



# Central Nervous System

Sheet 10

Subject | ...physiology

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Lastly , We talked about **vestibular system**,which provides information essential for the sense of equilibrium and for coordinating head movements with eye and postural movements .

and its the function in rotation that when you rotate or move in one direction, one side will be activated while the other will be inhibited .

as you don't move -in a base line-, similar activity on both sides, your body won't integrate any reflex nor order .

but if there is diferece on both sides due to movement ,vestibular system will have a conscious awareness of the movement and do the associated reflexes .

so that, any damage on one side leading to difference between the two sides , whether due to abnormality in the labyrinth itself, or demyelination of the nerve, or stroke on cochlea , or nerve cut, or infection of the nerve , or any cause leading to disbalance, your body will understand you're rotating or moving . leading to vertigo (a symptom where a person feels as if they or the objects around them are moving when they are not ) , nystigmus , and in severe cases developing into balance problems .

**Disorders related to vestibular system :**

The most common is **Ménière's disease**.in which extra fluid accumulates within the labyrinth of the inner ear → in creasing pressure → pressing gelatinous membrane inside the ( ....) and another gelatinous membrane (the otolithic membrane) , so it will press them to force them to move or affecting their movement due to extra pressure so their move will change so the right wont be equivalent to the left no تناسق →severe episode of vertigo could last up to two days ,many times they will also have nystagmus could be continuous or in a certain movement or position so that called (positional nystagmus) as we said sometimes its spontaneous they will also have nausea ,vomiting .

in this (1-2 days) they will have whole balance disturbance affecting walking, standing, and ability to perform number of activities , these episodes occur recurrently, (every two days or day after another ..)

solution : salt-restricted diet to decrease fluid retention , and with prescription of diuretics pills .

(diuretics are of two types . the first is water pills (potassium lasix). mainly fasten elimination of Na and water and it's the most given pill .

Usually diuretics in meniere disease are not always effective and not effective in all people .

In contrast to what is written in old medical books that we give water pills for water and potassium retention to reduce pressure and improve the function , new research shows that since endolymph is high in potassium, so the fluid inside the vestibular is high in potassium and the hair cells work by influx of potassium. If we reduce potassium, fluid will be reduced resulting in better effectiveness of the diuretics .

If only some effectiveness is achieved with diet restriction and water pills , surgical interventions are needed , in which causing a damage on the nerve itself on both sides to decrease .....), but of the most effective ways to decrease the symptoms specially in periods between the episodes is physiotherapy . similar to phantom limb, physiotherapy is much better than medications although still prescribed.so that to decrease symptoms between episodes the most effective is physiotherapy .

Generally in the middle east physician don't trust physiotherapy although its proven effectiveness .and they keep giving medications with low marginal effectiveness or not at all.

Q: Is distribution of endolymph equal on both sides in case of menieres disease OR in one ear ?

A: no . we have retention of fluid . fluid doesn't occumulate exactly the same in both ears . pressure isn't equally distributed that's causing misbalance

Since cochlea is associated with the labyrinth , the occumulation of fluid and associated pressure increase usually affects the cochlea so that patients usually encounter (tinnitus).and low frequency hearing loss .

Another vestibular disorder more important although not the most common is

**“ Benign Paroxysmal Positional Vertigo “**

(statistics say 25-35% of the population suffer from it). And found in wide spectrum :

-very Mild cases: ex . people who can't tolerate going to Amusement parks and they will throw up and suffer from head pain and dizziness.

-Moderate cases: ex. people who can't tolerate travelling or long driving journeys.(sometimes they suffer from the symptoms within 24 hours after the journey)

-severe cases or severe episodes for certain periods : ex. episodes of vertigo that coincide with particular movements and changes in body position such as getting up in the morning or turning over in bed , bending over , which makes them fear such movements. Or when patiens ecor having sudden episodes upon walking , driving or even sitting .

The most common accepted pathophysiology of this disorder suggests a defect in the Otoliths (Calcium crystals above the Otolithic membrane of the saccule and utricle) in which they fall out of place.

