UNIT 11 PUPIL AND PUPILLARY REFLEXES

Structure

11.0 OBJECTIVES

After studying this unit, you will be able to understand:

- the reflexes that control the pupillary reaction;
- the neuronal pathways for light reflex and near reflex; and
- to distinguish the main pupillary defects.

11.1 INTRODUCTION

Recall from the anatomy block (Block 1 of BOS-003) that the pupil is the centremost apperture of the iris, a contractile structure that regulates the amount of light entering the eye and increases the depth of focus for near vision. The normal diameter of the pupil is 2 to 4 mm. The size is controlled by the sphincter pupillae and the dilator pupillae.

11.2 PUPILLARY REFLEXES

There are two types of reflexes which control the pupillary reaction—the light reflex and near reflex. When light is shown on one eye, there is a constriction of the pupil (a direct light response). Simultaneously there is a constriction of the contralateral pupil (consensual light response). With the near reflex, the pupil contracts on accommodation and convergence.

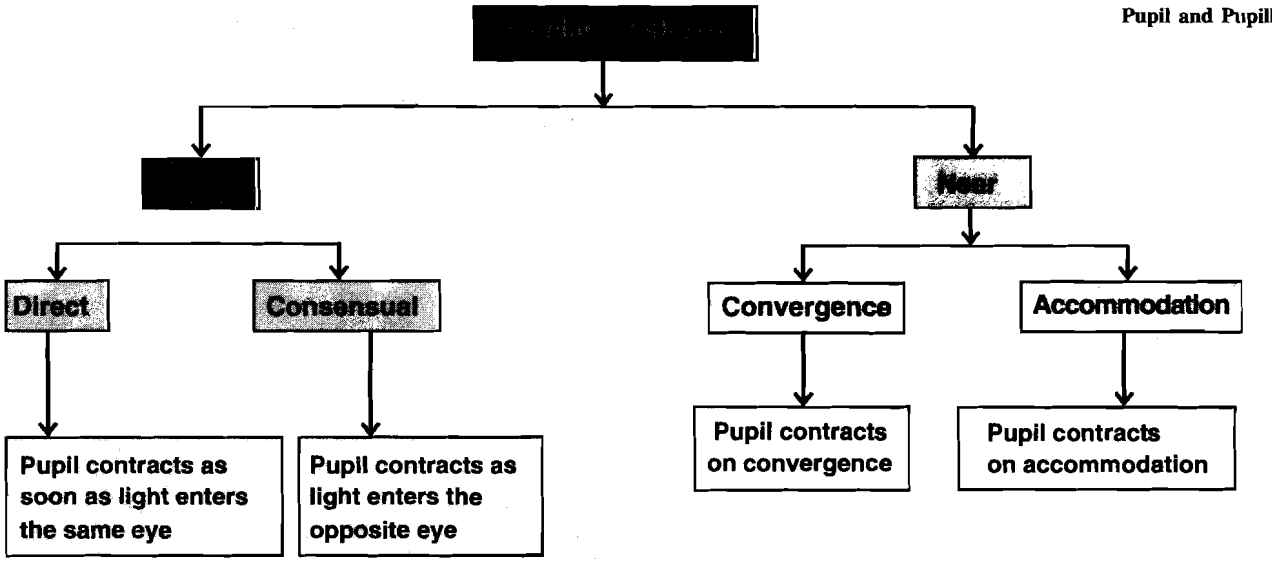

Fig. 11.1: Pupillary Reflexes

11.3 PUPIL

Pupil is the aperture in centre of the iris diaphragm that regulates entry of light into the eye. Colour of pupil is said to be black. Actually, pupil has no colour as it is not a structure. It is seen black because of darkness behind. In case of cataract it becomes gray or white.

11.3.1 Appearance of the Pupil

The pupil should appear round and regular. The normal diameter is 2-4 mm. On stimulation by light, the pupil constricts, so as to reduce the amount of light entering the eye.

