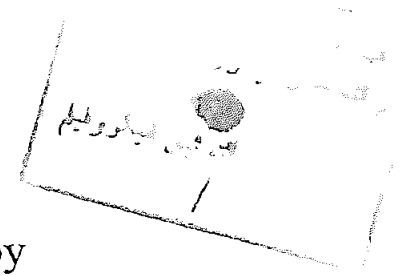
EVALUATION OF OPTIC NERVE IN EARLY OPEN ANGLE GLAUCOMA

Essay



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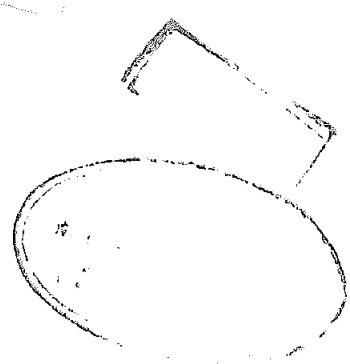

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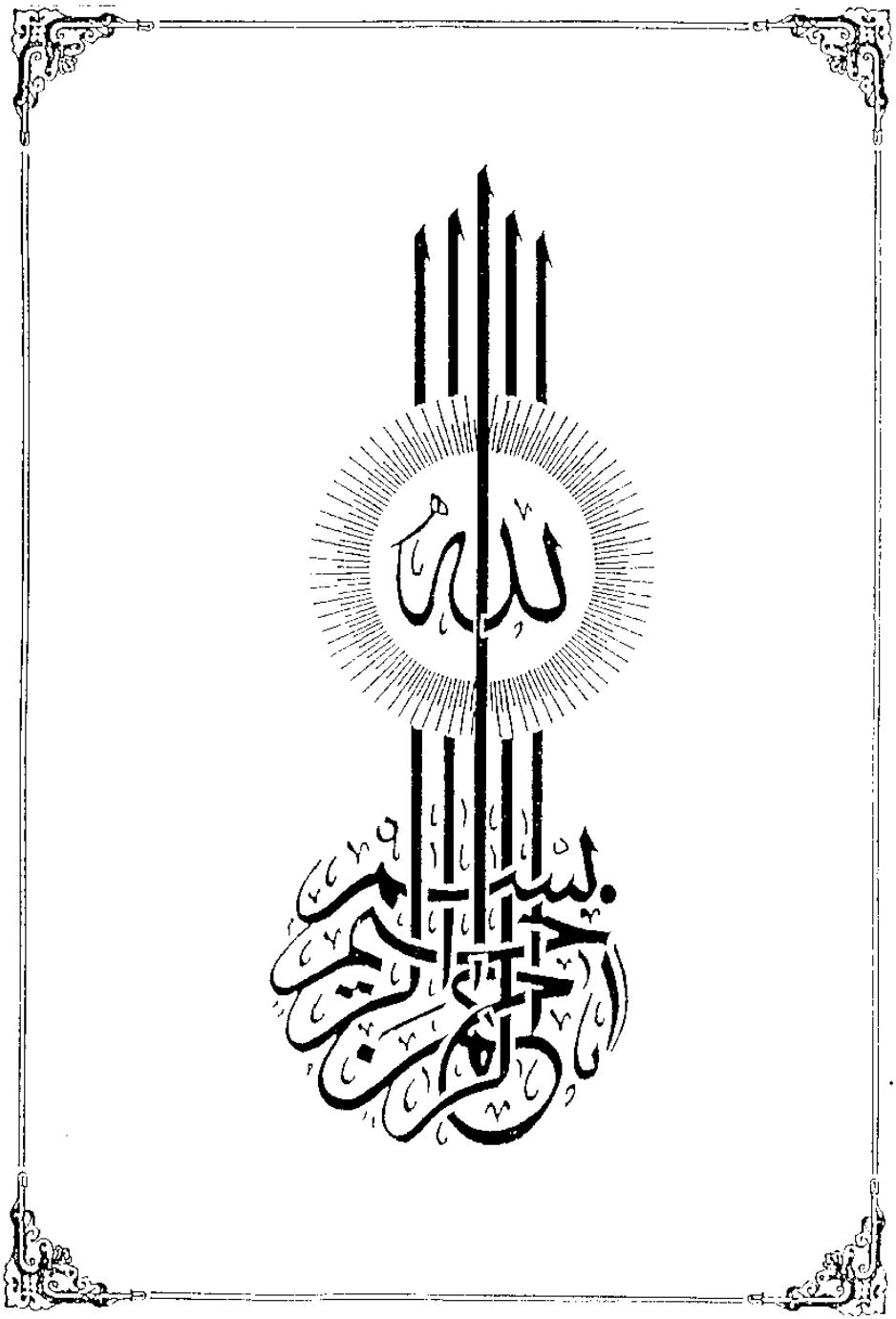
بسم الله الرحمن الرحيم

