VISUAL REFLEXES

Objectives:
1. Describe the near reflex and its structural basis.
2. Explain how a bright light shined in one eye causes both pupils to constrict.
3. Explain the importance given to dilated pupils in a trauma patient or person with loss of consciousness. What other signs or symptoms would you look for?

I. Midbrain, Tectum and Pretectum

A. Pretectal region

1. Located just in front of the tectum at the junction with the diencephalon. Just rostral to superior colliculus at level of the posterior commissure and junction of midbrain and thalamus. The pineal gland is just dorsal to the pretectal region.

2. Direct and consensual pupillary light reflex is mediated through this area.

B. The oculomotor nucleus, Edinger-Westphal nucleus, and oculomotor nerve at level of the superior colliculus.

Somatic motor functions:

1. Extraocular muscles.

2. Eyelid muscle - levator palpebrae superioris. Lesion causes lid droop (ptosis). This is not the muscle involved in the corneal reflex (orbicularis oculi). (Note: Ptosis can also be due to a lesion in the sympathetic innervation of the smooth muscle component of the eyelid)as in Horner's Syndrome.)
Midbrain sits in the tentorial notch

The pretectum is at the junction of the thalamus and midbrain
C. Edinger-Westphal nucleus has **Visceromotor functions** - parasympathetic, preganglionic cell bodies in the Edinger-Westphal nucleus. Postganglionic cell bodies in ciliary ganglion.

1. Sphincter muscle of iris.
2. Ciliary muscle for reducing tension on the zonular fibers of lens.

II. **Reflexes for adjusting the ocular apparatus.**

Beware that there are minor differences as to the exact location of the pathways and interneurons in various texts, but it does not matter.

A. Direct and consensual **pupillary light reflexes** (Fig. 1) - causes pupillary constriction (miosis)

B. **Near response** consisting of three parts (Fig. 2).

1. Accommodation (increased curvature) of lens.
2. Convergence of eyes.
3. Pupillary constriction.

C. **Pupillary dilatation (mydriasis) in response to dark** (“pupillary dark reflex”, Fig. 3) – Three-neuron pathway that projects from the hypothalamus to the spinal cord, then to the superior cervical ganglion, and finally to the pupil, eyelid, and sweat glands of the forehead and face.
Fig. 1 - Pupillary Light Reflex

Descending hypothalamic-reticulospinal fibers to thoracic sympathetic outflow (lateral horn; T1)

Pineal Gland

Pretectal Region

Pulvinar Thalamus

Brachium of Superior Colliculus

Tegmentum

E.W. Nucleus

R.N.

S.N.

III n.

Cerebral Peduncle

Optic Tract

Ciliary Ganglion

Lesion B

Retinal Ganglion Cells

Iris

Left Eye

LIGHT ON

LIGHT OFF

Iris

Right Eye

Consensual Pretectal Region
This is a cortical reflex based on retinal disparity. There are 3 parts to it:

1. Accommodation of lens
2. Pupillary constriction
3. Convergence

*Only need one hemisphere for reflex.*
Fig. 3 - Pupillary Dilatation Diagram

III. Examples of lesions affecting visual reflexes and oculomotor complex refer to preceding diagrams.

A. Right oculomotor nerve. (A on Fig. 2 - Near Reflex Diagram)
   1. Dilated right pupil and pupillary reflex absent on the right no matter which eye you shine light in. Present on left no matter which eye you shine it on.
   2. Near response reflex absent on the right.
   3. Ptosis on the right.
   4. Lateral strabismus on the right.
   5. Upward gaze paralysis on the right.

B. Left optic nerve. (B on Fig. 1 - Pupillary Light Reflex Diagram)
   1. Blind in left eye.
   2. Direct pupillary reflex absent on left.
   3. Consensual pupillary reflex absent on the right when light shined in left eye.
   4. Near response present both eyes.

C. Blindness due to occlusion of right posterior cerebral artery or middle cerebral artery. (C on Fig. 2 - Near Reflex Diagram)
   1. Left homonymous hemianopia.
   2. Pupillary reflex present.
   3. Near response ok; absent only if bilateral lesion.

D. (RARE Parinaud’s (dorsal midbrain) Syndrome: Compression of pretectum/tectum, possibly due to pineal gland tumor. (D on Fig. 1 - Pupillary Light Reflex Diagram). These symptoms may occur gradually and/or sequentially.)
   1. Upward gaze paralysis-center for upward gaze is near superior colliculus in pretectal region.
2. Pupillary light reflex sluggish or absent due to pressure on pretectal region, may occur with preservation of pupillary constriction to near response: Light-near dissociation.

E. **Horner’s Syndrome**: A problem with central or peripheral control of sympathetic nervous system (Fig. 3 – Pupillary Dilatation Diagram).

1. Ptosis: very slight droop of lid due to involvement of smooth muscle.
2. Miosis: constricted pupil due to unopposed action of **III n**.
3. Anhydrosis: dry skin of face and neck.

**NOTE**: Horner’s Syndrome can result from interruption of hypothalamo- and reticulospinal descending control to the lateral horn of the spinal cord. Preganglionic neurons go to the rostral sympathetic chain and postganglionic neurons travel along the carotid sheath and out to the orbit.

F. **Herniation**

As a result of pressure from an intracranial hematoma (e.g., an extradural hematoma), the following herniations may occur:
(a) of the cingulate gyrus under the falx cerebri;
(b) of the hippocampal gyrus (into the tentorial notch);
(c) of the cerebellar tonsil (into the foramen magnum).
F. Subdural hematoma or increased (supratentorial) intracranial pressure resulting in herniation of the temporal lobe, or uncus, over the edge of the tentorium with compression of III nerve, cerebral peduncle, posterior cerebral artery and reticular activating system in the midbrain = uncal herniation if one side and central herniation if both sides.

1. Involvement of III nerve.
   a. Sluggish or no pupillary reflex, and dilated (blown) pupil. Pupillary fibers of CN III sit on outside of the nerve and are affected first.
   b. Ptosis (III nerve).
   c. Extraocular movements may be normal or less affected (and patient may not respond to command if obtundted or comatose).

2. Involvement of the reticular activating system of the midbrain reticular formation.
   a. Semicomatose tending toward coma = obtundted.
   b. Decreased level of consciousness.

3. Increased motor reflexes or weakness of one or both sides of body due to pressure on one or both cerebral peduncles.
4. Damage of **visual cortex** = cortical blindness due to compression of posterior cerebral arteries during herniation. Less common.

5. **Evaluate uncal herniation by testing:**

   a. Pupillary light reflex
   b. Babinski Response (or flaccidity)
   c. Arousal with pin prick (pain)