Variation in the size, shape or reaction usually indicates some form of disease, disorder or use of medication. The pupil is usually dilated by the use of a topical mydriatic drug in the eye. In other cases dilation can occur due to acute glaucoma, retinal pathologies, optic nerve damage, and third nerve palsy. The pupil appears constricted in iritis and CNS diseases. Physical and physiological factors such as light intensity, light adaptation, refractive status, emotional factors, and age also affect the size of the normal pupil. The size and reactivity of the pupil are a measure of parasympathetic and sympathetic tone. The pupil may be irregularly shaped in cases of anterior synechiae (due to corneal perforation) and in posterior synechiae (iridocyclitis and glaucoma).

11.3.2 Accommodation

Accommodation is the ability of the overall refracting power of the eye to change to clearly view objects at different distances. This occurs due to:

1) a change in the curvature of the lens,
2) change in the distance between the cornea and retina,
3) placement of another lens system between the cornea and retina,
4) two or more optical pathways with different refractive powers.

11.3.3 Neuronal Pathways

Light Reflex

The neuronal pathway for light reflex can be afferent and efferent. In the afferent pathway, the pupillary fibres begin in the retina and follow to the pretectal area where synapse takes place. From that location, the fibres are projected to the Edinger- Westphal nucleus. In the efferent pathway, the iris is innervated by the Edinger Westphal nucleus. From the Edinger-Westphal nucleus in the midbrain, the fibres go to the III cranial nerve and then to the sphincter pupillae.

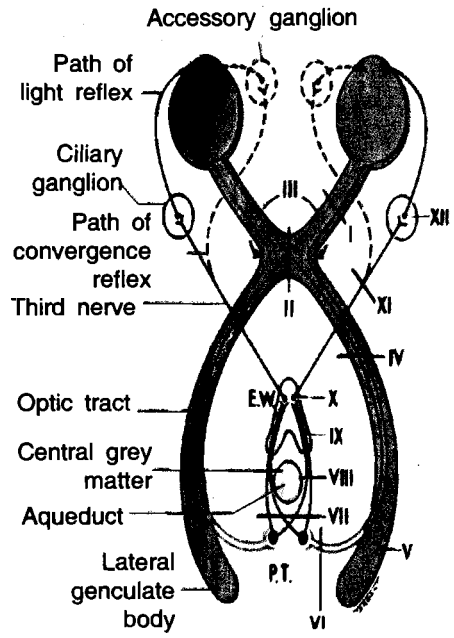

Fig. 11.2: Light reflexes

Near Reflex

The primary stimulus is the blurred image on the retina. In the afferent pathway of accommodation, the initiation for a near reflex begins in the cortical centres. The visual fibres are then projected equally to the Edinger-Westphal nuclei on either side through the occipito-mesencephalic tract. The efferent pathway is the same as that for the light.

