New York State Society of Opticians, Inc.

48 Howard Street
Albany, NY 12207
518/426-0599 • Fax: 518/463-8656
E-Mail: nysso@caphill.com
Web Site: www.nysso.org

New York State Continuing Education Mail-In Course

Realities of Presbyopia

By Buddy Russell, FCLSA

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This course is worth one (1) New York State Contact Lens Credit, which can be applied to Ophthalmic Dispensing/ Contact Lens licensing requirements.

Presbyopia has been defined as a "progressive age-related loss of accommodative amplitude." The young eye has the ability to change its focal range by a mechanism called *accommodation*. As the ciliary muscle contracts, the zonular fibers attached to the crystalline lens relax, resulting in a bulging of the crystalline lens. This shape change, or increased curvature, allows one to see near objects more clearly. The aging eye eventually loses this ability to change is focal length. This lost ability is normal, natural, and frustrating. It is a reality that most people will live approximately half of their lives as a presbyope.

Many theories have been discussed as to the exact mechanism that causes loss of accommodation. Because a single entity does not result in loss of accommodation, the cause of presbyopia is considered multifactorial.

The relative population of older individuals in the United States is increasing. As a result of better health, improved medications, and more knowledge surrounding health, we are living longer. The recognition of patterns of aging as they affect the eye and vision will equip us to manage the presbyopic patients that seek our help as practitioners.

Anatomical and Physiological Changes

Crystalline Lens

The crystalline lens grows at a slow but continuous rate into the ninth decade of life. The formation of new cells and fibers contribute to increased weight and volume. The growth rate accounts in part for the alterations in the radius of curvature seen in aging lenses. The radius of lens curvature at birth is 17 mm anteriorly and 9 mm posteriorly. By age 40, the lens radius is typically 13 mm anteriorly and 8 mm posteriorly. At age 60, the anterior surface radius is 11 mm, while the posterior surface is 6.5 mm. Lens growth rate is, in part, responsible for the gradual shallowing of the anterior chamber. This shallowing of the anterior chamber is a mechanism that may contribute to the development of narrow angle glaucoma.

The shape of the lens is considered to be controlled by a combination of elastic forces. These forces include the 1) lens capsule, 2) lens matrix, 3) shape of the lens, 4) power and shape of the ciliary muscle, and 5) tension of the zonules.

An overall decline in lenticular elasticity in the aging eye is contributed to largely by decrements in elasticity of the capsular components. Basal lamina of the epithelial cells are continually produced anteriorly by epithelial cells and posteriorly by the superficial cell fibers. As a result, the anterior capsule thickens from 11 microns at age twenty to 16 microns at age forty. Little change in capsule thickness posteriorly has been found.

The lens fiber matrix is a complex and highly organized system. Age related changes in the lens fiber architecture can cause *decreased optical clarity and increased spherical aberrations*. An alteration in cell shape and loss of gap junctions between the cells contribute to a *decrease in visual acuity*.

One function of the lens is to direct and focus light rays on the retina. Because the lens absorbs some light, the transparency can be altered. A reduction of lens transparency can lead to a *reduction in transmission of light to the retina*. In addition, absorption of certain light wavelengths by the lens may *alter the perceived color of the retinal image*. Although some of the effects of UV absorption by the lens are beneficial, there can be a *degradation of retinal image quality*. As the lens changes structurally with age, the effects of lens transmission, absorbance and scattering of light become more noticeable. This scatter-

(Continued on Page 2)

ing of light occurs as the lens fibers are compressed and condensed inward with age. This event causes a progressive increase in the refractive index of the lens.

Ciliary Body

Most of the ciliary body contribution to presbyopia is due to a reduction in mobility of the muscle fibers. This reduction in muscle fibers is thought to be due to an increase in connective tissue between the fibers. The shape of the ciliary body changes with age from a lenticular shaped structure to a more triangular shape.