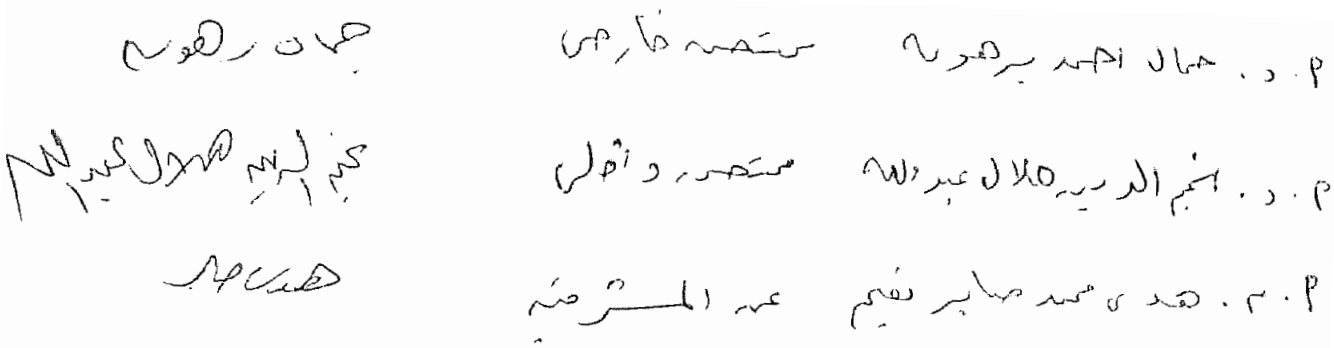
سبحانك

لا علم لنا إلا ما علمتنا إنك أنت العليم الحكيم

"صدق الله العظيم"

(سورة البقرة – آية ٣٢)





To My Family

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Abbreviations

CLV	:	Corrected loss variance.
dB	:	Decibel.
ERG	:	Electroretinogram.
IOP	:	Intraocular pressure.
LE	:	Left eye.
M	:	Macula.
N	:	Negative.
NFL	:	Nerve fiber layer.
OAG	:	Open angle glaucoma.
OHT	:	Ocular hypertensive patient.
ONH	:	Optic nerve head.
P	:	Positive.
PERG:	:	Pattern electroretinogram.
PVEP	:	Pattern visual evoked potential.
RE	:	Right eye.
RNFL	:	Retinal nerve fiber layer.
RPCs	:	Retinal peripapillary capillaries.
SD	:	Standard deviation.
VEP	:	Visual evoked potential.

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Introduction and Aim of the Work

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Open angle glaucoma is a chronic slowly progressive disease in which the anterior chamber angle, as seen with the goniolens, is open even the pressure is elevated **(Hogen and Zimmerman,1962)**.

