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ANATOMO-FUNCTIONAL DETERMINISM OF THE VESTIBULAR SYNDROME

D. Tutunaru, A.Nechita, D. Vesa, G.Ionescu, C. Georgescu, I. Fulga, V. Ardeleanu

Faculty of Medicine and Pharmacy , "Dunărea de Jos" University of Galati, Romania

valeriu_ar@yahoo.com

ABSTRACT

The vestibular syndrome is one of the most common diseases, with implications for both neurological and otology. The present paper is a review of the literature and an update of existing information showing nerve conduction paths of the vestibular system, and the possible implications for anatomic and functional.

KEYWORDS*: vestibular, brainstem, anatomical modifications.*

1. Introduction

Excitations about cephalic extremity position in space are collected in the vestibular apparatus of the inner ear - the utricle, and semicircular canals bag. Macula and the ampullary crests, are composed of sensory cells and supporting cells. The sensory cells are the ones who receive the labyrinth excitations.

The vestibular path

The vestibular path consists of brainstem vestibular way, having the role of stabilizing the head and determine its position in space, controlling its movements and the cerebellar vestibular path, essential in regulating muscle tone, especially of the antigravitational one [1].

Macules - receiving bodies. Utricle's macula is disposed in the horizontal plane of its lower surface of the utricle and plays an important role in determining the orientation of the head when it is upright. The macula is located in the vertical bag and head orientation signals when a person AFL roduction in its horizontal position. Each macula is otolitic membrane coating substance (holds $CaCO_3$ crystals - otoconies). At the macula there are thousands of numerous hairy cells that project their cilia into the gelatinous supraiacent membrane. Otoconies have a high specific weight so their cilia bend in the sense of gravity. Bases and the lateral faces of hairy cells have numerous sinaps with the sensorial endings of the vestibular nerve.

Macules utricular and saccular receptors are similar to those thorium n di n ampullary crests, except that the villi are covered by a gelatinous mass that dis ting n its small granules, called otoliţ i saccular macula is as functional ociată cochlea react When you bratorii stimuli intensity greater than 50 cycles / sec [2].

Hairy cells. Each cell presents the 50-70 stereocilia and a kinocil (Located in its center, longer) interconnected through small filaments. When cilia moves towards the kinocilia, many ion channels open in the neuron cell membrane around the base of stereocilia resulting in the management of large quantities of positive ions, producing the receptor cell depolarization. Bending of cilia in the opposite direction of the connections reduces blood filamentous ion channels closing, and hyperpolarization occurs receiver. In each of the macula, each hairy cell is oriented differently so that different from each other is promoted. Each orientation of the head in gravity field generates a different pattern of stimulation macular nerve fibers.

Semicircular ducts. There are 3 ducts in each vestibular apparatus: anterior, posterior and lateral (horizontal). They form right angles between them, each corresponding to one of the plans. Each duct presents a dilatation at one end: ampulla. This and the ducts are filled with endolymph. Each ampulla has another dillatation - the ampullary crest - above which there is the cupula – which has a gelatinous mass. Turning the head in a direction results in duct endolymph flow through the . In the Cupula of hundreds of cilia projecting hairy-cell leading to depolarization or hyperpolarization of these cells. From the hairy cells, impulses are sent through the vestibular nerve to inform CNS about the change in the head's rotation way and the movement speed in the 3 plans. The semicircular ducts detect the head's rotation – angular acceleration and have the role of predicting the inequilibrum, therefore the balance is maintaned.

The utricule and sacule. The system made up of utricule and sacule works efficiently for maintaining balance when we keep our head upright, having an important role in maintaining static balance. The macules of the utricule and sacule detect liniar acceleration, but do not have a role in detecting the liniar speed.

Other factors that influence balance are the proprioceptors of the cervical area, which offer adequate information about the head's position related to the rest of the body; proprioceptive and exteroceptive information from other areas of our body (the pressure sensation from the feet, air's pressure upon the whole body); visual information – a body movement moves instantaneously the image on the retin, this information being sent to the equlibrum centres.

The semicircular ducts' ampular crests' receptors. They are specialised cells, having cillia: stereocillia (modified microvilosities) and kinocillia (modified cillia). The ampullar crests' epithelium is made up of two categories of cells: sensorial and of maintenance. The sensorial cells are of two types: type 1 cells, piriformic, having a discriminative function, have the basal pole surrounded by a nervous network coming from the thick fibers' ends with fast conduct of the vestibular nerve, and type 2 cells, with a cillindric form; on their basal pole the thin fibers of the vestibular nerve reach to an end. Way of conduct

The bipolar protoneuron is found in the vestibular ganglion which has a superior and an inferior part. The superior part receives the fibers from the semicircular anterior and lateral canals' crests and from the utricular macula. The inferior part receives fibers from the posterior canal's crests and the sacular macula. Protoneuron's axons form the vestibular nerve which enters the brainstem, in the bulbopontin angle, passing between the inferior cerebellar penducle and the spinal tract of the trigeminal nerve.

The track's deutoneuron is located in the rhomboid fossa vestibular area , where there are the four vestibular cores (tabelul 1). The vestibular cores have the following afferences:

Primary vestibular nerve fibers

- ascending fibers from the ampullar crests of the

semicircular canals which end in the medial and superior cores and give collaterals to the lateral one
- descending fibers originating from macules that give collaterals to the medial core and end in the inferior one

Direct and crossed cerebellovestibular fibers
- from the vermian cortex which go to the lateral and lower cores
- from the fastigial core which go to the lateral core

Intestitiovestibular fibers which go to the medial core:

The third neuron , some authors found in the ventral posterior medial nucleus (VPMN) of the thalamus and hence impulses reach the temporal and frontal cortex. According to other authors, is located in the ventral nucleus of thalamus postero-inferior, and projection is parietal, crust at the lower end of the 2 and 5 areas.