Zonules

Despite the importance of the lens support system, not much is known regarding the effects of age on these structures. The zonules are a complex system of structures anchored at the basement membrane of the non-pigmented epithelium of the pars plana. These fibers travel anteriorly to the crypts between the ciliary processes. The zonules insert into the lenticular capsule at the equator and the adjacent anterior and posterior surfaces. It has been shown that zonular strength does decrease with age. With aging, more insertional sites are seen on the anterior versus the posterior lens surface. The question of whether this factor contributes to accommodation loss requires further research.

Vitreous

Studies of the vitreous are difficult. This is because the vitreous is approximately 98% water, is easily perturbed, and is difficult to isolate. The vitreous at birth exists in gel form and tends to maintain relative consistency until age 45 when changes, referred to as "*liquefaction*" (syneresis), occur. These changes occur centrally at first. The liquid environment of the vitreous in aging allows enhanced movement of the fibrillar structures and the common visual perception of floaters.

Floaters are focal condensations suspended within the vitreous and composed of collagen fibers. Because of the relationship of the vitreous with the retina, the lens, and the ciliary body, age-associated alterations in the vitreous can influence alterations to these surrounding structures. Perhaps most importantly, retinal detachment, has had a known association with changes in the vitreous for over 100 years.

Cornea

Corneal thickness does not change with aging in the central, midperipheral, or peripheral areas. However, many authors report age-related corneal shape changes. Corneal astigmatism changes from a principally with-the-rule orientation in 92.8% of young eyes to an against-the-rule orientation in 85.7% of patients aged 80 years. In general, the normal cornea becomes steeper and shifts from with-the-rule to against-the-rule astigmatism with age. This corneal shape change occurs at a time when the upper eyelid structures are becoming more lax. This decrease in pressure exerted on the globe has been implicated in age-related changes in corneal astigmatism.

There are also age-related changes in the corneal epithelium. Some of the changes include benign findings such as Hudson-Stahli lines, senile arcus (Fig. 1), Vogt's girdle, and Fuch's dimples. One author reports epithelial basement membrane dystrophy in 75% of patients over the age of 50.

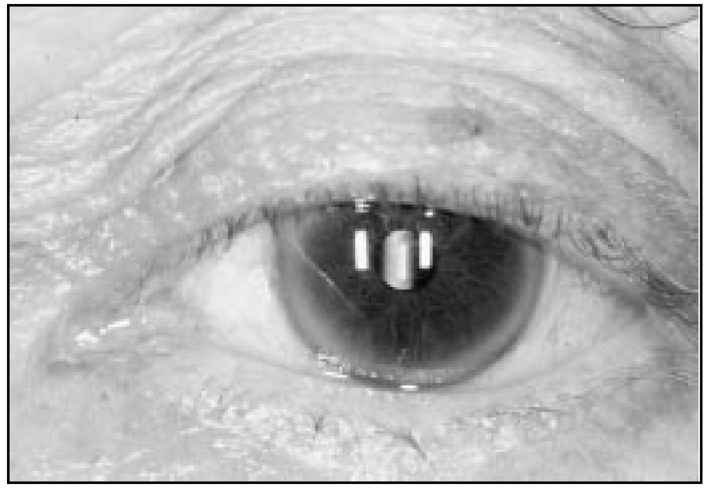

Figure 1: Senile acrus is a common finding in the aging population.

The aging corneal stroma clinically appears more hazy than in younger eyes. With age, there is an increase in the overall density of the stroma, acting to increase light scatter, which when observed through the slit lamp appears as haze. Corneal stromal changes are highly influenced by the age related changes in the corneal endothelium.

The corneal endothelium is made up of a single layer of regular, hexagonal cells. At birth, the corneal endothelium has approximately 3000 cells per square millimeter. Mitotic division of these cells is not known to occur after birth. Death of endothelial cells is followed by hypertrophy and migration of neighboring cells. With advancing age, the percentage of normally shaped and sized cells declines. Because the primary deturgescent pump mechanisms acting to keep the cornea appropriately hydrated and optically clear are located in the endothelium, alterations in the cell density or cell structure can be detrimental to corneal clarity and vision.