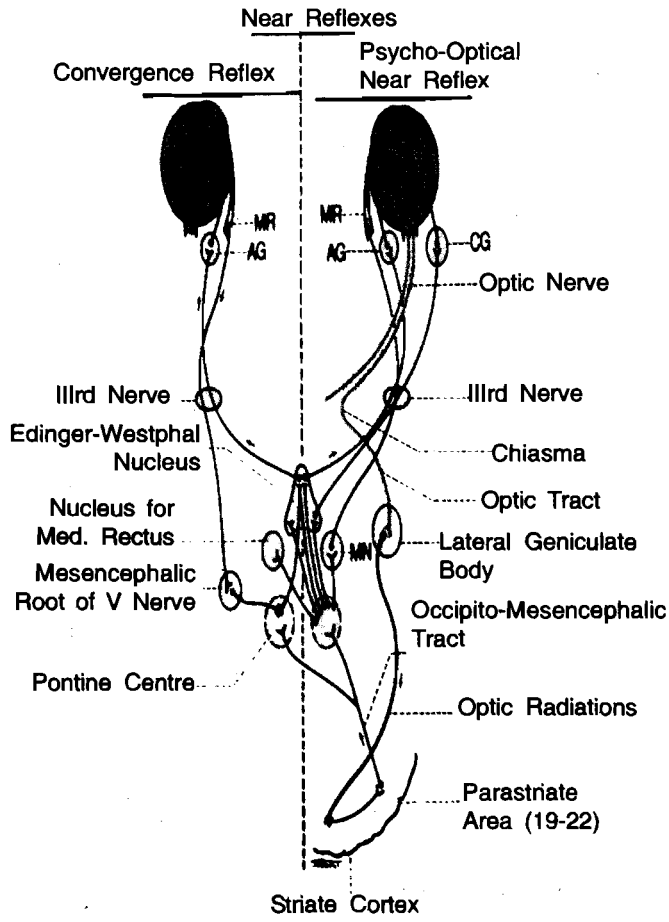

Fig. 11.3:Near reflexes

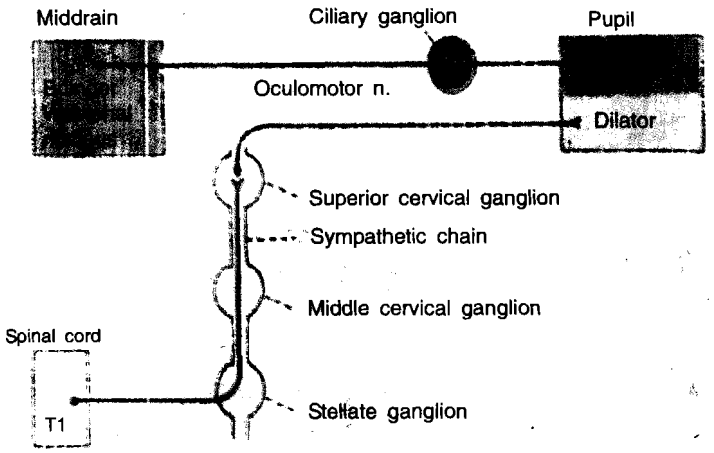

Fig. 11.4: Scheme to show the innervation of the pupil

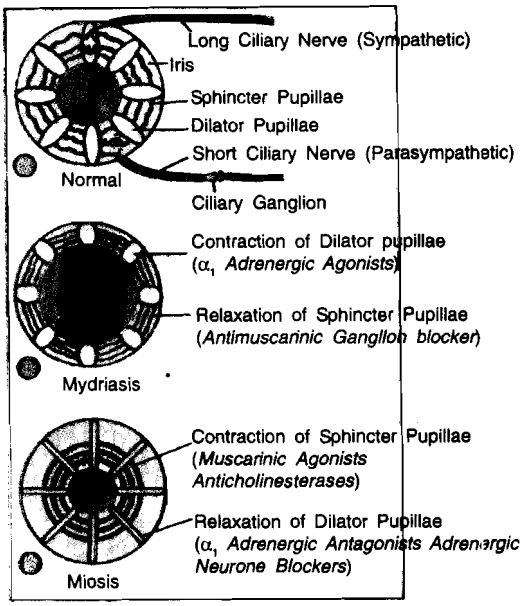

Fig. 11.5: Autonomic control of pupil (A); and site of action of mydriatics (B) and Miotics (C)

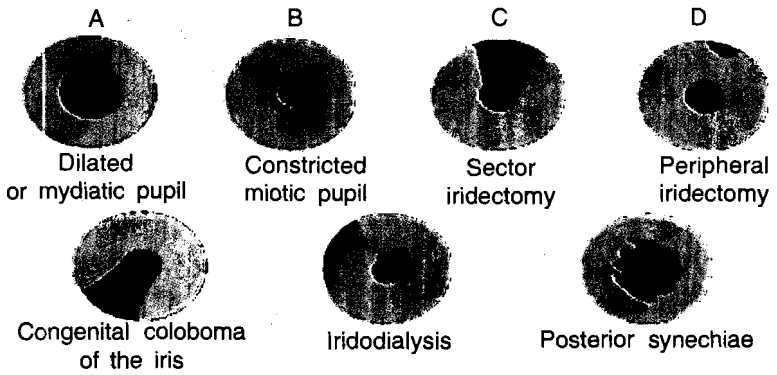

Fig. 11.6: Variations in pupillary size and shape

Check Your Progress 1

1) What is the swinging flashlight test used for?

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2) Where do the two neuronal pathways diverge?

