بسم الله الرحمن الرحيم

A STUDY OF THE DRUGS ACTING ON THE AUTONOMIC NERVOUS SYSTEM OF THE HUMAN EYE

A THESIS

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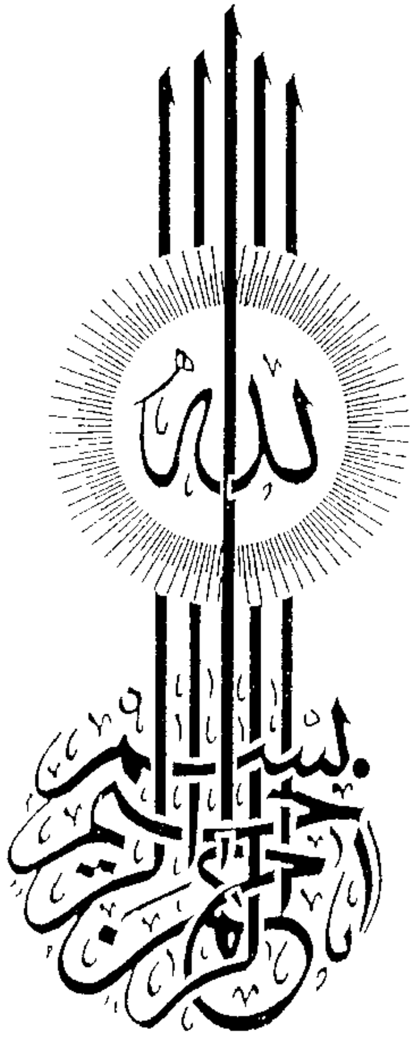
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ANATOMY

ANATOMY & DISTRIBUTION OF THE AUTONOMIC NERVOUS SYSTEM OF THE EYE

The autonomic nervous system includes part of the central and part of the peripheral nervous system , the latter being concerned with the innervation of the smooth muscles and the glands throughout the body,(Gray, 1973).

By definition it is entirely a motor (efferent) system,and it is "automatic" in the sense that most of its functions are carried out below the level of conscious.It is however highly integrated in structure and function with the rest of the nervous system,(Chusid, 1958).

It is divided,on the basis of function and outflow from the central nervous system,into sympathetic and parasympathetic portions.

A. SYMPATHETIC NERVOUS SYSTEM OF THE HUMAN EYE :(Fig.1)

The effective integrating center for the control of the sympathetic muscular activities associated with the eye is in the intermedio-lateral tract of grey matter of the lower cervical and upper thoracic region of the spinal cord "the inferior cilio-spinal center of Budge".

A "superior cilio-spinal center" is present in the medulla near the hypoglossal nerve,it subserves

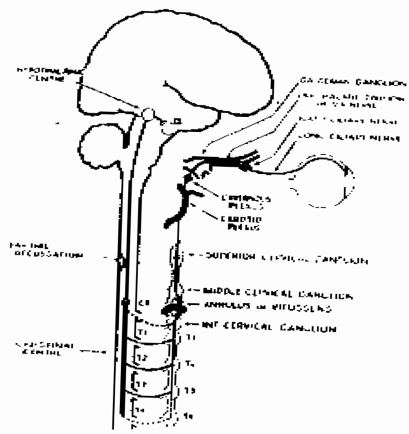

Fig.1: Sympathetic pupillary system.

(From Duke-Elder,J.S.,: System of Ophthalmology,The anatomy of the visual system, 1961).

pupillary dilatation.

Arising in the intermedio-lateral tract of the grey matter of the cord, in the cilio-spinal center, the preganglionic sympathetic fibers leave the central nervous system by the ventral roots of the thoracic nerves I to III. Most of the fibers going to the eye are said to leave in the 1st thoracic root. The white rami communicantes continue the course of the fibers up the cervical sympathetic chain, they travel through the inferior and middle cervical ganglia to the superior cervical ganglion where most of them terminate, (Duke Elder, 1961).

It seems, however, that other fibers may travel to the eye by way of the sympathetic plexuses associated with the vertebral and the basilar arteries, they leave the sympathetic chain immediately above the first thoracic ganglion and may be relayed in the ciliary ganglion. Others probably travel to the sympathetic cells scattered throughout the uveal tract which are sometimes collectively known as the ganglion of Müller.

In the superior cervical ganglion, which is situated at the base of skull between the internal jugular vein and the internal carotid artery, synapses occur between medullated white rami communicantes and neurons. Then the postganglionic sympathetic fibers are nonmedullated.

From the ganglion,branches are given off to the blood vessels of the head; the nervi carotici externus and the nervi carotici internus. The nervi carotici internus accompanies the carotid artery through the carotid canal to the skull.Here it breaks up into fine plexus closely adherent to the vessel wall and divisible into an internal carotid plexus on the lateral wall of the artery near the apex of the petrous bone and a cavernous plexus on the infero-medial aspect of the artery in the cavernous sinus.Almost all sympathetic branches to the orbit and all those to the eye are derived from the latter,and enter the orbit through the superior orbital fissure.

The pupillo-dilator fibers and the vasomotor fibers run in a separate paths. Section of the 1st thoracic and the 2nd thoracic nerves in the dogs,produces dilatation of the pupil but no vasomotor effects,while section of the 3rd thoracic nerve leads to the reserve effects. The two sets were found to be separated in the cervical sympathetic trunk in the carotid plexus and in the ciliary ganglion,(Duke Elder,1961).