Beginning at age 40, the threshold for sensitivity to corneal touch increases and continues to do so with advancing age. In other words, the cornea becomes less sensitive with age with the highest degree of sensitivity remaining at the temporal limbus.

Tear Film

The ocular tear film is the host environment for the contact lens. A less than optimal tear film can affect the wearability of contact lenses. A compromised tear film in quantity or quality can cause discomfort and vision problems, lens deposits, and tissue complications due to drying, rubbing, or binding problems with the contact lens.

There are age-related reductions in the quality and quantity of the ocular tear film. In patients over 50 years of age, basal tear secretion rates are approximately one-half those rates found in younger patients. Because of

(Continued on Page 3)

the reduction of certain immunoglobins contained within the normal ocular tear film, there is an increased incidence of bacterial infections.

Because it is clear that basal secretion rates are decreased with age, it would indicate that epiphora would implicate alterations in the outflow facility. However, the inferior naso-lacrimal fossa actually increases in size with age in both men and women. Studies have been done to determine what is the normal quantity of tears when age and sex were considered. One such study was done which found that the normal eye secretes from 0.5-0.67 Gm of tears per day and should wet a Schirmer's paper strip 15 mm in five minutes when the Schirmer test is performed without anesthetizing the cornea beforehand. Results from this study concluded that tear film quantities in eyes up to age 30 are fairly consistent. However, secretion values of patients aged 36 to 54 were so variable that it was impossible to postulate what flow of tears might be expected in any given case. This study showed little difference in values for each sex, but did indicate a definite decrease in volume of tears with age. It is also interesting that the difference in the volume of tears measured between a patient's two eyes was 5 mm or more in 32% of patients tested and a difference of 3 mm was found over 50% of the time. These findings could lead one to conclude that possibly the testing method described by Schirmer is less than ideal. The decreased quantity of aqueous of the tear film could also be related to the decreased corneal sensitivity in patients over 45. A decrease of the aqueous component of the tear film would increase osmolarity resulting in a decrease in tear film quality.

An increase in tear film evaporation is often due to alterations of the lipid layer. With age, the meibomian gland orifices narrow and become more "pouting." However, meibomian gland secretion increases at the lid margin with age despite a decrease in sebum secretion within the skin. The highest level of meibomian gland secretion is seen in males between 60 and 70 years of age.

Eyelids

Aging changes of the eyelids are perhaps the most externally perceptible effect of aging to the casual observer. The aged eyelid becomes dry, wrinkled, thinner and less elastic. The aged eyelid can become thin due to the decrease in muscle tissue beneath it. This thinner wrinkled appearance, which can be especially prominent at the outer angles of the eyes, has been described as "crow's feet."

Investigation of the lid tone, lid position and lid movement in a group of normal patients to observe age-related changes have been documented. Study results have found a significant correlation between increasing lower lid laxity and a decrease in the lower lid resting position with age.

An increase in the number of inflammatory cells, including mast cells, and fibroblasts, have been found in people whose skin has been highly exposed to the sun. Langerhans' cells are 40-50% fewer in sun-exposed than in non-sun-exposed aged skin. Ultraviolet light can also alter the function of interleukin cells. Taken together, these factors could alter T-cell activation and could decrease immune response to viral, fungal, and bacterial skin diseases in the aged eyelid.

Pupil

The pupil regulates the amount of light entering the eye. Excessive or reduced amounts of light can affect vision. A reduction in pupil size, or "senile miosis," has been noted with age. Pupillary light reactions and near responses seem to be less active with age. The mechanism by which this occurs probably has more than one explanation. One possible reason may be that as the iris thins with age, it becomes more rigid, which when accompanied by decreased sphincter strength, makes the pupil less prone to dilation.

In addition, others believe that the dilator muscle, which reacts briskly to light in young eyes, loses some strength with age. Other authors have discussed alterations in the innervation of adrenergic and chlorenergic nerve supply within the iris.

