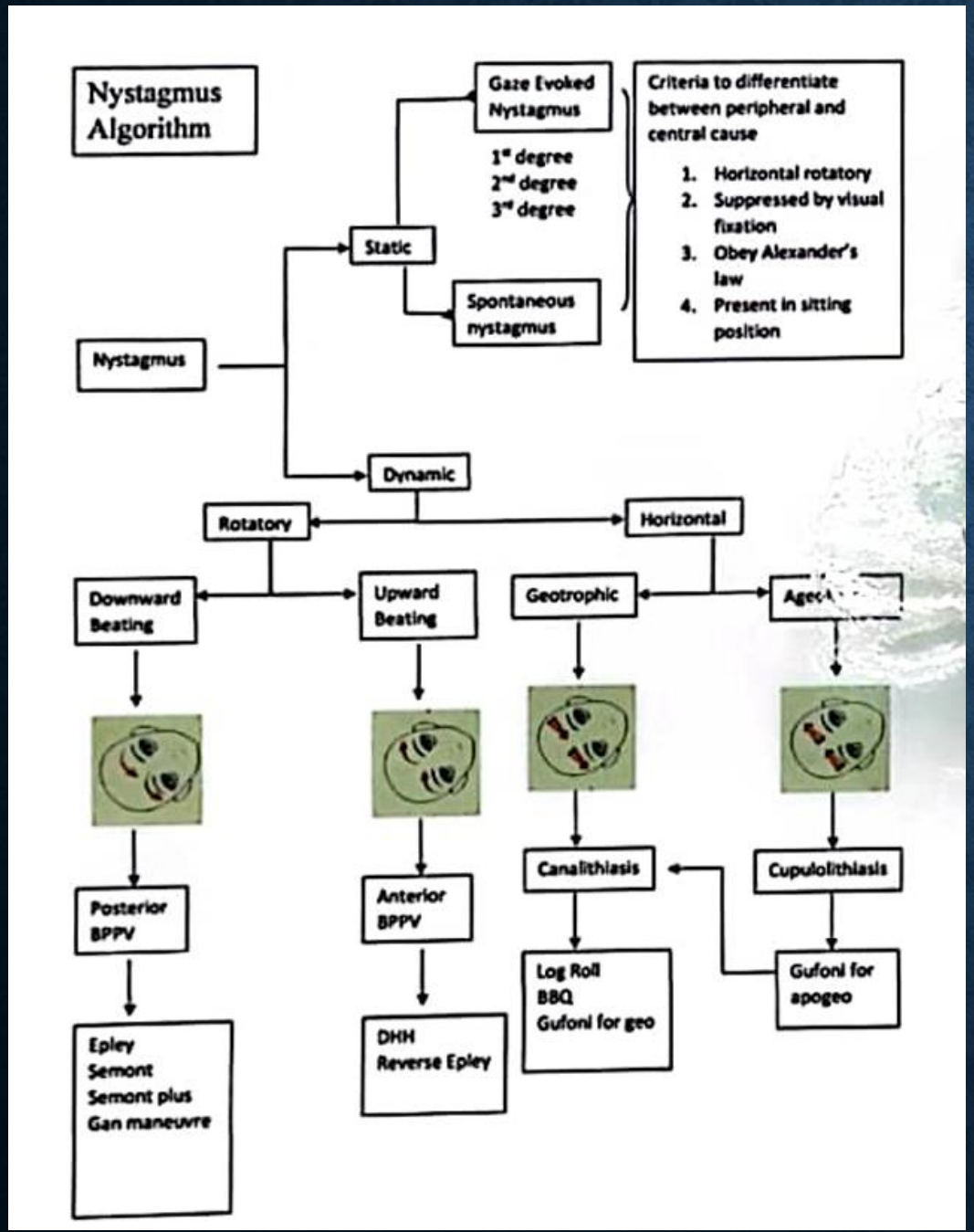
HEAD IMPULSE TEST

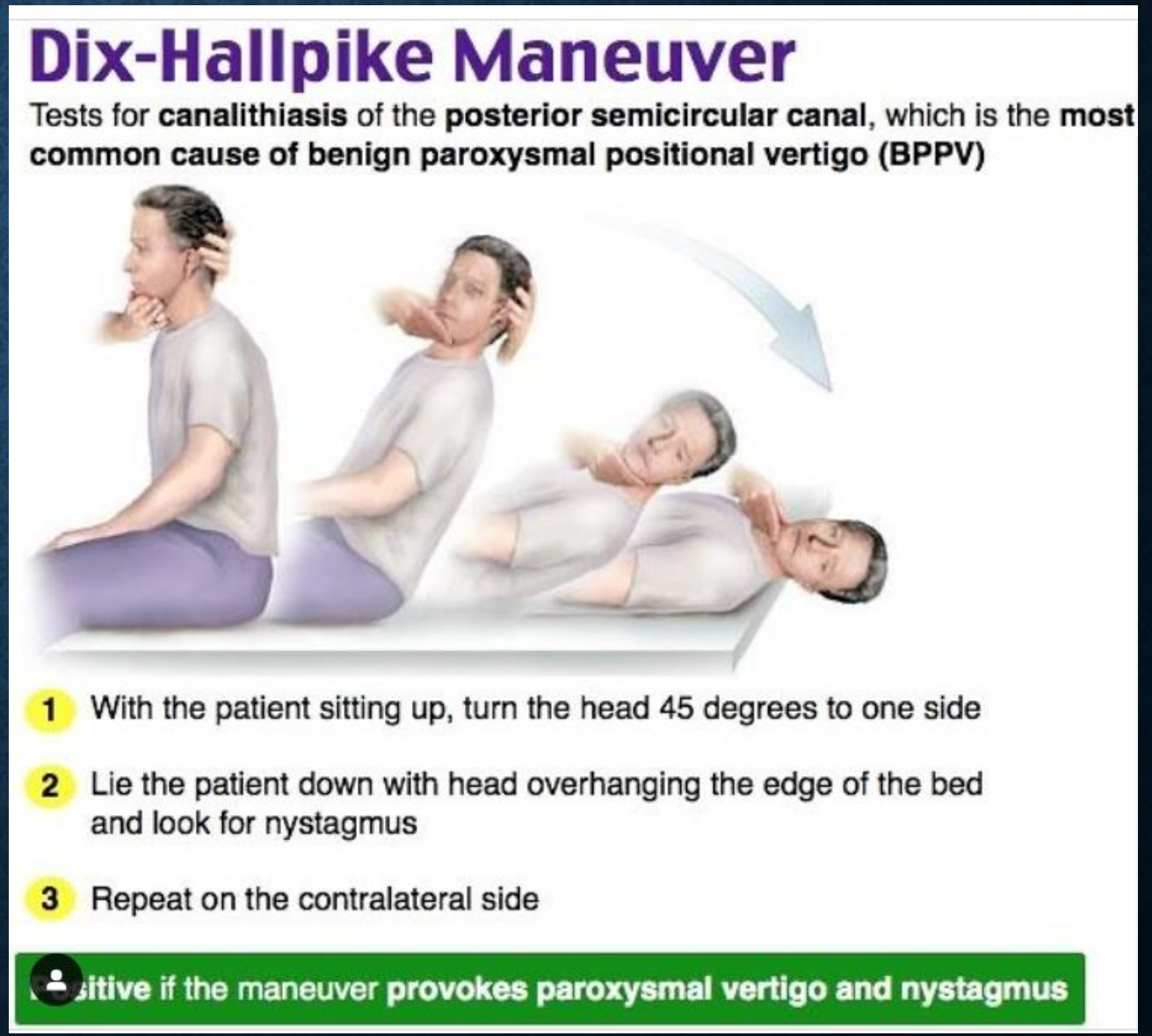


The woman in the above video has left ear vestibular neuritis and had nystagmus which was beating to the right. She has a positive head impulse test when her head is turned to the left.

Test	Central Origin	Peripheral Origin
Head Impulse Test	Normal test result - patient keeps visual focus with quick head movement	Abnormal test result - patient loses focus with quick head movement indicating VOR is not intact

Positioning Maneuvers





NYSTAGMUS : CLINICAL EXAMINATION

Examination	Findings (examples)
1. **With fixation** Gaze straight ahead To the side, up and downward	▪central fixation nystagmus usually central ▪Downbeat/upbeat, acquired pendular, congenital nystagmus ▪Gaze evoked nystagmus
2. **Without fixation** Frenzel's glasses or new M glasses	It has latency! Its peripheral Follow alexanders laws-its peripheral
3. **Positioning maneuver**	positioning/position nystagmus is peripheral
4. **Spontaneous**	Usually congenital/central

Symptoms	Peripheral vertigo	Central vertigo
Nystagmus	Combined horizontal and torsional; inhibited by fixation of eyes; decreases over several days; no changes with gaze change	Purely vertical, horizontal or torsional; not inhibited by gaze fixation; lasts for weeks and months; changes with the change of gaze direction
Imbalance	Moderate, one direction, no changes in gait	Severe, unable to stand, and walk
Nausea and vomiting	May be severe	Varies
Hearing loss or tinnitus	Common	Rare
Other neurological symptoms	Rare	Frequent
Latency of Nystagmus in provocative diagnostic test	Longer (≥20 s)	Shorter (<5 s)

NYSTAGMUS – DIRECTION? SUPPRESSION?

