SUCCESSFUL AGING

Seeing Into the Future

Vision and Aging

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The leading causes of visual impairment in North Americans are age-related, but appropriate care can preserve useful vision for most older adults. Cataract surgery is highly successful. Early detection and treatment of glaucoma can prevent vision loss. Laser treatment is remarkably effective against diabetic retinopathy. Vision loss due to macular degeneration cannot be delayed in all patients, but low-vision rehabilitation can maximize the usefulness of remaining sight.

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Vision has been considered the most precious of the senses, as treasured as life itself. Public opinion surveys repeatedly have shown that the United States public fears blindness second only to cancer. A population-based study showed that functional visual impairment increased from 7% at age 71 to 39% in patients aged 90 years and older.[1] Age-related loss of vision affects central visual acuity, peripheral vision, contrast sensitivity, and color vision.

The ramifications of a high prevalence of visual impairment in an aging population are many. Care and services provided for persons who are blind or have visual impairments cost the nation in excess of $22 billion each year. Visual impairment can lead to loss of self-esteem and loss of independence in activities of daily living, automobile driving, and general mobility. Visual impairment has been shown to be a risk indicator for reduced survival.[2]

Huge advances have been made in preserving vision for citizens of industrialized countries over the past several decades, and successful aging with good vision is now possible for many who would have suffered visual impairment in the past. Nevertheless, the well-documented aging of the US population threatens to result in a large number of visually impaired older adults.

Physiologic Aging of the Eyes and Visual System

The eyelids share the general loss of tone and substance that is common to other aging cutaneous tissues. The result is an acquired laxity that can result in ptosis of the eyelids and eyebrows, redundancy of the skin of the eyelids, and eyelid malpositions. Although these disorders rarely threaten vision, they frequently contribute to discomfort or disfigurement. Fortunately, oculoplastic surgical techniques have evolved to correct most of these states readily.

Both benign and malignant tumors occur on the eyelids. Basal cell carcinoma occurs more frequently on the lower eyelid and inner canthus than anywhere else on the body. Early detection leads to excellent treatment results, and prevention should be directed to limiting sun exposure.

Tear production declines throughout life.[3] Mild tear deficiency may produce annoying symptoms of foreign body sensation and burning while severe dryness can be associated with corneal ulceration and opacity, resulting in vision loss. Tear deficiency is a frequent problem for older adults, especially when the eyes are exposed to wind, heat, or low humidity. Symptomatic relief is obtained with one of the many tear replacement products available commercially. Severe cases

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may benefit from occlusion of the puncta of the lacrimal drainage system.

Intraocular pressure increases with age in most people.[4] Elevated intraocular pressure is a significant risk factor for the development of the characteristic optic nerve damage and consequent visual loss known as glaucoma. Some persons develop glaucoma without measurable elevation of intraocular pressure.

The human lens grows throughout adult life but the globe does not, resulting in shallowing of the anterior chamber.[5] The changes in crystalline lens dimensions with age, the associated change in the geometry of zonular attachments, and changes in viscoelastic properties of the lens capsule and lens matrix result in a progressive loss of accommodative ability from youth to middle life.[6] The loss of accommodation reaches critical proportions when the ability to read at arm's length is lost, usually about age 45 years. The onset of presbyopia is often the most specific evidence of the aging of the human body to its inhabitant. Most accommodative facility has been lost by 55 years of age.

The delicate collagen framework of the vitreous gel often collapses in middle life to form aggregates that are sufficiently large to cast shadows on the retina. These vitreous "floaters" do not impair visual acuity but can be a source of annoyance to some persons. When only a thin layer of cortical vitreous remains adjacent to the retina, the gel may collapse inward, an event known as posterior vitreous detachment (PVD). As the posterior vitreous detaches from the retina, patients experience light flashes (photopsia). New floaters, including a large shadow caused by glial tissue detached from the surface of the optic disc, appear suddenly. The acute symptoms of PVD subside over a time period ranging from several days to several months. More than 60% of persons over age 70 have clinical evidence of PVD. All patients with symptoms of PVD (acute onset of flashes and floaters) deserve an urgent dilated ophthalmologic examination to rule out retinal tears.