From these arterial plexuses the sympathetic outflow to the orbit may be classified as follows :-

A. From the cavernous plexus the following branches are given off :

I. To the 3rd nerve at its point of division.

2. To the 4th nerve.

3. To the Gasserian ganglion and also to the ophthalmic division of 5th nerve, the fibers travel along the nasociliary branch of the ophthalmic to reach the globe by the long ciliary nerves. These fibers are specially concerned with pupillary dilatation.

4. To the ciliary ganglion, as its sympathetic root, entering the orbit as a small twig through the superior orbital fissure, and passing through the ganglion to the eye in the short ciliary nerves. These are essentially vasomotor.

5. Vascular branches are continued along the ophthalmic artery and each of its twigs.

B. From the carotid plexus the following branches are given off :

1. To the 4th nerve, as it crosses the internal carotid artery in the cavernous sinus.

2. Vascular branches following the branches of the ophthalmic artery mainly vasomotor, and also containing fibers accompanying the lacrimal artery to the lacrimal gland.

3. By way of deep petrosal nerve and the vidian nerve of the pterygoid canal to the spheno-palatine ganglion,and then through the inferior orbital fissure to supply the periorbita,the involuntary orbital muscle of Muller,and,perhaps, the lacrimal gland by being incorporated with zygomatic nerve.

It is also to be noted that all the sympathetic fibers to the eye itself enter the globe by the way of the ciliary nerves.It is also of importance to remember that these vascular plexuses which surround the great vessels and their branches are by no means entirely composed of postganglionic sympathetic fibers; they also contain parasympathetic fibers as well as afferent autonomic fibers,while small clumps of autonomic ganglia are not uncommonly found among them.

Seven types of fibres are contained in the sympathetic supply to the eye and orbit :-

1. Sympathetic oculo-motor fibres to the dilator pupillae and the ciliary muscle.
2. Vasomotor nerves to all types of ocular vessels: arteries,capillary and veins.The function of the nerves is largely vasoconstrictive (adre-nergic) although the presence of vasodilators

(cholinergic) in the sympathetic system is established, nothing is known of their ocular effects. Anatomically, the sympathetic fibers can be traced to the uveal vessels and also through the nerve of Tiedemann to the retinal vessels. Their constrictive effect on the vessels of the uveal tract is beyond doubt, although it is relatively small, but their precise effect upon the retinal circulation has been questioned Bailliart and his colleagues (1952) observed a transient vasoconstriction in the retinal arteries of the dog on stimulation of the sympathetic and a dilatation after section of the spinal cord.

3. Fibers to the plain muscle of Muller.
   Stimulation of the orbital muscle produces proptosis in animals but no such effect has been demonstrated in man.
4. Nerves to the chromatophores in the uveal tract.
5. Fibers to the extrinsic ocular muscles, the recti and obliques.
6. Fibres to the lacrimal gland.
7. Autonomic fibers in association with the vaso-motor supply of the retina travel to the pigment epithelium.

B. PARASYMPATHETIC NERVOUS SYSTEM OF THE EYE :(Fig.2)

Parasympathetic ocular activities are mediated by Edinger-Westephal and perhaps by the median nucleus of Perlia in the third nerve nuclear complex.

This center receives two sets of afferent fibers.The first is from the higher autonomic centers, involving both stimulation and inhibition from the hypothalamus and anterior thalamus through which it is connected to the frontal and occipital cortex and to the limbic lobe.The second is from the retina from which afferent fibers subserving the pupillary reactions reach the pretectal nucleus to be relayed to the Edinger-Westephal nucleus.

The nucleus of Edinger-Westephal probably subserves the pupillary musculature.It is paired and interposed anteriorly between the two lateral nuclei.It is composed of small multipolar cells of the preganglionic autonomic type.

The nucleus of Perlia is probably concerned with convergence.It lies close to the center of the medial rectus muscle,and thus convergence and medial movement,whose centers lie close together,although often affected together,are not necessary so,(Wolf,1976).

The parasympathetic system has two outflow: cranial and sacral.The cranial outflow is divided into

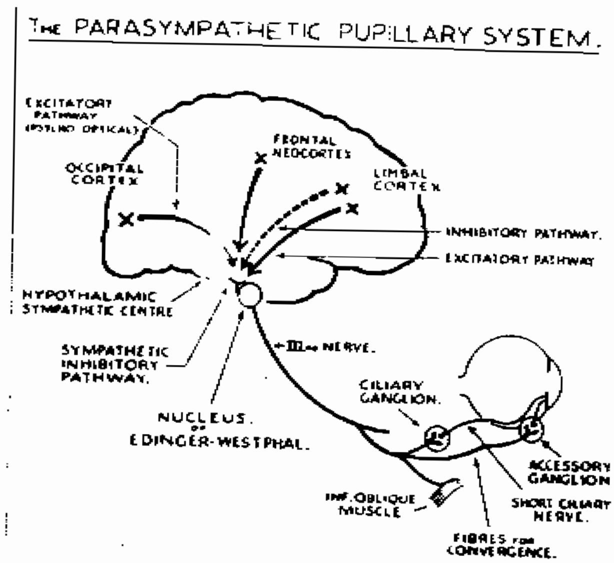

Fig 2: The Parasympathetic pupillary system

(From Duke-Elder,J.S.: System of Ophthalmology, the anatomy of the visual system,1961).