Fast phase is beating towards the more active labyrinth !

The 3D direction corresponds to the plane of the canal(s): 'ewalds's first law" 1872

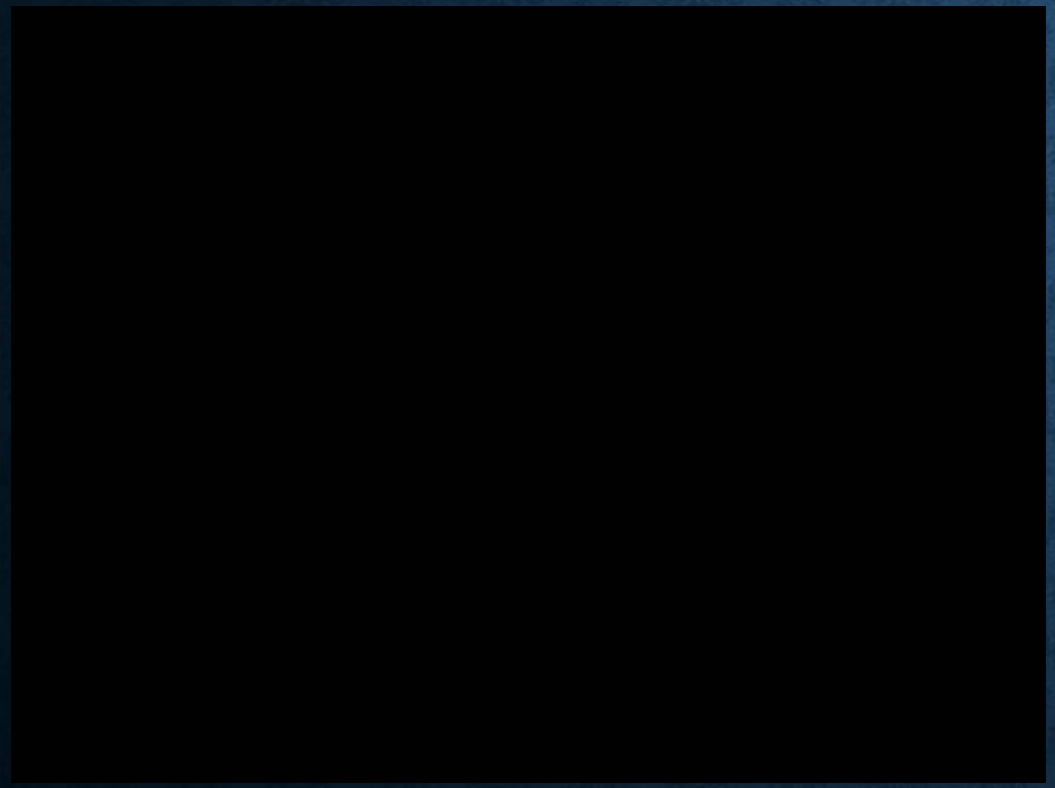
Nystagmus that **not** reduced by visual fixation is **not** a peripheral nystagmus

Eye and head movements occur in plane of canal being stimulated and in direction of endolymph flow

