

PHYSIOLOGICAL SENILE CHANGES OF THE HUMAN EYE

**An essay submitted
in partial fulfillment of master
degree in ophthalmology**

***By*
Mohammad Alaa El-Din El-Esawi**

***Under supervision of
Prof. Dr.
Golzamin El-Hawary
Professor of ophthalmology
Faculty of Medicine
Ain Shams University***

***Dr.
Dina Ezzat
Ass. professor of ophthalmology
Faculty of Medicine
Ain Shams University***

***Faculty of Medicine
Ain Shams University***

2009

تغيرات الشيخوخة الفسيولوجية للعين البشرية

رسالة مقدمة توطئة للحصول على
درجة الماجستير في طب وجراحة العين

محمد علاء الدين العيسوي

الأستاذة الدكتورة / جلزمين الهواري
أستاذ طب وجراحة العين
جامعة عين شمس

الدكتورة / دينا عزت
أستاذ مساعد طب وجراحة العين
جامعة عين شمس

كلية الطب
جامعة عين شمس
٢٠٠٩

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to Professor Dr. Golzamien El- Hawary, professor of ophthalmology, Ain Shams university , for her great encouragement , sincere guidance, supervision and for her enrichment with her vast experience and valuable instructions.

I also feel greatly indebted and grateful to Dr. Dina Ezzat, assistant professor of ophthalmology, Ain Shams university, for her guidance , great help and actual support in this study.

CONTENTS

	Page
I. Introduction	1
II. Aim of the work	3
III. The eyelids	4
.Anatomy	4
.Physiological senile changes	7
<i>Clinical changes</i>	7
<i>microscopic changes</i>	10
IV. The lacrimal system	17
.Anatomy	17
.Histology of the lacrimal gland	19
.Physiological senile changes	20
V. The conjunctiva	23
.Anatomy and histology	23
.Physiological senile changes	26
VI. The cornea	29
.Anatomy	29

.Physiological senile changes	33
<i>Clinical changes</i>	33
<i>Corneal shape changes</i>	36
<i>Structural changes</i>	38
VII. Trabecular meshwork	44
.Histology and physiology	44
.Physiological senile changes	46
VIII. The human lens	51
.Anatomy	51
. Physiological senile changes	55
<i>Anatomical and histological changes</i>	55
<i>Biometric, optical and physical changes</i>	61
<i>Metabolic changes and the effect of external agents</i>	64
IX. The vitreous	72
.Anatomy	72
.Physiological senile changes	76

X. The iris	81
.Anatomy	81
.Physiological senile changes	86
XI. The ciliary body	88
.Anatomy	88
.Physiological senile changes	93
XII. The choroid	97
.Anatomy, physiology and histology	97
.Physiological senile changes	100
<i>Accumulation of Debris</i>	100
<i>Lipid Deposits</i>	101
<i>Changes in the Extracellular Matrix</i>	102
XIII. The Retina	103
.Anatomy	103
.Physiological senile changes	107
XIV. References	117
XV. Summary	153
XVI. Arabic Summary	156

LIST OF ILLUSTRATIONS

Figure	Page
Fig. 1: Anatomy of the eyelids	6
Fig. 2: Change of the shape of the upper eyelid with age	7
Fig. 3: Blepharochalasis	8
Fig.4: Severe bilateral involutional ptosis	8
Fig.5: Senile entropion	9
Fig.6: Senile ectropion	10
Fig. 7: Electron microscopy of aged orbicularis muscle fibers.	11
Fig. 8: Nemaline bodies (rods).	11
Fig.9: Numerous large mitochondria in the subsarcolemmal area.	12
Fig.10: Crystalline mitochondrial inclusion.	12
Fig. 11: Irregular distribution of the succino-dehydrogenase activity in aged muscle.	13
Fig. 12: Tubulo-reticular aggregates.	14
Fig. 13: Fingerprint inclusion.	14

Fig. 14: Filamentary sarcoplasmic inclusion.	15
Fig. 15: Paracrystalline sarcoplasmic inclusion.	15
Fig. 16: Transversal section of the interstitial connective tissue of orbicular muscle.	16
Fig.17: Anatomy of the lacrimal system.	17
Fig18: Histological findings of age-related changes of the lacrimal gland.	21
Fig. 19: Lobular atrophy with fibrosis.	22
Fig.18: Parts of the conjunctiva.	24
Fig.19: Histology of the bulbar conjunctiva of normal adults.	26
Fig.20: Photomicrographs demonstrating representative impression cytologic specimen staining from the eyes with and without conjunctivochalasis.	28
Fig. 21: Anatomy of the cornea.	30
Fig. 22: Confocal images of the anterior and posterior stroma with different Keratocyte density.	32