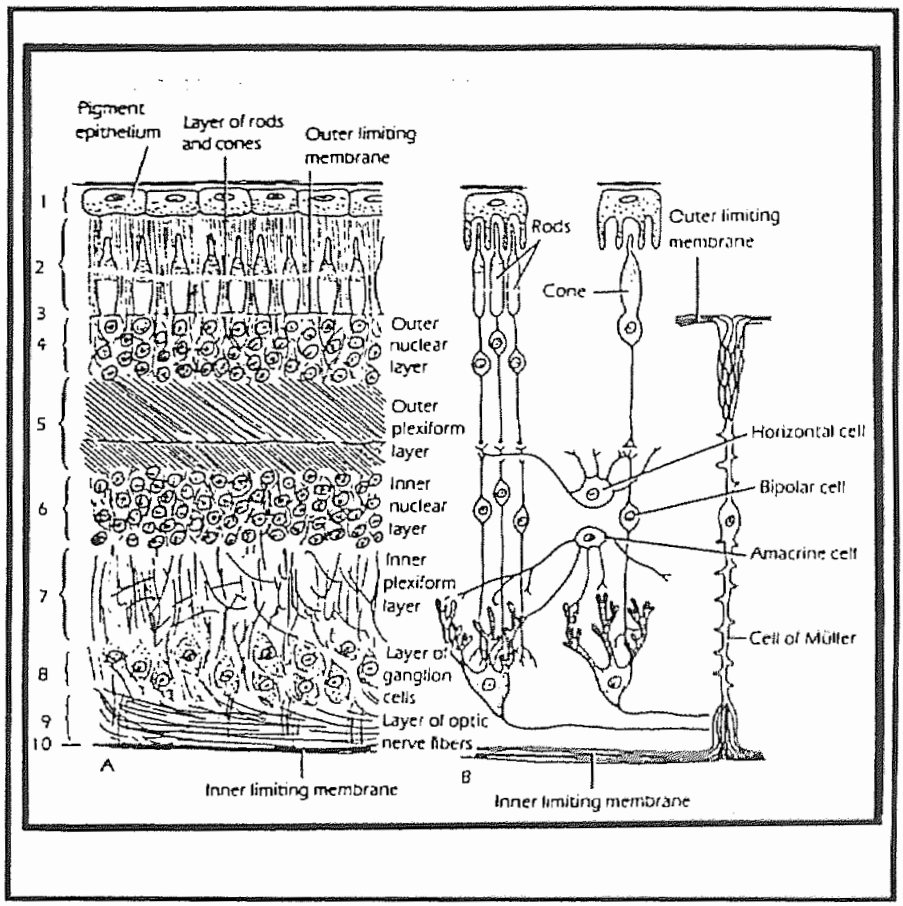
Open angle glaucoma is a very injurious disease. A large number of patients present for the first time with serious visual field defects and irreversible optic nerve damage due to pathological changes affecting the inner retinal layers and optic nerve fibers.

Many methods that have been described for early diagnosis of open angle glaucoma. Among which are :

- Automated perimetry.
- Nerve fiber layer assessment.
- Optic nerve head topography.
- Psychophysical tests.
- Electrophysiological tests.
- Fluorescein angiography.

The aim of the present essay is to evaluate the early functional and structural changes which affect the optic nerve in cases of open angle glaucoma for better assessment and diagnosis of open angle glaucoma .

Anatomy



(Fig. 1) Schematic representation of the neural retina.
(Quoted from Snell and Lemp, 1989).

ANATOMY

Ganglion Cell Layer Anatomy

The ganglion cells are so named because they resemble cells found in the nervous ganglia. They are situated in the inner part of the retina. The ganglion cells are the second neuron in the visual pathway . They vary in diameter from 10 to 30 μm. Most of them are small (midget ganglion cells) but a small number are large. The ganglion cells are multipolar cells and their dendrites synapes with the axons of bipolar cells and amacrine cells. The midget ganglion cells are linked by single midget bipolar neurons to a single cone cell (**Fig.1**). The ganglion cells have non-myelinated axons that make a right angled turn when they reach the inner surface of the retina. The axons then converge at the exit of the optic nerve at the optic disc. In most of the retina the ganglion cells form a single layer, however, the number of layers increases from the periphery of the retina to the macula where there may be as many as ten layers. They decrease again towards the fovea where they are absent **(Snell and Lemp, 1989).**

Nerve Fiber Layer (NFL) Anatomy

From each retinal ganglion cell, a single axon extends into the retinal nerve fiber layer towards the optic nerve head . Within the nerve fiber layer, axons are grouped into individual channels formed by elongated glial processes of Muller cell origin. The cell bodies of the Muller processes are located deeper to the nerve fiber layer within the inner nuclear layer.The extended processes of these specialized astrocytes

and other glial cells within the retina envelop individual axons and ganglion cell bodies, separate neural tissue from retinal vasculature and provide structural support for the various tissue elements within the inner retinal layers(**Radius,1994**).