In horizontal canal, ampullopetal flow causes greatest response

Inposterior and superior canals, ampullofugal flow causes greatest response

GAZE EVOKED TEST



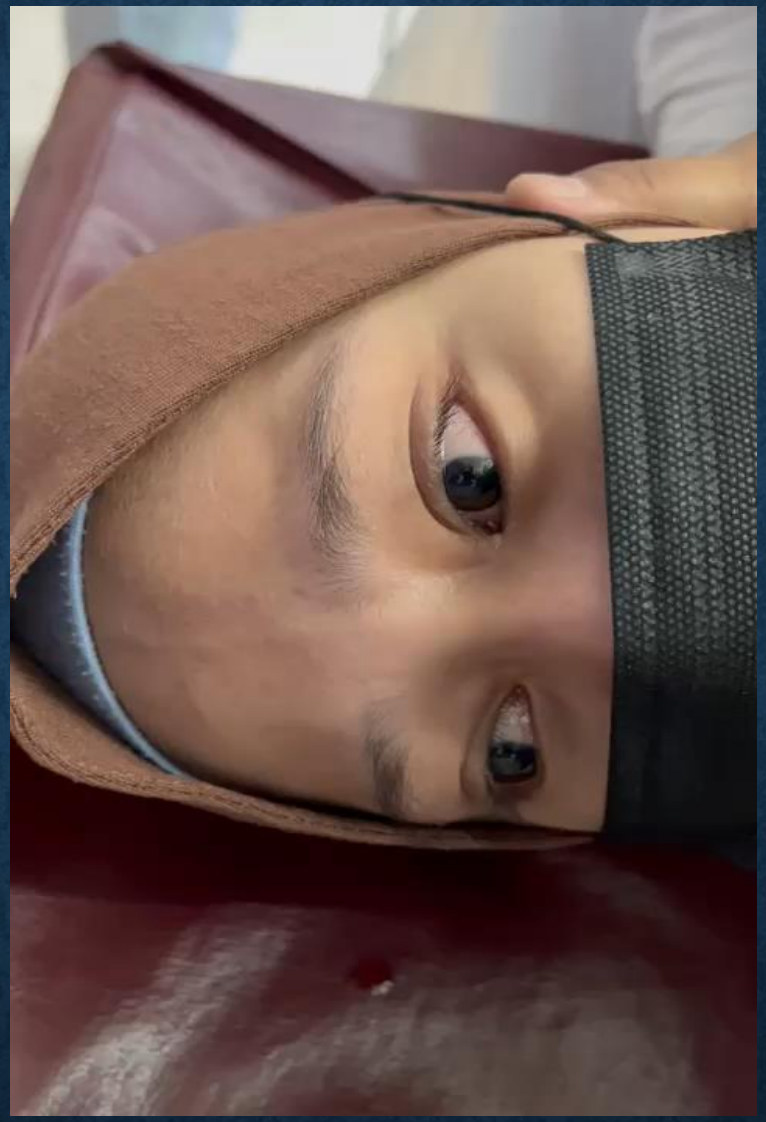
Video of GEN in a patient with Cerebellar Subarachnoid cyst

An important point of information to be gained from the fixation test is the adequacy of gaze holding, as impaired gaze holding may indicate the presence of a central (cerebellar or brainstem) lesion.

Gaze-evoked nystagmus (gen) is a drift of the eye which is only present for certain directions of gaze away from straight ahead. It is the most common form of nystagmus encountered in clinical practice. When using EOG recordings, any persistent nystagmus for ocular displacements of 30 degrees or less is considered abnormal.

Spontaneous nystagmus

Rotatory nystagmus



Horizontal nystagmus

Vertical nystagmus

ATAXIA

Ataxia is **incoordination or clumsiness of movement** that is not the result of muscular weakness. It can be caused by vestibular, cerebellar, or sensory (proprioceptive) disorders. Ataxia can affect eye movement, speech (producing dysarthria), individual limbs, the trunk, stance, or gait.

	Vestibular	Cerebellar	Sensory
Vertigo	Present	May be present	Absent
Nystagmus	Present	Often present	Absent
Dysarthria	Absent	May be present	Absent
Limb ataxia	Absent	Usually present (one limb, unilateral, legs only, or all limbs)	Present (typically legs)
Stance	May be able to stand with feet together; typically worse with eyes closed	Unable to stand with feet together and eyes either open or closed	Often able to stand with feet together and eyes open but not with eyes closed (Romberg sign)
Vibration and position sense	Normal	Normal	Impaired
Ankle reflexes	Normal	Normal	Depressed or absent

FUKUDA STEPPING TEST

- The purpose of the Fukuda Stepping Test is to assess labyrinthine function via vestibulospinal reflexes.

- The amount of rotation and displacement are measured after taking 50 or 100 steps in place with the eyes closed and blindfolded in a quiet, dimlit room with arms outstretched at 90°.

ROMBERG TEST

- The Romberg test is a test of the body's sense of positioning (proprioception), which requires healthy functioning of the dorsal columns of the spinal cord.
- A positive test is an inability to maintain an erect posture over 60 seconds with eyes closed.

TEST FOR SKEW

During this test, the examiner covers the eyes alternately while looking for the corrective vertical eye movement in the uncovered eye. The corrective movement of the uncovered eye indicates that it was not visualizing the target and hence there is an underlying vertical misalignment.