Systemic Medications

Many aging patients find themselves using more systemic medications and using them more frequently. For this reason, contact lens professionals who work with the presbyopic population must be aware of the impact these medications can have on the ocular system. Medications, whether prescribed or over-the-counter, can affect the eye in a variety of ways. The contact lens practitioner should be familiar with the various medications and their potential influence with regard to contact lens wear. Patients using systemic medications may experience symptoms such as ocular dryness, decreased vision, photophobia, and decreased comfort while wearing contact lenses. Medications can also cause increased lens deposition and soft lens discoloration.

Decreased Lacrimation

The ocular tear film is the host environment for the contact lens. A less than optimum tear film can greatly affect the wearability of contact lenses. The majority of the tear film is made up of aqueous. When the tear film has proper balance of aqueous and solutes, the osmolarity is approximately 302 milliosmoles per liter. Any reduction of aqueous or increase in the solutes results in increased osmolarity of the tear film. Therefore, drugs that reduce lacrimal secretion will increase tear film osmolarity and potentially contribute to contact lens wear difficulties. Drugs associated with the reduction of lacrimal secretion include, but are not limited to, anticholinergics, antihistamines, contraceptives, tranquilizers, analgesics, non-steroidal anti-inflammatories, diuretics, antihypertensives, and beta-blockers.

Blink Rate Changes

Lubrication of the eye is dependent on the frequent and complete movement of the upper lid over the ocular surface. The normal blink reflex occurs approximately every five to seven seconds. Medications that have a sedative

(Continued on Page 4)

effect will decrease the normal blink rate. In addition, this slow or lazy blink may prevent the upper lid from reaching the lacrimal lake adjacent to the lower lid. This change in the normal blink can cause contact lens dehydration and encourage the formation of lens deposits. Drugs that cause a reduction in blink rate include antihistamines, muscle relaxants, sleep enhancers, anti-anxiety medications, and anti-depressants.

Mydriasis

The iris is an excellent indicator of autonomic activity because of the balance between adrenergic and cholinergic nerve innervation to the iris dilator and sphincter muscle. Central nervous system stimulants, such as amphetamines and decongestants, can cause mydriasis (pupil dilation). Central nervous system depressants, such as phenobarbital and other anti-anxiety agents can dilate the pupil. In addition, antihistamines and other drugs that have an anticholinergic effect cause mydriasis. Although the constriction mechanism for the near vision may be compromised, these drugs do not tend to cause cycloplegia. Contact lens wearers using medications that cause mydriasis may experience reduced vision (distance and near), increased flare, and photophobia. Ocular dryness and deposit formation can also occur as a result of the decreased blink rate associated with many of these medications.

Soft Lens Discolorations

Some medications that act directly on the digestive tract, such as those taken for bowel disease, can cause soft lens discoloration. This is believed to occur as a result of the absorption of the drug into the intestines and liver. Both tetracycline and Ex-Lax have been reported to cause soft lens discoloration.

Transient Myopia

Systemically administered sulfonamides can induce transient myopia. These drugs are often prescribed as a vaginal suppository or cream. In addition, diuretics and carbonic anhydrous inhibitors have also been reported to cause this temporary refractive change.

Topical Ophthalmic Drugs

Excluding contact lens rewetting drops, the FDA suggests the use of topical ophthalmic drops in the absence of contact lenses. Many topical ophthalmic drops are preserved with benzalkonium chloride (BAK). These drops, when used with contact lenses, may result in a toxic reaction. Toxicity is a close-related phenomenon. Higher water content soft lenses will tend to absorb the BAK concentration and increase the risk of chemical keratitis. BAK in sufficient concentrations, can injure the corneal epithelial microvilli, and thereby prevent adherence of the mucus layer of the tear film to the cornea. Almost all the ocular side effects caused by BAK are fairly superficial and reversible upon discontinuing the drug.

Although most ophthalmic topical medications are not approved by the FDA to be administered while wearing contact lenses, the prescribing physician may deem it necessary. Frequent follow-up visits, along with an accelerated lens replacement schedule, should be implemented to ensure successful contact lens wear.