Another aspect of the anatomy is the topography of the nerve fibers in the optic nerve head in relation to their site of origin in the retina. This is important in understanding visual field defects.The axons from peripheral retina enter the peripheral part of the optic nerve,while those of the posterior retina enter its central part.The superior,inferior and nasal axons run relatively straight paths towards the disc, as do the axons of the neurons of the nasal macula which form the papillomacular bundle (**Fig.2**).The rest of the temporal axons take a curved route and enter the upper and lower temporal portions of the disc (**Henkind et al., 1979**).

The convergence of ganglion cell axons from the retinal periphery towards the optic disc gives rise to an increasing thickness of the nerve fiber layer as the nerve head is approached in the nasal half of the retina. This leads to a nerve fiber layer thickness of 40 to 60 μm at 1 mm from the nerve head. At the superior pole, the greater number of temporal retinal ganglion cells that send axons over the foveal area crowded together to give a nerve fiber layer thickness twice that of either the nasal retina or the nerve fiber layer zone between the fovea and the nerve head. The thickest zone of NFL occurs at the 12-and 6-o'clock positions at the rim of the nerve head, where it measures almost 320 μm.The visibility of NFL striations depends on two factors; the thickness of the NFL and the nature of the glial separations.In the normal nasal retina,1mm from the nerve head, the striations are often uniform and well separated by dark

linear stripes.The likely explanation for NFLstriations is that light passes through the internal limiting membrane and is differentially reflected back to the viewer from the nerve bundle and the glial septa that separate them **(Quigley et al., 1982)**.

Anatomy of the vasculature of the inner retina

Within the inner retina, there are blood vessels which originate from the central retinal artery.These small caliber vessels lack sympathetic innervation and they are impermeable to fluorescein dye. Within the retina the arterioles divide into three relatively distinct capillary layers; **(1)** a deep, mesh-like capillary bed, lying mainly in the inner nuclear layer.**(2)** a superficial mesh-like capillary bed situated mainly at the ganglion cell level and **(3)** a very superficial retinal capillary bed lying within the nerve fiber layer, the radial peripapillary capillaries (RPCs), distinctly different from the other retinal capillaries though originating from the same retinal arterioles. It is this bed of RPC's which may be of some interest in glaucoma. The RPC's are elongated superficial retinal capillaries with few interconnections which have a distribution at the posterior pole, mainly supero-and inferotemporal to the optic nerve head and are absent in the papillomacular bundle. Thus, their anatomical distribution resembles a double Bjerrum scotoma. All retinal capillaries drain into branches of the central retinal veins **(Henkind et al., 1979)**.

Optic Nerve Head
Anatomy

At the optic nerve head all axon fiber bundles turn to exit from the eye through the scleral canal. The canal is not truely perpendicular but instead runs from lateral to medial and slightly inferior as it traverses the eye wall. Consequently axons from the nasal retina turns acutely at the nerve head whereas axons from the temporal retina follow a more obtuse angle as they enter the nerve. **(Anderson,1989)**.

Nerve fiber bundles occupy the margins of the nerve head, whereas the central retinal vessels and associated adventitia are near the core **(Fig.3)**. The central part of the nerve, devoid of tissue, is referred to as the optic cup. The size of this central cup depends up on the actual number of neurons within the optic nerve and the dimensions of the scleral canal. **(Anderson,1989)**.

Hoskins and co-workers (1989) described the average horizontal diameter of the optic nerve head as 1.618 mm and the vertical diameter as 1.796 mm.The diameter of the optic nerve head depends upon the diameter of the scleral canal at the level of Bruch's membrane. The canal is usually conical in shape, the posterior part is wider than the anterior part but it may be cylindrical and very rarely it may either be of triangular type with its central parts narrowest or an elbow extension type with the central part widest. The ophthalmoscopic configuration of the optic nerve head and the size of the physiological cup depend on the size, shape and the direction of the scleral canal . The smaller the canal diameter, the smaller is the cup and vice versa **(Hoskins and Kass, 1989)**.