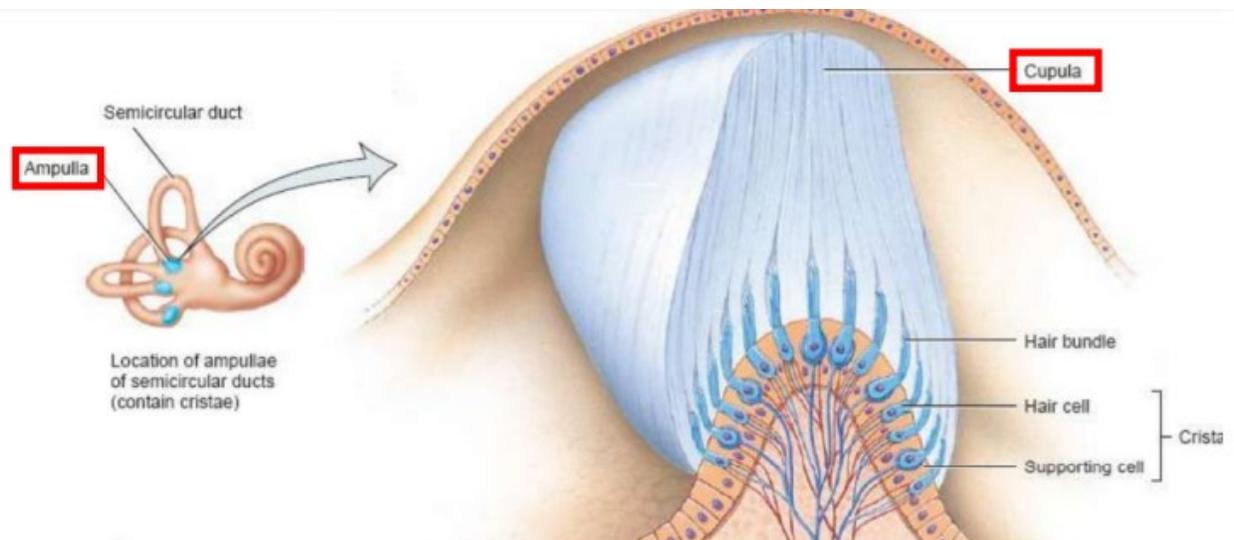
((otoconial crystals from the utricle separate from the otolith membrane and become lodged in the cupula of the posterior canal ))

Notice that falling of the Otoliths has 2 consequences leading to this disease,

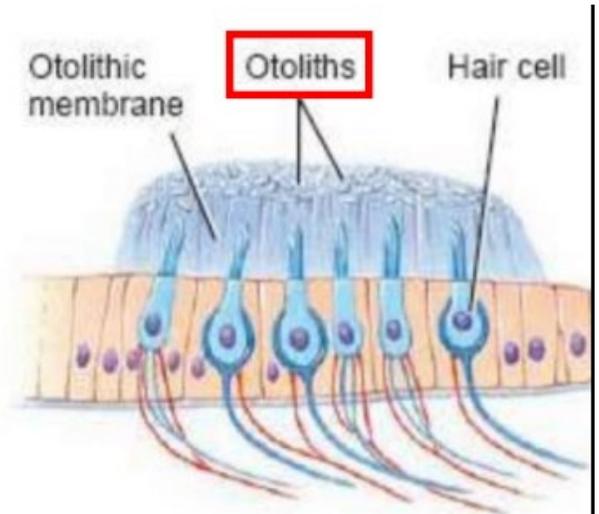
firstly , it decreases the sensitivity of the otolith membrane to gravity making the movement of the otolith membrane less than normal (as their goal was to make the otolith membrane heavier and more sensitive to gravity) and one ear will

differ from the other ; luckily , the brain can mostly adapt to this decrease in sensitivity and it won't be very severe.

Secondly, if the Otolithic Crystal was Big enough, it can rotate in the vestibular system and may even close one or more of the semicircular canals! Preventing the movement of the fluid in the canals or the gelatinous membrane of the Cupula which is the cause of severe cases. (See below photos of the Otoliths and Cupula)



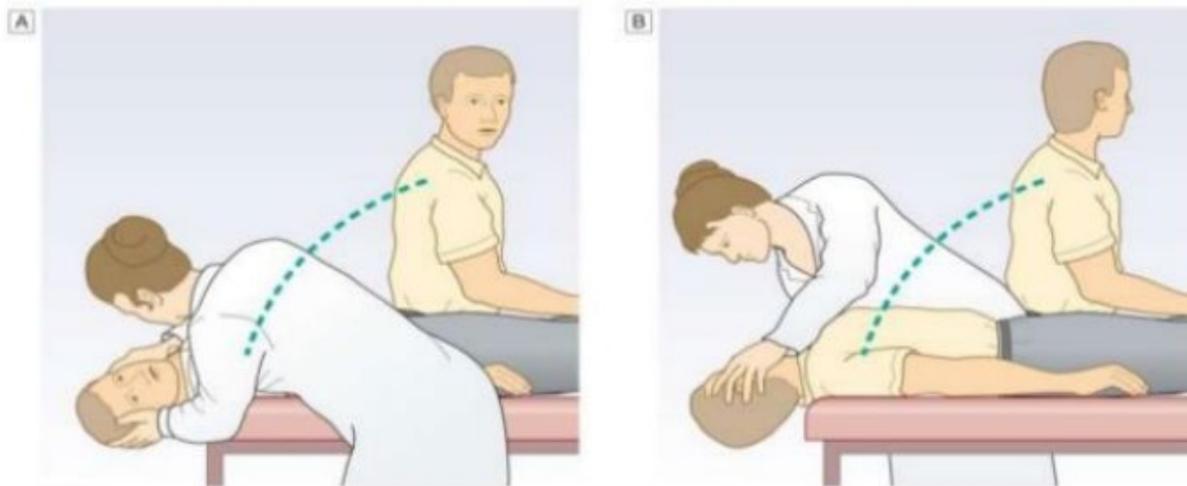
Luckily , Big Crystals of Otoliths dissolve after falling out from the otolith membrane within 2 Weeks – 1 Month , that's why severe symptoms don't last forever , however there might be another incidence of a new large crystal falling out, creating another 2 Weeks- 1 Month of severe symptoms.