Although reduced retinal illumination due to pupillary narrowing associated with aging and interference with light transmission through the ocular media, particularly the lens, probably account for much of the loss of visual function associated with physiologic aging, retinal cell loss also may play a role.[7] The rods of the central retina, responsible for vision under conditions of dim illumination, appear to be preferentially vulnerable to aging whereas foveal cones remain remarkably stable in number. Cell loss in the ganglion cell layer and retinal pigment epithelium appear to parallel the rod loss.[8]

Whether or not any visual disturbances are specific for Alzheimer's disease remains uncertain because of the lack of objective evidence and the difficulty of obtaining reliable subjective responses from affected persons.[9] One small study failed to find a difference in ganglion cell counts in postmortem retinas from patients with Alzheimer's disease and age-matched controls.[10]

Leading Causes of Visual Impairment in Elderly Persons

Cataract

Cataract is a clouding of the crystalline lens. Contrary to popular belief among laypersons, it is neither a growth ("a film") nor a deposition of some foreign substance but rather a loss of transparency due to protein aggregation and the scattering of light. Although the onset of cataract can be influenced by factors such as trauma, diabetes mellitus, drugs, and other ocular disorders, the vast majority of cataracts currently are attributable to no cause other than aging. In one rural community in the United States, visually important cataract was reported in 3.9% of men and 10.0% of women between the ages of 55 and 64, increasing to 38.8% of men and 45.9% of women 75 years of age or older.[11]

At present no proven medical or dietary measures will prevent or retard cataract formation. Because there are suggestions that long-term exposure to sunlight and UVB radiation may influence cataract development, wearing UVB-blocking sunglasses in bright sunlight is prudent. A broad-brimmed hat or cap also protects the eyes and shades the skin of the face from neoplasm-inducing radiation as well.

Cataract surgery is the most frequently performed surgical procedure in the older-than-65 age group and, if measured in terms of desired results (improved vision), the most successful. More than 85% of patients undergoing cataract surgery note improvement in function and satisfaction with vision.[12] Patients with visually important cataracts in both eyes note further improvement after successful surgery in the second eye.

Surgical intervention is indicated when visual function falls below that required to meet a patient's needs and when removal of the cataract is likely to improve vision. Modern cataract surgery is not dependent on the stage of development of the cataract and can be done at any time, but surgery is indicated only when vision is substantially impaired and cannot be corrected by other means.

Most cataract surgery in this country is done under regional or local anesthesia in an ambulatory setting. Under microscopic control through a small incision, the surgeon removes a portion of the anterior lens capsule, the lens nucleus, and the lens cortex and then inserts into the capsular bag a lens implant of a power based on preoperative measurements. Most patients have improved vision early in the postoperative period. Complications are rare but can be vision-threatening and can lead to blindness in a monocular patient.

Contrary to popular belief, cataract surgery always requires invasive surgery and never is accomplished by the use of a laser alone. Opacification of the residual posterior capsule, however, occurs in many patients in the months and years following cataract surgery. The opacified capsule can be opened with a neodymium:yttrium-aluminum-garnet laser, restoring vision to preopacification levels. Laser capsulotomy is associated

TABLE 1.—*Frequency of Screening to Identify Patients at Risk for Glaucoma**

Age, yr	Asymptomatic African Americans	Other Asymptomatic Patients
20–39	Every 3–5 yr	Less frequently than every 3–5 yr
40–64	Every 2–4 yr	Every 2–4 yr
≥65	Every 1–2 yr	Every 1–2 yr

*From the American Academy of Ophthalmology.[14]

TABLE 2.—*Eye Examination Schedule for Persons With Diabetes Mellitus**

Age of Onset of Diabetes Mellitus, yr	Recommended Time of First Examination	Routine Minimum Follow-up†
0–30	5 yr after onset	Yearly
≥31	At time of diagnosis	Yearly
Before pregnancy	Before conception or early in first trimester	3 months

*From the American College of Physicians.[17]
†Abnormal findings will dictate the need for more frequent follow-up examinations.

with a low but significant rate of vision-threatening complications and, like cataract surgery itself, should be done only to relieve visual impairment.

