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PHS ASSIGNMENT

Discuss the Physiology of Balance

- balance is mediated by the vestibular nuclei in the brain stem.
- the labyrinth (a part of the inner ear), is a major organ of our vestibular (balance) system.
- the three semicircular canals of the labyrinth is associated with sensing rotary motion.
- the brain senses the direction and speed of rotation of the head by the movement of fluid in the semicircular canals.
- balance is maintained by the interactions between the labyrinth and other systems in the body, such as the visual and skeletal systems.
- the main inputs into the balance system are the:
  - a. vestibular labyrinths
  - b. visual system (eyes)
  - c. somatosensory system, especially proprioception
- the main outputs from the vestibular nuclei are:
  - a. vestibulo-ocular:
    - permitting reflex eye movements related to posture
  - b. vestibulo-spinal which supply:
    - anti-gravity muscles in the lower limbs
    - reflex arcs which control gait

Postural balance is controlled by intricate connections between the vestibular, visual and proprioception system. Among these, the vestibular system is one of the key factors in coordinating and maintaining balance. The peripheral apparatus for the vestibular system consists of the semicircular canals, which sense head rotation; and the otoliths, which sense gravity and linear acceleration. The central vestibular pathways form a large network from the

vestibular nuclei, ocular motor nuclei, integration centers in the pons and rostral midbrain, vestibulocerebellum, thalamus, to the multisensory vestibular cortex areas in the temporoparietal cortex. The most important structures for the central vestibular pathways are those mediating the vestibulo-ocular reflex (VOR), and the descending pathways into the spinal cord along the medial and lateral vestibulospinal tract which mediate postural control. The cortical structures involved in vestibular function are the parietoinsular vestibular cortex, the retroinsular cortex, the superior temporal gyrus and the inferior parietal lobule. Activation of the cortical network during vestibular stimulation is not symmetrical; dominance is stronger in the nondominant hemisphere, in the hemisphere ipsilateral to the stimulated ear and in the hemisphere ipsilateral to the slow phase of the vestibular caloric nystagmus. Disorder of the vestibular pathway, anyway along its various tracts, may result in balance and coordination impairments and lead to misperception of motion.

Balance is a choreographed arrangement that takes sensory information from a variety of organs and integrates it to tell the body where it is in related to gravity and the earth.

Information from the vestibular system of the inner ear (semicircular canals, the saccule and the utricle) is sent to the brainstem, cerebellum, and spinal cord. Potential balance abnormalities do not require conscious input from the cerebrum of the brain. Abnormal vestibular signals cause the body to try to compensate by making adjustments in posture of the trunk and limbs as well as making changes in eye movement to adjust sight input into the brain.

There are three semicircular canals in the inner ear positioned at right angles to each other like a gyroscope. They are able to sense changes in movement of the body. With such changes, endolymph waves within the canals cause hair cells located within their base to move. Position of the head is sensed by hair cells of the utricle and saccule which is stimulated when the head moves and the relationship to gravity changes.

There is a small dense area of nerve fibers called the macule located in each of the saccule and utricle. The macule of the saccule is oriented vertically while the utricle macule is horizontal. Each macule consists of fine hair bundles which are covered by an otolithic membrane that is jelly-like and covered by a blanket of calcium crystals. The calcium crystals are the structures that ultimately stimulate the position hairs and provoke nerve impulses created by the position changes and transmit that information to the brain stem and cerebellum.

Abnormalities of the vestibular system may cause:

- a. vertigo (the sensation that the room is spinning);
- b. benign paroxysmal positional vertigo;
- c. labyrinthitis, and
- d. Meniere's Disease

