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Normal CNS, Special Senses, Head and Neck

TOPIC: Diencephalon

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LECTURE: Monday, 16 March 2009, 11:00a.m. – 12:00 noon

READING: Martin, Neuroanatomy, Text and Atlas (3rd Edition), pp. 38-44, 88-89, 125-126.

OBJECTIVES AND GOALS:

From the reading and lecture the students should know:

1. the five regions of the diencephalon and the relationship of these structures to the third ventricle
2. nuclei of the dorsal thalamus that process somatic sensory, auditory, and visual information and the cerebral cortical areas with which these nuclei are interconnected
3. nuclei of dorsal thalamus that are interconnected with primary motor cortex and motor association areas
4. nuclei of the dorsal thalamus that are interconnected with the limbic lobe
5. nuclei of the dorsal thalamus that are interconnected with the multimodal sensory association cortex and with the frontal multimodal association cortex
6. the genu and 4 limbs of the internal capsule and the areas of cortex to which each is connected
7. nuclei of the hypothalamus that control the function of the anterior lobe of the pituitary gland and those that control the function of the posterior lobe of the pituitary gland
8. know nuclei of the hypothalamus that influence male and female sexual behavior, parental behavior and aggression in mammals
9. nucleus of the hypothalamus that is important in entraining/maintaining circadian rhythms
10. arteries that supply the dorsal thalamus, hypothalamus and internal capsule.

Sample Test Question:

Which lobe of the cerebral cortex is interconnected with the anterior nucleus of the dorsal thalamus?

- A. frontal
- B. limbic
- C. occipital
- D. parietal
- E. temporal

Answer: B

I. Introduction

The diencephalon is a

II. Regions of the Diencephalon:

- A. Epithalamus (pineal and habenula)
- B. Thalamus
- C. Hypothalamus
- D. Ventral thalamus (subthalamus)
- E. Posterior pituitary

III. Anatomical Relations of the Diencephalon

- a. The **third ventricle** forms the **medial** boundary of the diencephalon.
- b. The **internal capsule** forms the **lateral** boundary of the diencephalon.

IV. Organization of Dorsal Thalamus - Four general principles

V. Interconnections between Dorsal Thalamus and the Cerebral Cortex

- a. The posterior thalamic nuclei receive and integrate sensory information.
 - i. Ventral posterolateral nucleus (**VPL**) is reciprocally connected to the primary somatic sensory cortex in the parietal lobe.
 - ii. Medial geniculate nucleus (**MGN**) is reciprocally connected to the primary auditory cortex in the temporal lobe.
 - iii. Lateral geniculate nucleus (**LGN**) is reciprocally connected to the primary visual cortex in the occipital lobe.
 - iv. The **pulvinar** and **lateral dorsal** nuclei are reciprocally connected to the multimodal sensory association cortex of the parietal, occipital and temporal lobes.
- b. The anterior and medial thalamic nuclei are reciprocally connected to the motor systems and the limbic system, which processes. Collectively these thalamic and cortical areas orchestrate coordinated and appropriate behavioral responses to sensory information.
 - i. Ventral anterior (**VA**) and ventral lateral (**VL**) nuclei are reciprocally connected to the primary motor cortex and the motor association cortices (premotor and supplementary motor).
 - ii. Anterior and lateral dorsal nuclei are reciprocally connected to the limbic lobe.
- c. The medial dorsal (**MD**) nucleus is reciprocally connected to the association cortex of the frontal lobe.
- d. Thalamocortical and corticothalamic fibers pass through the internal capsule. The four parts of the internal capsule connect the thalamus to the lobes of the cortex in a topographical arrangement.
 - 1. **anterior limb** interconnects thalamus and frontal lobe

2. **posterior limb** interconnects thalamus and parietal lobe
3. **retrolenticular limb** interconnects thalamus and occipital lobe
4. **sublenticular limb** interconnects thalamus and temporal lobe.

e. In addition, axons that originate in cortex and project to the brainstem and spinal cord also pass through the internal capsule.

- a. **corticobulbar** axons pass through the **genu**
- b. **corticospinal** axons pass through the **posterior limb**
- c. **corticopontine** axons are found in both **anterior and posterior** limbs.

VI. The Ventral Thalamus

- a. The **subthalamic nucleus** is the largest nucleus in the ventral thalamus. It is part of the circuitry of the basal ganglia.

VII. The Hypothalamus

- a. The hypothalamus is a unique area of the brain because, in addition to neuronal signaling, it sends and receives hormonal signals via the vascular system. It also monitors blood glucose levels and the tonicity and temperature of the blood.
- b. Functions:
 - i. controls the anterior and posterior pituitary
 - ii. controls the autonomic nervous system
 - iii. controls behaviors essential for survival, including eating, drinking, sleep, thermal regulation, sexual behavior, parental behavior and aggression.
- c. **Medial Zone** divided into four areas, rostral to caudal:
 - i. **preoptic area (POA)**
 1. Medial POA important in circuitry that controls male sexual behavior and parental behavior; neurons with estrogen and androgen receptors are regulated by endocrine feedback from the testes, ovaries and adrenals.
 - ii. **supraoptic area**
 1. paraventricular and supraoptic nuclei: axons of these cells terminate on capillaries in the posterior pituitary and release oxytocin and vasopressin into the systemic circulation.
 2. suprachiasmatic nuclei are circadian oscillators; form part of circuitry that releases melatonin and influence gonads, thermal regulation and sleep-wake cycles.
 - iii. **tuberal area**
 1. periventricular and arcuate nuclei express receptors for gonadal, adrenal, and thyroid hormones. These nuclei provide feedback regulation for the

- anterior pituitary through the portal venous system.
2. ventromedial nucleus neurons express estrogen, androgen, and progesterone receptors. They belong to neural circuits that control female sexual behavior and aggression.

iv. mammillary area

1. mammillary bodies are large nuclei that receive input from the hippocampus via the fornix and project to the anterior nuclei of the thalamus through the mamillothalamic tract.
 2. damage to the mammillary bodies and their connections with the hippocampus produces anterograde amnesia.
- d. **Lateral Zone** is the **Lateral Hypothalamic Area** that extends through the rostro-caudal length of the hypothalamus
1. an area of diffuse neurons that participate in regulating
 2. autonomic function
 3. sleep-waking cycles and arousal
 4. major connections are with the reticular formation and limbic system
 5. **medial forebrain bundle** is a fiber bundle with both ascending and descending fibers that passes through the lateral hypothalamic area. It makes connections between the limbic areas rostral to the hypothalamus, the hypothalamic nuclei and the brain stem.

VIII. Blood Supply to the Thalamus and Internal Capsule

- A. The thalamus is supplied with blood by arteries from the basilar's terminal branches, the thalamoperforating and thalamogeniculate arteries.
- B. Striate branches from the middle cerebral artery supply the internal capsule. Occlusion of the lenticulostriate arteries is a common cause of strokes that produce contralateral hemiplegia
- C. Blood is supplied to the hypothalamus by many small branches directly off of the arteries of the Circle of Willis