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11.4 PUPILLARY DEFECTS

There are certain deviations from normal pupillary reflexes which point towards certain specific pathology. Such pupillary defects are described below.

11.4.1 Marcus Gunn Pupil (RAPD)

Relative Afferent Pupillary Defect occurs in a pupil of an eye that is blind from optic nerve disease. When light is shifted to the affected pupil it will dilate instead of remaining constricted. This happens because the input from the optic nerve to

the midbrain from the affected side is less than from the normal side. A Swinging flashlight test can be performed to confirm this disorder.

Swinging Flashlight Test

The patient looks into the distance while the examiner shines a bright light first into one eye for a few seconds and then the other. As the light shifts from the normal eye to the affected eye, the direct light stimulus is not enough to keep the pupils small, therefore both eyes dilate.

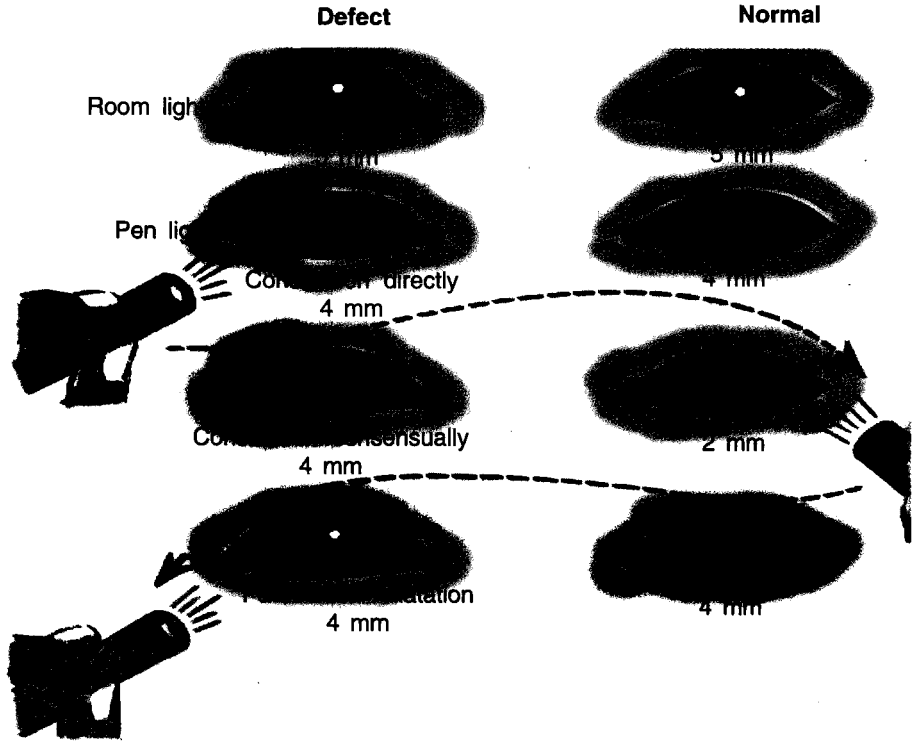

Fig. 11.7: Swinging flashlight test

11.4.2 Argyll Robertson Pupil (ARP)

Argyll Robertson Pupil (ARP) occurs in patients who have tertiary syphilis. There is a "light-near dissociation" because pupils react better to near than to light. An accommodation reflex is present and pupillary light reflex is absent.

Light-Near Dissociation Test

The near response should be tested in a well lit room so that the object is clearly visible. The patient is given an accommodative target to look at (e.g., a detailed object).