Fibers from the nucleus of Bechterew go to the cerebellum and vermis crust ends , lobe pneumogastric - flocculus , and the roof nucleus (nucleus fastigiata) . Fibers coming from the medial and spinal nucleus and collaterals reach into the reticular substance of the brainstem and Deiters 's nucleus [3]. From the nucleus of Deiters, the vestibulospinal motor goes down in the marrow beam (tractus vestibulo - spinalis). Other fibers coming from the vestibular cores enter in the constitution of the medial longitudinal beam. This way, they are put in contact – homo and heterolateral – with the motor cores of the ocular globe's muscles, the other cranial nerves and the ones from the spine. Other fibers establish connections with longitudinal medial beam's nucleus (nucleus interstitialis) with substance reticular nuclei and red nucleus of Stilling. Superior fibers reach even up to the the lentiform nucleus and hypothalamus [4]. There are numerous bucco-tectal fibers, tubers moving towards cvadrigcmeni posteriori (inferior colliculus). A feature of the vestibular nuclei connections with other configurations is the connection in both directions. This concerns especially the connections with the cerebellum and reticular substance. In summary, vestibular reflex pathways are represented by connections with the cerebellum, medial longitudinal bundle, reticular substance and spinal cord - vestibulospinal beam [5].

Labyrinth areas are not very well known, as follows: Area 1 - the superior temporal gyrus, area 2 - the parietal lobe in the vicinity of area 5, area 3 - the upper and middle frontal gyrus. Stimulation of the posterior superior temporal gyrus lead to feeling of vertigo (dizziness; like receptor stimulation, conjugate deviation of the eyeballs. Fibers mixed with acoustic go and is not clearly known thalamic relay. Thalamic relay can be made by vestibular stimulation .

Vestibular syndrome, take the following clinical forms:
- peripheral vestibular syndrome is caused by traumatic injury and inflammation of the inner ear, giving violent dizziness, nystagmus to the opposite side of the lesion and deafness or hearing loss;
- central vestibular syndrome is produced by infectious or tumor vascular lesions in the central vestibular nuclei and pathways [6];
- Meniere's syndrome is characterized by repeated episodes of vertigo, with great balance disorder, accompanied by nausea, vomiting and anxiety, followed by diseased ear deafness [7];
- seasickness and tickets are a stark form of vestibular syndrome characterized by dizziness, pallor, nausea, vomiting, fainting.

Vertigo physiologically occurs in one of the following situations:
- the brain is experiencing a synchronization between the three sensory systems stabilizers;
- vestibular system is subjected to unusual movements of the head;
- there are unusual position of the head or neck, as in

extreme extension.

Table I. *Vestibular nuclei of the brainstem*

The core	Related	Efferent	Functions
1. Lateral vestibular core (Deiter's core)	Utricule and semicircular canals	Projecting ipsilateral lateral vestibulospinal tract	Alpha and gamma motoneurons facilitate the work of the previous horns that innervate limb antigravity muscles to maintain posture
2. Medial vestibular core (MVC) (Schwalbe) 3. Superior vestibular core (SVC) (Bechterews)	Mainly to the semicircular canals	MVC neurons make monosynaptic connections with the motor cervical neurons which innervate the neck's muscles Other neurons from MVC and SVC send (ascending and descending) axons with a big diametre in the Medial Longitudinal Beam (MLB)	MVC neurons connected to the cervical spine conectați cu măduva cervicală function in stabilizing the head in space. MLB fibers produce upward vestibulo-ocular reflex by the synapses of nerve nuclei III , IV and VI. Descending fibers of the MLB are designed at different levels of spinal anterior horn ipsilateral to make synapse with alpha motoneurons, inhibiting them
4. Lower vestibular core	The semicircular canals, utricula, sacula, vermis	Is projected in the vestibulospinal and vestibuloreticular tracts	It has a role in the integration of vestibular afferents , multisensory , and cerebellum .

In pathological vertigo may occur after visual system damage (can be caused by new glasses / wrong or a sudden onset of extraocular muscle paresis with diplopia), somatosensory - rarely isolated, it is usually due to a peripheral neuropathy or vestibular - is often accompanied by nausea, nystagmus, ataxic gait and postural disorders. Because vertigo increases with rapid movements of the head, patients tend to keep your head still [8].

Vestibular Migraine is commonly associated with vestibular symptoms such as vertigo and dizziness. There is a special category in the new classification made by the International Headache Society for vestibular migraine. However, once the symptoms often described, it is noted that the rotational vertigo takes a few seconds to minutes, which is not described in any type of migraine.

References

1. **Netter, F.** Atlas of human anatomy, Callisto, 2006.
2. **Guyton, A.** Tratat de fiziologie a omului, Callisto, 2007.
3. **Haulica, I.** Fiziologie umana, Ed. Medicala, 2007.
4. **Kahle ,** Color Atlas of Anatomy, Thieme, 2003**.**
5. **Hendelman,** Atlas of functional neuroanatomy, Taylor&Francis Group, 2006 .
6. **Despopolous ,**Color atlas of physiology, Thieme, 2003.
7. **Borundel, C ,** Manual de medicina interna, All, 1994.
8. **Harrison's** Principles of Internal Medicine, McGraw-Hill, 2005**.**