Glaucoma

Glaucoma is thought to affect nearly 2.5 million persons in the United States. An estimated 80,000 North Americans are legally blind from glaucoma, and many more are visually impaired.[13]

Primary open-angle glaucoma accounts for at least 90% of all cases, and primary angle-closure glaucoma occurs in less than 10%. Both types of glaucoma increase in prevalence with age, and both have a familial incidence. Primary angle-closure glaucoma is more prevalent among Asians, and primary open-angle glaucoma is more common in African Americans. Elevated intraocular pressure in both forms of glaucoma is caused by obstructed outflow of aqueous through the angle of the anterior chamber. In primary angle-closure glaucoma there is synechial or appositional closure of the angle by the iris; in primary open-angle glaucoma the mechanism of obstruction is poorly understood.

Because vision loss and optic nerve damage due to glaucoma usually are irreversible, early diagnosis and treatment are essential. Definitive treatment of acute primary angle-closure glaucoma is urgent and requires the creation of an opening in the iris (iridotomy), usually by the use of a laser. Laser iridotomy often is curative, but in some cases, permanent angle damage may require medications or further surgical therapy for the long-term control of intraocular pressure.

The treatment of primary open-angle glaucoma is directed at lowering the intraocular pressure through some combination of medical treatment, laser surgery, and incisional surgery. Once a diagnosis of primary open-angle glaucoma is made, lifelong care will be required but vision will be retained in most compliant patients.

Because it is so frequent for vision loss due to glaucoma to occur in the absence of increased intraocular pressure on spot checks, glaucoma screening by intraocular pressure checks alone no longer can be recommended. Mass screenings that include either or both visual field testing and optic disc examination for cupping are cumbersome and require advanced technology and skill. Although primary care physicians should be alert to risk factors for glaucoma and should be familiar with the appearance of a glaucomatous optic disc, periodic professional eye examinations are the most efficient approach at present to early detection and diagnosis. Because glaucoma often is asymptomatic until far advanced, periodic eye examinations are recommended every three to five years for African-American patients between ages 20 to 39, for all patients every two to four years from ages 40 to 64, and every one to two years for those aged 65 and older (Table 1).[14] Patients with a history of glaucoma in first-degree relatives require earlier and more frequent monitoring.

Diabetic Retinopathy

The incidence of diabetic retinopathy is related directly to the duration of the diabetic state. Nearly all persons with diabetes mellitus will have some retinopathy after 20 years, a life expectancy often exceeded through modern diabetes management. Only a generation ago, most patients with diabetes surviving 20 years or more suffered vision loss, often severe. The intuitive belief that better control of serum glucose levels delays the onset and lessens the severity of retinopathy has recently been confirmed.[15] Nevertheless, risk still exists for all patients with diabetes, even those under tight control.

Vision loss due to diabetic retinopathy results from either the proliferation of new blood vessels with vitreous hemorrhage and traction retinal detachment or nonproliferative retinopathy with leakage from damaged retinal blood vessels and resultant macular edema. Severe vision loss from both proliferative and nonproliferative diabetic retinopathy can be prevented by timely laser treatment.

The treatment of diabetic retinopathy is remarkably effective. The combined results of the Diabetic Retinopathy Study and the Early Treatment Diabetic Retinopathy Study landmark clinical trials, sponsored by the National Eye Institute, show that with prompt treatment as much as 98% of severe vision loss or blindness from diabetic retinopathy can be prevented.[16] Patients who suffer loss of vision as a result of vitreous hemorrhage or retinal detachment because timely laser treatment was not done or because laser treatment failed often can have some vision restored by vitrectomy (microsurgical removal of the vitreous) and reattach-

ment of the retina. Preventing these complications by laser surgery is much preferred, however.

All patients with diabetes mellitus require periodic screening examinations for the presence of diabetic retinopathy so that laser surgery can be done when first indicated and vision can be preserved. The currently recommended times for initial and follow-up examinations are detailed in Table 2.[17]

Accurate screening for diabetic retinopathy requires dilation of the pupils. Although other practitioners probably could be trained adequately to detect diabetic retinopathy through dilated pupils, ophthalmologists are currently the only group that regularly exercise this practice pattern. In the future it may become practical to image the fundus for viewing by an expert at a remote location.