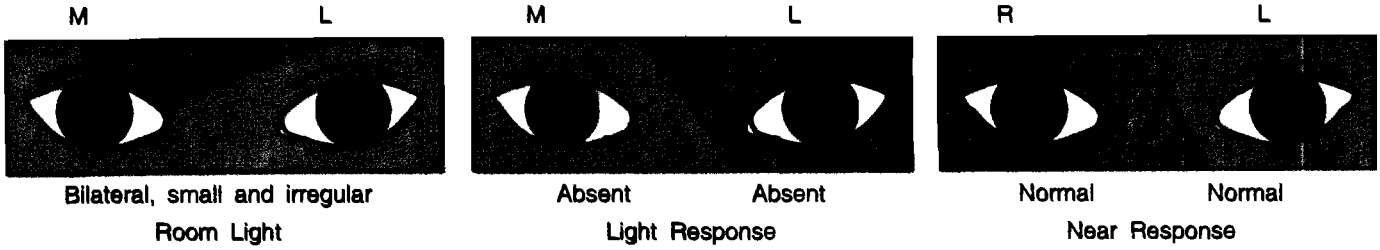

Fig. 11.8: Argyll Robertson pupil

11.4.3 Adie's (Tonic) Pupil

In Adie's syndrome there is no evident cause for the denervation. Most patients are women, aged 20-40 and have poor light reaction in one eye. When examined with a slit lamp some sphincter response can be seen but in most cases the pupils of affected eyes have lost half of sphincter function.

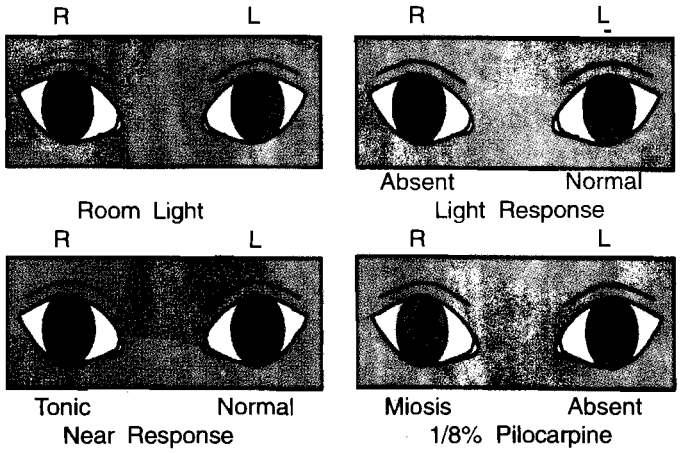

Fig. 11.9: Adie's pupil

11.4.4 Horner's Pupil

Horner's syndrome occurs because of ipsilateral interruption of the sympathetic outflow to the head and neck. It can result from lesions anywhere along the sympathetic pathway. The characteristics of Horner's syndrome are miosis, ptosis, enophthalmos, anhidrosis, and hetero-chrome iridis. There is a dilation lag in Horner's patients because of a sympathetically denervated iris. The Horner's pupil dilates more slowly than the normal pupil does because it lacks the pull of the dilator muscle.

