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**MEDICINE AND SURGERY**

**NEUROPHYSIOLOGY**

**1) DISCUSS THE PHYSIOLOGY OF SLEEP.**

Sleep is the natural periodic state of rest for mind and body with closed eyes characterized by partial or complete loss of consciousness. Loss of consciousness leads to decreased response to external stimuli and decreased body movements. New borns require about 18-20 hours of sleep while 7-9 hours for adults. Several physiological changes take place during sleep. They include:

- Plasma volume decreases by about 10% during sleep.
- The heart rate reduces during sleep. It varies between 45 and 60 beats per minute. Blood Pressure Systolic pressure falls to about 90 to 110 mm Hg. Lowest level is reached about 4th hour of sleep and remains at this level till a short time before waking up. Then, the pressure commences to rise. If sleep is disturbed by exciting dreams, the pressure is elevated above 130 mm Hg.
- Rate and force of respiration are decreased. Respiration becomes irregular and Cheyne-Stokes type of periodic breathing may develop.
- Salivary secretion decreases during sleep. Gastric secretion is not altered or may be increased slightly. Contraction of empty stomach is more vigorous.
- Formation of urine decreases and specific gravity of urine increases.
- Sweat secretion increases during sleep.
- Lacrimal secretion decreases during sleep.
- Tone in all the muscles of body except ocular muscles decreases very much during sleep. It is called sleep paralysis.

- Certain reflexes particularly knee jerk, are abolished. Babinski sign becomes positive during deep sleep. Threshold for most of the reflexes increases. Pupils are constricted. Light reflex is retained. Eyeballs move up and down.
- Brain is not inactive during sleep. There is a characteristic cycle of brain wave activity during sleep with irregular intervals of dreams. Electrical activity in the brain varies with stages of sleep.

There are two types of sleep which include:

- **RAPID EYE MOVEMENT SLEEP (REM SLEEP):** Rapid eye movement sleep is the type of sleep associated with rapid conjugate movements of the eyeballs, which occurs frequently. Though the eyeballs move, the sleep is deep. So, it is also called paradoxical sleep. It occupies about 20% to 30% of sleeping period. Functionally, REM sleep is very important because, it plays an important role in consolidation of memory. Dreams occur during this period.
- **NON-RAPID EYE MOVEMENT SLEEP (NREM OR NON-REM SLEEP):** Non-rapid eye movement sleep is the type of sleep without the movements of eyeballs. It is also called slow-wave sleep. Dreams do not occur in this type of sleep and it occupies about 70% to 80% of total sleeping period. Non-REM sleep is followed by REM sleep. In NREM, sleep is divided into four stages based on the EEG pattern.
  - **Stage I (Stage of Drowsiness):** Alpha waves are diminished and abolished. EEG shows only low voltage fluctuations and infrequent delta waves.
  - **Stage II (Stage of Light Sleep):** Stage II is characterized by spindle bursts at a frequency of 14 per second, superimposed by low voltage delta waves.
  - **Stage III (Stage of Medium Sleep):** During this stage, the spindle bursts disappear. Frequency of delta waves decreases to 1 or 2 per second and amplitude increases to about 100  $\mu$ V.
  - **State IV (Stage of Deep Sleep):** Delta waves become more prominent with low frequency and high amplitude.

Sleep occurs due to the activity of some sleep-inducing centers in brain. Stimulation of these centers induces sleep. Damage of sleep centers results in sleeplessness or persistent wakefulness called **INSOMNIA**. These sleep centers explain the mechanism of sleep. Sleep centers are complex pathways between the reticular formation of brainstem, diencephalon and cerebral cortex are involved in the onset and maintenance of sleep. However, two centers which induce sleep are located in brainstem. Inhibition of ascending reticular activating system also results in sleep.

- **Role of Raphe Nucleus:** Raphe nucleus is situated in lower pons and medulla. Activation of this nucleus results in non-REM sleep. It is due to release of serotonin by the nerve fibers arising from this nucleus. Serotonin induces non-REM sleep.
- **Role of Locus Ceruleus of Pons:** Activation of this center produces REM sleep. Noradrenaline released by the nerve fibers arising from locus ceruleus induces REM sleep.
- **Inhibition of Ascending Reticular Activating System:** Ascending reticular activating system is responsible for wakefulness because of its afferent and efferent connections with cerebral cortex. Inhibition of ARAS induces sleep.

## 2) **DISCUSS THE ROLE OF BASAL GANGLIA IN COORDINATING MOVEMENT.**

Basal ganglia are the scattered masses of gray matter submerged in subcortical substance of cerebral hemisphere. Basal ganglia form the part of extra pyramidal system, which is concerned with motor activities. Roles of basal ganglia which are concerned with movement coordination include:

- **Control of Muscle Tone:** Basal ganglia control the muscle tone. In fact, gamma motor neurons of spinal cord are responsible for development of tone in the muscles. Basal ganglia decrease the muscle tone by inhibiting gamma motor neurons through descending inhibitory reticular system in brainstem. During the lesion of basal ganglia, muscle tone increases leading to rigidity.
- **Control of Reflex Muscular Activities:** Some reflex muscular activities, particularly visual and labyrinthine reflexes are important in maintaining

the posture. Basal ganglia are responsible for the coordination and integration of impulses for these reflex activities. During lesion of basal ganglia, the postural movements, especially the visual and labyrinthine reflexes become abnormal. These abnormal movements are associated with rigidity. Rigidity is because of the loss of inhibitory influence from the cerebral cortex on spinal cord via basal ganglia.

- **Control of Automatic Associated Movements:** Automatic associated movements are the movements in the body, which take place along with some motor activities. Examples are the swing of the arms while walking, appropriate facial expressions while talking or doing any work. Basal ganglia are responsible for the automatic associated movements. Lesion in basal ganglia causes absence of these automatic associated movements, resulting in poverty of movements. Face without appropriate expressions while doing any work is called mask-like face. Body without associated movements is called statue-like body.
- **Control of Motor Activity:**
  - **Regulation of Voluntary Movements:** Movements during voluntary motor activity are initiated by cerebral cortex. However, these movements are controlled by basal ganglia, which are in close association with cerebral cortex. During lesions of basal ganglia, the control mechanism is lost and so the movements become inaccurate and awkward. Basal ganglia control the motor activities because of the nervous (neuronal) circuits between basal ganglia and other parts of the brain involved in motor activity. Neuronal circuits arise from three areas of the cerebral cortex: Premotor area, Primary motor area and Supplementary motor area. All these nerve fibers from cerebral cortex reach the caudate nucleus. From here, the fibers go to putamen. Some of the fibers from cerebral cortex go directly to putamen also. Putamen sends fibers to globus pallidus. Fibers from here run towards the thalamus, subthalamic nucleus of Luys and substantia nigra. Subthalamic nucleus and substantia nigra are in turn, projected into thalamus. Now, the fibers from thalamus are projected back into primary motor area

and other two motor areas, i.e. premotor area and supplementary motor area.

- **Regulation of Conscious Movements:** Fibers between cerebral cortex and caudate nucleus are concerned with regulation of conscious movements. This function of basal ganglia is also known as the cognitive control of activity
- **Regulation of Subconscious Movements:** Cortical fibers reaching putamen are directly concerned with regulation of some subconscious movements, which take place during trained motor activities, i.e. skilled activities such as writing the learnt alphabet, paper cutting, nail hammering, etc.