Macular Degeneration

The macula is the specialized centrally located area of the retina that is uniquely capable of tasks requiring the detection of fine detail such as reading and the recognition of facial features. Although some forms of macular degeneration strike young persons, the great preponderance of cases are related primarily to aging.

Age-related macular degeneration is the leading cause of irreversible severe vision loss in persons older than 60. It is present in 30% of persons older than 75 and will develop in 23% of the remainder within five years.[18] Age-related macular degeneration is nearly exclusively a disorder of white persons and is more frequent in women than in men. Cases tend to cluster in families. Smoking and cardiovascular disease are known risk factors.[19] Sunlight exposure has been suggested but not proved to be an associated factor.

Age-related macular degeneration is characterized by the presence of drusen, yellow-white deposits of extracellular material containing photoreceptor debris external to the retinal pigment epithelium. Some forms of drusen are inherited in an autosomal dominant pattern. The presence of drusen alone does not make a diagnosis of age-related macular degeneration, but they are associated with disturbances of the retinal pigment epithelium that may lead to atrophy with vision loss, constituting nonexudative (dry) age-related macular degeneration. Drusen also predispose to the development of choroidal neovascularization with loss of vision due to subretinal exudation of fluid and blood, the exudative (wet) form of age-related macular degeneration. Age-related macular degeneration typically is bilateral, but vision loss may be asymmetric.

Vision loss due to nonexudative age-related macular degeneration typically is slowly progressive, and no known treatment will influence this course. A large clinical trial, the Age-Related Eye Disease Study, is under way to assess the influence of vitamin and mineral dietary supplements, but at this time no accepted clinical trial results are available to support the intense marketing of these products to the public.

Conversion of the nonexudative form of age-related macular degeneration to the exudative form is heralded by a sudden loss of central vision, often associated with changes in the size and shape of perceived objects. A series of randomized clinical trials known as the Macular Photocoagulation Study showed that focal laser photocoagulation directed to choroidal neovascularization well defined on fluorescein angiography was capable of stabilizing vision and leading to an outcome better than a natural history.[20] Less than 20% of patients with exudative macular degeneration satisfy the criteria for this treatment, however, benefits are limited, and recurrences after treatment are frequent.

Age-related macular degeneration impairs only the central vision, not the peripheral visual fields. All but the most severely affected patients are able to maintain relatively normal mobility, but independence in activities of daily living can be substantially altered unless special techniques and devices are acquired and used.

Coping With Visual Impairment

Visual impairment may be correctable by optical devices or surgery or noncorrectable due to ophthalmologic or neurologic states. Noncorrectable visual impairment often is called low vision. Low vision lies between normal vision and blindness (or near-blindness) wherein patients require special mobility training and the substitution of other senses for vision (such as learning Braille). Patients with low vision may appear outwardly normal to others but may be unable to read or recognize their friends in public.

Patients with low vision should be encouraged and assisted to maximize the usefulness of their remaining vision.[21] Powerful spectacles, handheld or stand magnifiers, and closed-circuit video units or computers are the most frequently used reading devices. Proper illumination intensity and direction are critical. Spot distance viewing is facilitated by a pocket telescope. A variety of clever personal and household aids for the partially sighted add to independence and to the enjoyment of life.

Physicians may inadvertently contribute to the sense of disappointment or despair patients experience with visual impairment. The lack of effective medical or surgical treatment for disorders such as macular degeneration does not mean that nothing more can be done. Physicians should be aware of community resources for the visually impaired and encourage patients to use them.

Horizons

Aging of the "baby boom" population over the next several decades will pose great challenges for the prevention and treatment of age-related visual impairment, but innovative research offers promise. New drugs may delay the onset of visually disabling cataract beyond the usually expected life span. Genes have been identified that lead to certain forms of glaucoma. Improvements in diabetes management will reduce the incidence of

retinopathy, and new retinal imaging techniques may facilitate screening. The genetic basis for age-related macular degeneration is being sought to open the door to new prevention strategies. Macular degeneration research also will be directed toward the inhibition of choroidal neovascularization and toward retinal cell transplantation. Rehabilitation techniques and devices will become more widely available to the hidden population of the visually impaired.

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