**Dix-Hallpike test** is the definitive diagnostic test for Benign Paroxysmal Positional Vertigo, And is also considered a method of Treatment.

The Procedure involves the following steps:

1. The patient sits on a bench relaxed
2. Turn the patient's head 45 Degrees to one side
3. Pull the patient suddenly to a Supine position with the head pointing 20 Degrees Posteriorly and Observe eyes for Nystagmus – And ask the patient if there are any rotational feelings
4. Pull the patient to a Sitting position again suddenly with head tilted in same way. Observe eyes for Nystagmus and ask the patient if there are any rotational feelings ( A positive result includes a burst of Nystagmus )
5. Repeat same steps on the other side Why is this procedure considered also a treatment? Because in severe cases, these steps can move the otolith crystal to the base of Inner Ear Labyrinth decreasing its effects on the semicircular canals. So we repeat these steps until the patient feels improvement.



## Vestibular neuritis

infection of nerve → misconduction in that side → misbalance

so that any infection affecting the vestibular branch will cause vestibular neuritis . the most common cause is virus infection (flu, Herpes) so that if patients history include recent skin rash due to herpes or versella zoster or flu ,most propably signs are due to vestibular neuritis and not othe disorders .

another disease which is developmental . if the development of the labyrinth and canal didn't completely close , in this case the fluid of the canals is affected by the

pressure of the extra-dural space or middle ear pressure, resulting in symptoms affect a person's balance and hearing , solution is surgical intervention to close the defect which is called **semicircular canal Dehiscence**.

### **Back to vestibular eye movement :**

When rotation to one side counter clock wise ( from left to right ) , left is excited , right is inhibited ,eye will move to the right , if it is continuous and keep moving from right to left eye move to corner then back to center , and if this is continuous its called nystagmus.

Nistigmous pathway :

left is active right is inhibited , so eye moves to right . In right eye moving lateral rectus (abducent) in left eye moving medial rectus (oculomotor )

What occurs is that order don't reach directly to nuclei nor muscles. order always reaches abducent nucleus , stimulation of abducent nucleus, abducent nerve to lateral rectus and takes the order to the contralateral oculomotor motor to move the medial rectus.

This fiber is a fiber bundle , so a fiber tract will be apparent in the brain stem known as **Medial longitudinal fasciculus (MLF)**.

Among the fibers, there are those of abducent and oculomotor

So that if rotating counter clock wise, left becomes excited → order to vestibular nucleus →.controlateral abducent nucleus →through right abducent nerve activation of right lateral rectus and sends through **MLF** to left oculomotor →left medial rectus in this case eye moves to right side . (fibers from abducent synapse with those of oculomotor)

Another connection is when moving the eye to right, .activation of right lateral rectus and inhibition relaxation of medial rectus -→inhibiton of left abducent →inhibition of right oculomotor

When in baseline, right same as left , eye wont move , ...activation of left moving to right and visa versa...if this movement is continuous eye moves to corner then back to the central . or to the right then to the central .because the patient will be

fixing his vision on something . (right back to central , right back to the left ).  
Which when continuously occurring we called nystagmus .

Usually ,we name Nystagmus according to the direction of the fast phase.

Left beating nystagmus (right the back to the left)

If I could stimulate the left without moving the patient , in this case eye will move to right →left beating nystagmus

If damage /inhibition on the right → left beating nystagmus

Base line activity, on both sides , the same , more than one factor affecting baseline activity , ex , temperature .

Upon increasing temperature → ion movement increases →baseline activity increases

Decreasing temperature →base line activity decreases

This is the principle of the **caloric test**, in which warm water in left ear →increase activity of left ear →left beating nystagmus

But Cold water in left ear →activity in left ear decreases → right beating nystagmus

Most common to diagnose the vestibular system especially for patients having coma to check the caloric effect and which level of brain stem is affected .

Normal person cold on right ear , eye slowly to right then to the left . if warm water it goes back to the right .(normal person)

Damage not at level of brain stem , reflex wont be affected , so caloric patient responds as normal

But if Damage of lower part of brain stem, where vestibular nuclei are located or even the connections of neurons , this case , stimulation of the nerve but not reaching the eye no matter cold or warm , eye wont move.

So that ,lower brain stem lesion→ no reflex

If Upper brain stem lesion , damage to MLF, warm water to right ear , it will be stimulated → stimulation carried to left abducent which is intact →left eye moves lateral , but since MLF which goes to contralateral oculomotor is damaged so the right eye wont move ....If cold water , right is inhibited , so the stimulated is in the left → right abducent →right eye , left eye wont move .

Sorry for any mistake

The part of Benign Paroxysmal Positional Vertigo is mostly copied from 2016 sheet