Fig. 23: Specular microscopy image of a normal adult endothelium.	33
Fig.24: Peripheral ring of corneal arcus as seen at slit lamp.	35
Fig. 25: Both crocodile shagreen and limbal gridle of Vogt.	36
Fig. 26: Typical structure of the corneoscleral- trabecular meshwork .	44
Fig. 27: Typical structure of the uveal meshwork.	45
Fig. 28: Typical age-related changes of corneoscleral trabecular meshwork: increased electron density of the collagen and decrease of fibril- granular material.	47
Fig. 29: Typical age-related changes of the trabecular meshwork: accumulation of electron-dense material, decrease of fibril-granular material, and increased electron density.	48

Fig. 30: Typical age-related changes of the trabecular meshwork: mitochondrial abnormalities in the trabecular cells.	48
Fig. 31: Polarization microscopic picture of a sample of the TM of an eye of a young subject.	49
Fig. 32: Polarization microscopic picture of a sample of the TM of an eye of an old subject.	50
Fig. 33: crystalline lens and zonular ligaments.	51
Fig. 34: Simplified drawing of the ocular lens.	54
Fig. 35: Changes in the lens equatorial and pole-pole dimensions with age.	61
Fig.36: Posterior vitreous detachment.	79
Fig.37: Asteroid bodies of the vitreous.	80
Fig. 38: The iris and its location as an anterior extension of the uvea.	81
Fig.39: Anterior surface of the iris.	82
Fig. 40: Iris microanatomy.	83
Fig. 41: Surface anatomy of the front of the iris.	85

Fig.42: Transmission electron microscopy picture of aged human iris.	87
Fig. 43: The inner aspect of the ciliary body.	89
Fig. 44: Aging changes of ciliary epithelium.	94
Fig. 45: Light micrographs of sagittal sections through young and old human CM.	95
Fig. 46: Normal right retina as seen through an ophthalmoscope.	103
Fig. 47: Schematic diagram of the human retina.	104
Fig.48: vertical section of the human fovea.	105
Fig.49: Flat preparation of retinal pigment epithelium.	106

LIST OF ABBREVIATIONS

A2E	Lipofuscin fluorophore
AGEs	Advanced glycation end products
A-P axis	Antro-posterior axis
ATP	Adenosine tri-phosphate
b	bulbar conjunctiva
bm	basal membrane
BM	Bruch's membrane
c	caruncle
c	collagen fibers
c	Schlemm's canal
CCT	Central corneal thickness
CM	Ciliary muscles
CNS	Central nervous system
CX	Cystic space
DM	Dilator muscle
E	Epithelium
el	elastic fibers
f	forniceal zones of the conjunctiva

F	Fibril-granular material
F	Fibrosis within ciliary muscle
FR	Fuchs' roll
G	Ganglion cells
GAGs	Glucosaminoglycans
GJs	Gap junctions
H	Henle fibres
ICZ	Inner collagenous zone
ILL	Internal limiting membrane
IMPs	Intramembrane particles
INL	Inner nuclear layer
IS	Inner segment
KCS	Keratoconjunctivitis sicca
l	limbal area
mf	microfilaments
mtDNA	mitochondrial DNA
nf	nerve fibers
OCZ	Outer collagenous zone
OLM	Outer limiting membrane
ONL	Outer nuclear layer

OS	Outer segment
p	palpebral or tarsal conjunctiva
PNS	Peripheral nervous system
PVD	Posterior vitreous detachment
ROS	Reactive oxygen species
RPCD	Reticular peripheral cystoid degeneration
RPE	Retinal pigment epithelium
s	semilunar fold (s)
SC	Schlemm's canal
SL	Schwalbe's line
SM	Squamous metaplasia
sm	smooth muscle cells
SP	Sphincter pupillae
st	stroma
TA	Tubular aggregates
TC	Trabecular cells
TMW	Trabecular meshwork
TPCD	Typical peripheral cystoid degeneration
Uv	Uveal Trabecular meshwork
UVR	Ultraviolet radiation

Introduction

Aging is a process of gradual and spontaneous change, resulting in maturation through childhood, puberty and young adulthood then decline through middle and old age (Richard et al., 2007).

Visual impairment among the elderly is a major health problem. With advancing age, the normal function of ocular tissues decreases and there is an increased incidence of ocular pathology (Loh and Ogle, 2004).

Age-related eye changes include functional alterations in accommodation, acuity, refractive power , visual fields, contrast sensitivity, corneal sensation , dark adaptation and tear production as well as multiple structural changes including lens enlargement resulting in narrowing of anterior chamber angle, decrease lens translucency resulting in decreased retinal illumination, also there may be rod cell loss, liquefaction of vitreous gel, loss of eyelid tone and rising of intra ocular pressure (Landefeld et al., 2004).