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Review

# Age-related eye disease

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ABSTRACT

As with many organs, compromised function of the eye is accompanied with age and has become increasingly prevalent with the aging population. When decreased visual loss becomes significant, patients' ability to perform activities of daily living becomes compromised. This decrease in function is met with morbidity and mortality, as well as a large socioeconomic burdon throughout the world. This review summarizes the most common age-related eye diseases, including cataract, glaucoma, diabetic retinopathy, retinal vein occlusion, and age-related macular degeneration. Although our understanding of the genetic and biochemical pathways of these diseases is sill at its primitive stages, we have become able to help our patients improve the quality of life as they age.



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## 1. Introduction

As with many organs, compromised function of the eye is accompanied with age and has become increasingly prevalent with the aging population. When decreased visual acuity and visual field loss become significant, they begin to affect patients' ability to perform activities of daily living (ADLs), such as reading, writing, driving, and ambulating. The Beaver Dam Eye Study showed that poor visual acuity, poor contrast sensitivity, and discrepant vision between the two eyes served as biomarkers for aging and frailty and were positively correlated with a risk of falling [1]. Even more alarmingly, the same study identified visual impairment as an independent risk factor of mortality with a hazard ratio of 1.24 [2]. Primary care providers and patients would benefit from familiarizing themselves with age-related sight-threatening conditions in order to identify them earlier along their disease trajectory and appropriately seek specialized ophthalmic care in order to minimize morbidity and mortality.

## 2. Cataract

Cataract formation is a slow, progressive, and irreversible process that occurs at the site of the native crystalline lens. This lens, along with the cornea, serves to bring objects into focus by modulating refractive power according to object distance. Aging brings about loss of lens clarity and media opacities secondary to denaturation of lens proteins and oxidative damage [3]. Symptoms include blurred vision, glare, halos around lights, poor vision at night and in dim settings, diminished contrast sensitivity, and monocular double vision.

Cataract is the most common cause of visual impairment and blindness worldwide, with approximately 17.7 million people blinded in a 2004 report by the World Health Organization [4]. Of course, the prevalence of cataracts in any particular population is dependent on access to ophthalmic care and cataract surgery. The Bever Dam Eye Study published the 15-year incidence of cataract and exhibited an increasing incidence of cataract formation and cataract surgery with age in all groups below the age of 75 [5]. Risk factors for cataract aside from aging in otherwise healthy eyes include gender, illiteracy, ultraviolet light exposure, smoking, certain medication intake, rural residence, and unhealthy lifestyle [5,6]. Other local ocular risk factors for cataract include trauma, inflammation, vitreoretinal surgery, and topical steroid use.

The presence of cataract does not necessitate cataract surgery, as this condition exists across a broad spectrum from asymptomatic to moderate visual impairment to almost complete blindness. Mild forms of cataract can simply be observed, along with fine-tuning of spectacle correction to account for the progressive refractive shift accompanied with cataract formation. Patients are monitored for deteriorating visual acuity and/or symptoms that interfere with normal ADLs. Timing for cataract surgery is considered by weighing specific individual needs against the risks of surgery.

When cataract surgery is indicated, the most conventional form of surgery is phacoemulsification, which involves ultrasonic fragmentation of the crystalline lens through a small (2.8–3.2 mm) incision. Once all the lens material is removed from its native capsule, a synthetic intraocular lens (IOL) can be folded and implanted through the same incision. The major risks of cataract surgery are rare and include infection and catastrophic suprachoroidal bleeding - both of which could result in severe and permanent visual loss, or even loss of the eye. Other more common and treatable post-operative complications include refractive error, inflammation, capsular opacification, cystoid macular edema, retinal tears, and retinal detachment. Laser-assisted cataract surgery using a femtosecond laser that delivers ultrashort bursts of energy focused at specific tissue locations has provided extra precision to modern surgery. It has been shown to afford easier surgery, improved refractive outcomes, lower complication rates, shorter phacoemulsification time, and increased surgical volume [7].

Presbyopia after cataract surgery has been an inconvenient and unavoidable side-effect. It stems from the fact that the conventional implanted IOL only has one focal length, leaving objects existing at all other distances blurred. Premium IOLs have been designed to provide focused vision across a range of distances. Two common types include multifocal IOLs, which vary their refractive properties over the surface area of the implant, and accommodating IOLs, which can subtly shift their position within the eye and result in modulation of the eye's overall refractive power. Side-effects of these implants include photic phenomena, such as glare and halos, as well as incomplete correction along the full range of distances required for ADLs [8]. Some of these complaints can be compounded in patients with comorbid macular conditions, such as age-related macular degeneration.

## 3. Glaucoma

Glaucoma is a chronic degenerative optic neuropathy and is considered to be the second-leading cause of blindness worldwide [9]. Due to its strong correlation with intraocular pressure, glaucoma is categorized according to the status of the iridocorneal angle, which is the site of aqueous humor egress from the eye. Primary open-angle glaucoma is characterized by an open and unobstructed angle without any other detectable conditions that may impede aqueous outflow. On the other hand, primary angle closure glaucoma involves gradual progressive appositional closure as a result of the peripheral iris bowing forward, often an anatomical abnormality prevalent among people of sino-mongolian (Chinese) and Eskimo ancestry. Regardless of the mechanism of glaucoma, the end result is loss of the ganglion cell layer's axons, which manifests as thinning of the neuroretinal rim of the optic nerve head (cupping) with associated visual field loss. With advanced glaucoma, loss of central vision and eventual irreversible total blindness can be the end result. Glaucoma tends to manifest as bilateral disease, but can be asymmetric in severity.

It is estimated that 3% of the worldwide population over the age of 40 suffer from glaucoma, many of whom are undiagnosed [9]. In 2010, 60.5 million people were afflicted by glaucoma, 4.5 million of whom were riddled with bilateral blindness [9]. As with cataracts, age has been the most extensively documented risk factor for glaucoma [9]. Other risk factors include ethnicity (particularly African-Americans), genetic heritability [10], diabetes, hypertension, trauma, uveitis, myopia and topical corticosteroids.

In terms of diagnosing glaucoma, methods can be broadly categorized into those that detect functional deficits and those that detect structural damage. The conventional functional tool has been visual field testing, which has gone through evolution since its inception. Standard automated perimetry (SAP) with threshold testing is the most established method, but is limited by low sensitivity and high variability [11,12]. Advances in visual field testing, such as frequency-doubling technology (FDT) and short-wavelength automated perimetry (SWAP), have afforded us with earlier detection, less retest variability, and shorter testing time [13]. Structural glaucomatous damage is based on identifying optic disc excavation over time indicative of nerve fiber layer loss. New technology, including confocal scanning laser ophthalmoscopy, scanning laser polarimetry, and OCT has been developed to supplement the clinical exam, allowing us to detect and monitor glaucomatous damage earlier in its trajectory, as well as correlate it with functional deficits [13].

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