Despite the changes related to the aging eye, the presbyope can wear contact lenses successfully. As you have read, there is a lot more to presbyopia than an inability to see at near. The contact lens practitioner who dispenses the best products, provides caring service and has the ability to know what to fit on whom, will have satisfied patients. Patients will continue to look until they find those practitioners who have the knowledge to answer their questions, meet their needs, and offer the alternatives to spectacles or refractive surgery. Millions of people who have enjoyed single vision contact lenses now need our expertise in order to continue to be successful contact lens wearers.

New York State CEC Mail-In Course #02-05

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Realities of Presbyopia

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1. The eye will do which of the following in order to see near objects more clearly?
a. Relax the ciliary muscle b. Contract the zonular fibers
c. Bulge the crystalline lens d. All of the above

2. Systemic medications may:
a. Cause symptoms of ocular dryness
b. Decrease vision
c. Create photophobia
d. All of the above

3. The shallowing of the anterior chamber may be one factor in the development of:
a. Narrow angle glaucoma b. Cataracts
c. Astigmatism d. Iritis

4. In which group is meibomian gland secretion the highest?
a. Females between 60 and 70 years of age
b. Females under the age of 60
c. Males between 60 and 70 years of age
d. Males under the age of 60

5. With age, the shape of the ciliary body changes from a lenticular shaped structure to a:
a. Oval shape b. Triangular shape
c. Round shape d. Diamond shape

6. Floaters are:
a. Focal condensations b. Suspended within the vitreous
c. Composed of collagen fibers d. All of the above

7. Photophobia is:
a. Sensitivity to light b. Sensitivity to touch
c. Over-exposure to UV radiation d. Irreversible

8. The vitreous is approximately how much water?
a. 2% b. 20%
c. 89% d. 98%

9. With age, corneal astigmatism primarily changes from:
a. With-the-rule to against-the-rule
b. Regular to irregular
c. Lenticular to residual
d. Against-the-rule to with-the-rule

10. Benzalkonium chloride is:
a. Non-toxic
b. Used as a preservative in many topical ophthalmic drops
c. The only preservative that is safe for contact lens use
d. All of the above

11. The corneal endothelium has approximately how many cells per square millimeter at birth?
a. 300 b. 3,000
c. 30,000 d. 300,000

12. The reduction of certain immunoglobins in the tear film may result in:
a. Increased resistance to bacterial infections
b. Decreased resistance to bacterial infections
c. Meibomian gland dysfuntion
d. Epiphora

13. Changes in the crystalline lens fiber architecture can cause:
a. Increased optical clarity b. Decreased spherical aberrations
c. Decrease in visual acuity d. Narrow angle glaucoma

14. "Senile miosis" is:
a. A reduction in the size of the pupil as a patient ages
b. An increase in the size of the pupil as a patient ages
c. A deposit of fat in the stromal layer of the cornea
d. A clouding of the crystalline lens as the patient ages

15. The crystalline lens grows steadily until which decade of life?
a. 2nd b. 4th
c. 6th d. 9th

16. "Syneresis" means:
a. Liquefaction b. Gel form
c. Retinal detachment d. Solidification

17. The normal blink reflex occurs every:
a. 3 to 5 seconds b. 5 to 7 seconds
c. 7 to 10 seconds d. 10 to 12 seconds

18. Mydriasis is:
a. Pupil constriction b. A non-responsive pupil
c. Pupil dilation d. A sign of presbyopia

19. What has been implicated in the age-related changes in corneal astigmatism?
a. Corneal trauma b. Laxity in the upper eyelid
c. Cataracts d. Presbyopia

20. When topical ophthalmic drops are used in conjunction with contact lenses:
a. It is important that the drops are preserved with BAK
b. No more than one drop per eye should be administered daily
c. Lenses should be replaced on an accelerated schedule
d. All of the above

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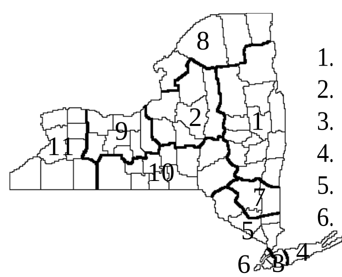

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* ***For new members, membership fees with applications received after March 1 will be pro-rated at 50%.***