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17/MHS01/168

300 LEVEL

MEDICINE AND SURGERY

NEUROPHYSIOLOGY

Assignment

1) Discuss the physiology of sleep

2) discuss the role of basal ganglia in coordinating movement

Answer

1) 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. Depth of sleep is not constant throughout the sleeping period. It varies in different stages of sleep.

Sleep requirement

 It is not constant. However, average sleep requirement per day at different age groups is:

1. Newborn infants : 18 to 20 hours

2. Growing children : 12 to 14 hours

3. Adults : 7 to 9 hours

4. Old persons : 5 to 7 hours.

Types of Sleep:

1. Rapid eye movement sleep or REM sleep: It 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.

2. Non-rapid eye movement sleep, NREM sleep or non-REM sleep: It 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.

Mechanism of Sleep

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.

Physiological Changes During Sleep

Sleep influences all of the body’s major physiologic systems, including thermoregulatory, musculoskeletal, endocrine, respiratory, cardiovascular, gastrointestinal, and immune systems. Sleep also impacts individual’s weight, mental health, and overall quality of life.

All of these relationships are bi-directional: in other words, many of these physiologic systems also influence an individual’s sleep. Partial or total lack of sleep, disturbed sleep, and poor quality sleep can all drastically change an individual’s thinking and behavior and negatively impact his or her physical, mental, and emotional health.

a. Thermoregulation and Sleep: Core body temperature is regulated by [circadian rhythm](https://sleepdisorders.sleepfoundation.org/glossary/c#circadian-rhythm). Our body temperature is higher during the day and declines at night. In normal sleepers and normal conditions, sleep onset occurs as a person’s body temperature falls and his or her heat loss increases. These changes also prompt the maintenance of sleep. This is why exercise should ideally occur four to six hours before bedtime, in order to ensure that the person’s core temperature is not elevated when they try to go to sleep. Body temperature continues to decline during sleep until about 4:00 AM, when it starts to rise again. People usually wake up during this rising part of the [circadian rhythm](https://sleepdisorders.sleepfoundation.org/glossary/c#circadian-rhythm), as the body warms up and stops losing heat.

b. The Musculoskeletal System and Sleep: Physiologically, most muscles relax during non-rapid eye movement (NREM) sleep and exhibite a lack of muscle tone similar to paralysis (atonia) during rapid eye movement (REM) sleep, except for the ocular muscles and the diaphragm. This atonia prevents us from moving around and hurting ourselves or bed partners during sleep, but it can also contribute to the aetiology of certain sleep disorders, such as [narcolepsy](https://sleepdisorders.sleepfoundation.org/glossary/n#narcolepsy).

c. The Endocrine System and Sleep: The endocrine system has a complex response to sleep. The secretion of some hormones increases during sleep (e.g., growth hormone, prolactin, and luteinizing hormone), while the secretion of other hormones is inhibited (e.g., thyroid stimulating hormone and cortisol).

Some hormones are tied directly to a particularly sleep stage. Growth hormone is typically secreted in the first few hours after the onset of sleep and generally is released during slow-wave sleep. Cortisol is tied to the circadian rhythm, and peaks in late afternoon, regardless of the person’s sleep status or the darkness/light cycle. Melatonin is released in the dark and is suppressed by light58. Thyroid hormone secretion occurs in the late evening.

d. The Respiratory System and Sleep: Sleep has a large impact on the respiratory system, and vice versa. Ventilation and respiration both change while a person sleeps. Specifically, they become faster and more erratic during rapid eye movement (REM) sleep. The cough reflex is also suppressed during REM and NREM sleep.

e. The Cardiovascular System: Blood pressure and heart rates both change during sleep. There are brief increases in the person’s blood pressure and heart rate during K-complexes, sleep arousals, and large body movements. In the few hours before a person wakes up, and as the person wakes up in the morning, there is an increase in both heart rate and blood pressure, this may contribute to the higher risk of having a heart attack in the early morning and soon after awakening.

Lack of sleep and disordered sleep are also associated with heart attacks and, possibly, stroke. Arrhythmias occur very commonly during sleep and are influenced by the circadian rhythm.

f. Gastrointestinal Tract: Salivary secretion decreases during sleep. Gastric secretion is not altered or may be increased slightly. Contraction of empty stomach is more vigorous.

g. Obesity & Weight: Lack of sleep is associated with an increased risk of obesity: the shorter length of time a person sleeps, the greater their risk of being obese, based on the Body Mass Index (BMI).

Sleep Disorders

1. Insomnia: It is the inability to sleep or abnormal wakefulness. It is the most common sleep disorder. It occurs due to systemic illness or mental conditions such as psychiatric problems, alcoholic addiction and drug addiction.

2. Hypersomnia: It is the excess sleep or excess need to sleep. It occurs because of lesion in the floor of the third ventricle, brain tumors, encephalitis, chronic bronchitis and disease of muscles. Hypersomnia also occurs in endocrine disorders such as myxedema and diabetes insipidus.

3. Sleep Apnea Syndrome: Sleep apnea is the temporary stoppage of breathing repeatedly during sleep. Sleep apnea syndrome is the disorder that involves fluctuations in the rate and force of respiration during REM sleep with short apneic episode.

5. Nightmare: It is a condition during sleep that is characterized by a sense of extreme uneasiness or discomfort or by frightful dreams. Discomfort is felt as of some heavy weight on the stomach or chest or as uncontrolled movement of the body. After a period of extreme anxiety, the subject wakes with a troubled state of mind.

2) ROLE OF BASAL GANGLIA IN COORDINATING MOVEMENT

The basal ganglia have many functions but its role in coordinating movement is going to be discussed. The basal ganglia functions in regulation of voluntary movements, regulation of conscious movements and regulation of subconscious movements.

i. 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: a. Premotor area b. Primary motor area c. 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.

ii. 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. For example, when a stray dog barks at a man, immediately the person, understands the situation, turns away and starts running. iii. 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.  3. CONTROL OF REFLEX MUSCULAR ACTIVITY 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.