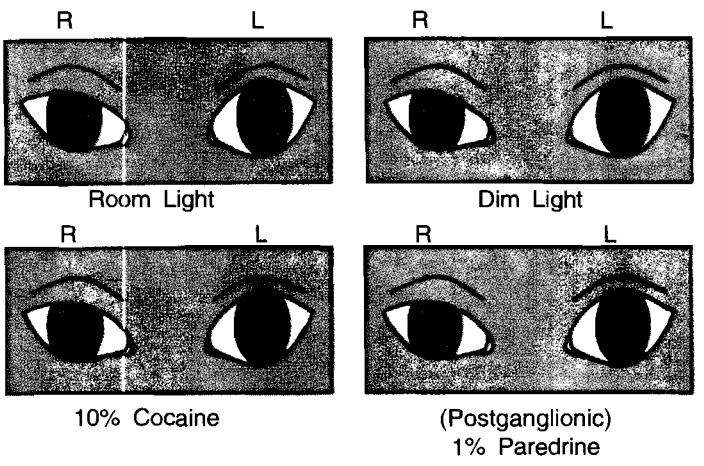

Fig. 11.10: Horner's pupil

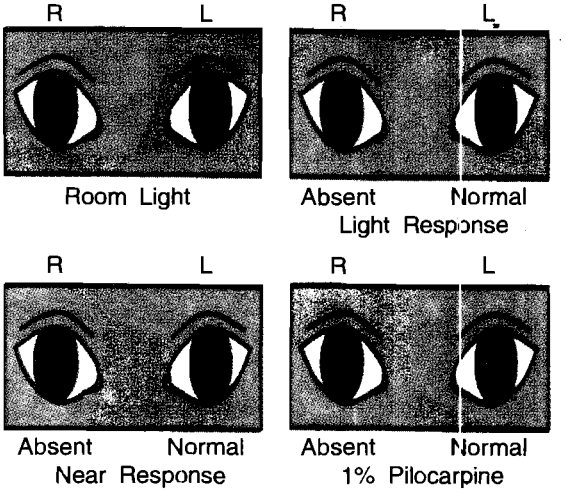

Fig. 11.11: Toxic pupil

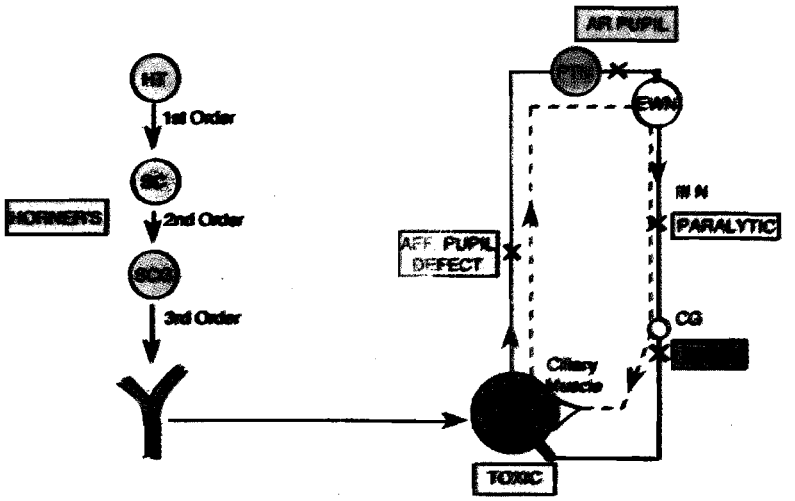

Fig. 11.12: Abnormal pupil — sites of lesion

11.4.5 Iris Coloboma

Coloboma is a congenital abnormality due to non-fusion of the embryonic choroidal fissure. It can affect any part of the eye and may involve the optic nerve, retina, and choroids. Less commonly the iris and lens may be affected.

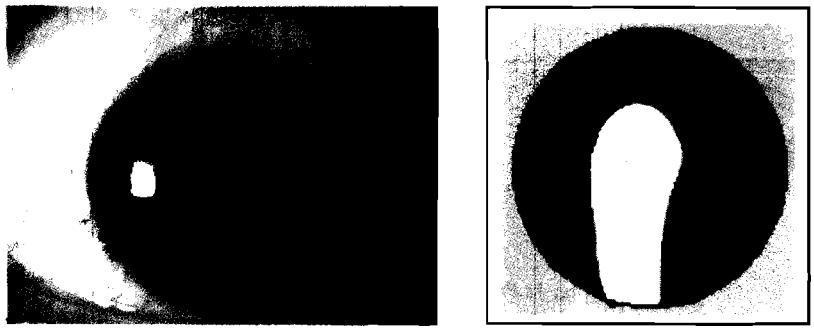

Fig. 11.13: Iris coloboma

Check Your Progress 2

1) What are the signs of Horner's syndrome?

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2) Where is the defect in the Argyll Robertson pupil?

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11.5 LET US SUM UP

In this unit you have learnt the two types of reflexes that control the pupil are the light and near reflex. Accommodation is the ability of the overall refracting power of the eye to change to clearly view objects at different distances. The main pupillary defects are the Marcus Gunn pupil, Argyll Robertson pupil, Adie's pupil, Horner's pupil, and Iris Coloboma. In next unit you will study about muscles and movement of the eye.

11.6 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1) It is done to check the relative afferent pupillary defect in an eye that is blind from optic nerve disease.

2) For both the neuronal pathways i.e. light reflex and near reflex the efferent fibres go to are 3rd cranial nerve and then to sphincter pupillae.

Check Your Progress 2

1) Miosis, ptosis, enophthalmos, anhidrosis and heterochrome iridis.

2) The defect in Argyll Robertson pupil is due to light near dissociation because pupil react better to near than light.