- Positive Test of Skew in a patient with cerebellar stroke Note the VERTICAL movement of the eyes in the cover/uncover test

Test	Central Origin	Peripheral Origin
Test of Skew	Abnormal correction (98% specific)	Normal, no skew

HINTS TEST
(HEAD IMPULSE TEST + NYSTAGMUS + SKEW TEST)

- 3 steps bedside oculomotor examination **more sensitive than early MRI-Diffusion-weighted imaging**
- AVS characterized by the rapid onset (over seconds to hours up to days) of vertigo, nausea/vomiting, and gait unsteadiness.
- It also associated with head motion intolerance and nystagmus lasting days to weeks.
- **>25% of AVS presented to ED represent as posterior circulation infarctions (3,6)**
- **CT scans have low sensitivity** (approximately 16%) for acute infarctions particularly in posterior fossa stroke
- MRI brain is not always readily available
- **False-negative MRI** can occur in AVS (50% normal in less than 24hr)
- Classical teaching suggest a focus on long-tract or frank cerebellar signs, **but fewer of AVS presentations have limb ataxia, dysarthria or other obvious neurological features.**

Jorge C. Kattah, MD, V. Talkad, MD, David Z. wang, DO, Yu-Hsiang Hsieh, PhD, MS, and David E. newman-Tokwe, MD, PhD

Original publish 2009

https://dol.org/10.1161/STROKEAHA.109.551234/stroke.2009;40:3504-3510

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     1. M glasses/frenzel glass : peripheral vestibular spontaneous vs central fixation **Nystagmus**
     2. **Head impulse test** (HIT) : Vestibulo-Ocular Reflex function
     3. **Positioning maneuvers** : Positional nystagmus
     4. **Romberg test/Fukuda test** : Sensory deficit

2. Is it peripheral or central ?

- The big **4 central signs**
  1. **Head impulse test**
  2. **Nystagmus**
  3. **Test for skew**
  4. **Gaze Evoke Test**

HOW TO DIFFERENTIATE BETWEEN ACUTE PERIPHERAL AND ACUTE VESTIBULAR DISORDERS; THE 4 BIG CENTRAL FOUR

Head impulse test

Acute vertigo and nystagmus normal HIT is always central

Nystagmus

Nystagmus not reduced by fixation: not a peripheral nystagmus

Spontaneous nystagmus is always central

Nystagmus that change in direction is central

Vertical Nystagmus is always central

Nystagmus with no latency

Skew test

Prominent skew deviation is central (30%)

Gaze evoke test

Gaze-evoked nystagmus (opposite to SPN: Bruns' nystagmus, 30%) is always central

APPROACH TO THE ‘ACUTE VESTIBULAR SYNDROME’ (AC?VS)

1. Patient history (3T 1A)

Time course, **T**ype, **T**riggers/modulating factors, **A**ssociated. Symptoms

- Duration >60 min
- First episode
- Spontaneous occurrence
- Central accompanying symptoms
- **+ABCD² score**

2. Bedside examination

The big **4 central signs**

3. Imaging

CT, CT Angio in acute phase

Caveat : MRI : 50% normal in <24h

APPROACH TO THE ACUTE VESTIBULAR SYNDROME

JOSEPHSON SA, SIDNEY S, PHAM TN, BERNSTEIN AL, JOHNSON SC. HIGHER ABCD² SCORE PREDICTS PATIENTS MOST LIKELY TO HAVE TRUE TRANSIENT ISCHEMIC ATTACK. STROKE, 2008 NOV;39(11);3096-8

ABCD2 score					
	Age	**Blood pressure**	**Clinical features**	**Duration**	**Diabetes**
No point	<60 year old	Normal	No speech disturbance and no unilateral (one sided) weakness	<10 minutes	No diabetes
1 point	≥ 60 years old	Raised >140/90 mmhg	Speech disturbance present but no unilateral weakness	10-59 minutes	Diabetes present
2 points	-	-	Unilateral weakness	≥60 minutes	-

Score 1-3 (low)
-2 days risk = 1.0%
-7 days risk = 1.2%

Score 4-5 (moderate)
-2 days risk = 4.1%
-7 days risk = 5.9%

Score 6-7 (high)
-2 days risk = 8.1%
-7 days risk = 11.7%

IN CONCLUSION CLINICAL ASSESSMENT OF VERTIGO AND DIZZINESS

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1.Time course
2.Type
3.Triggers/modulating factors
4.Associated symptoms

1.Nystagmus
2.Head impulse test (HIT)
3.Positioning maneuvers
4.Romberg test/Fukuda test

1.Head impulse test
2.Nystagmus
3.Skew test
4.Gaze evoke test

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THANK YOU