



DOCTOR
I HAVE A
QUESTION
a guide for
patients and
their families

The Glaucoma Foundation

The Glaucoma Foundation's mission is to fund groundbreaking research and educate the public about glaucoma. The Foundation works to stimulate and support basic and applied research in glaucoma, to gain and disseminate new information about the biological causes and treatment of glaucoma, and to further efforts to identify and develop novel approaches to preserve visual function and reverse blindness caused by glaucoma.

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Protecting Your Vision

The first step in understanding glaucoma is to know a few basic facts about the eye and how it works. With this information, it will be easier to discuss your condition and treatment with your eye doctor. Working together, you and your doctor will be able to act as a team to protect your vision.

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How Does the Eye Work?

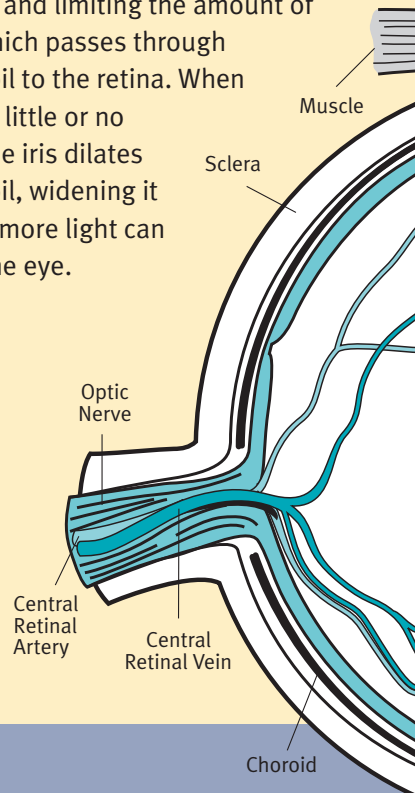
The eye is like a camera. It has a lens which focuses light, just like the lens of a camera. The focused image in a camera is recorded on film, and in the eye the focused image is formed on the retina, in the back of the eye. The image information (color, shape and movement) is then sent to the brain via the optic nerve, which connects the eye to the brain. This is very similar to a digital camera, which can be connected to your computer via a computer cable, allowing the images to be transferred to your computer. In glaucoma, the lens and retina function normally, but the optic nerve is damaged and images cannot be transmitted to the brain.

Key Parts of the Visible Eye

Let's look at the eye more closely. The sclera is the white outer surface of the eye, a thin, yet tough, protective outer shell, which is covered by the conjunctiva (white-colored outer skin of the eye that contains some blood vessels). At the center front of the eye is the cornea. It is a clear tissue through which light

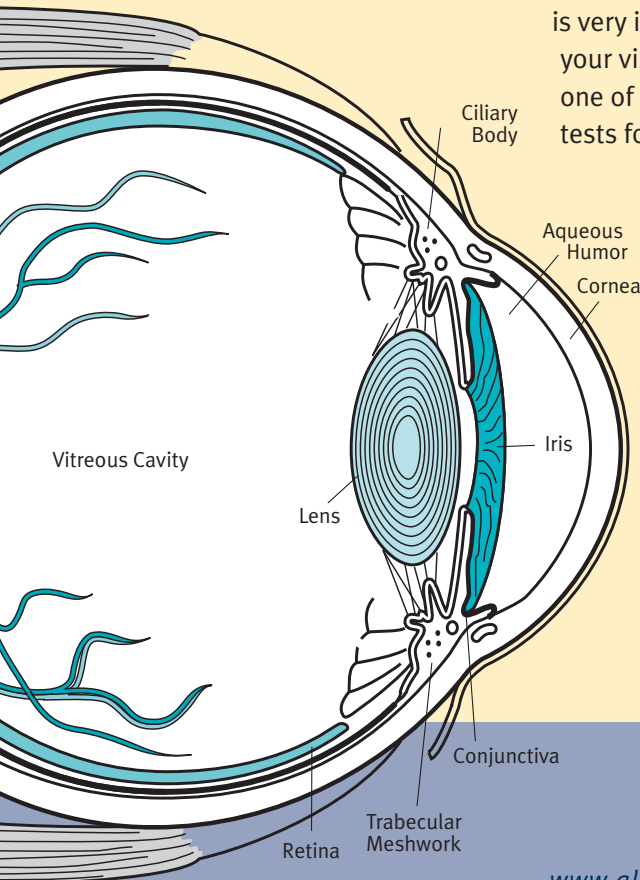
rays enter the eye and it provides the eye with much of its light-focusing power.

The pigmented portion of the eye is called the iris. It is responsible for eye color. It also controls the size of the pupil, the dark-colored area in the center of the iris. Together, the iris and pupil act like the aperture of a camera. When there is a great deal of light, as outdoors on a sunny day, the iris constricts the pupil, making it smaller and limiting the amount of light which passes through the pupil to the retina. When there is little or no light, the iris dilates the pupil, widening it so that more light can enter the eye.



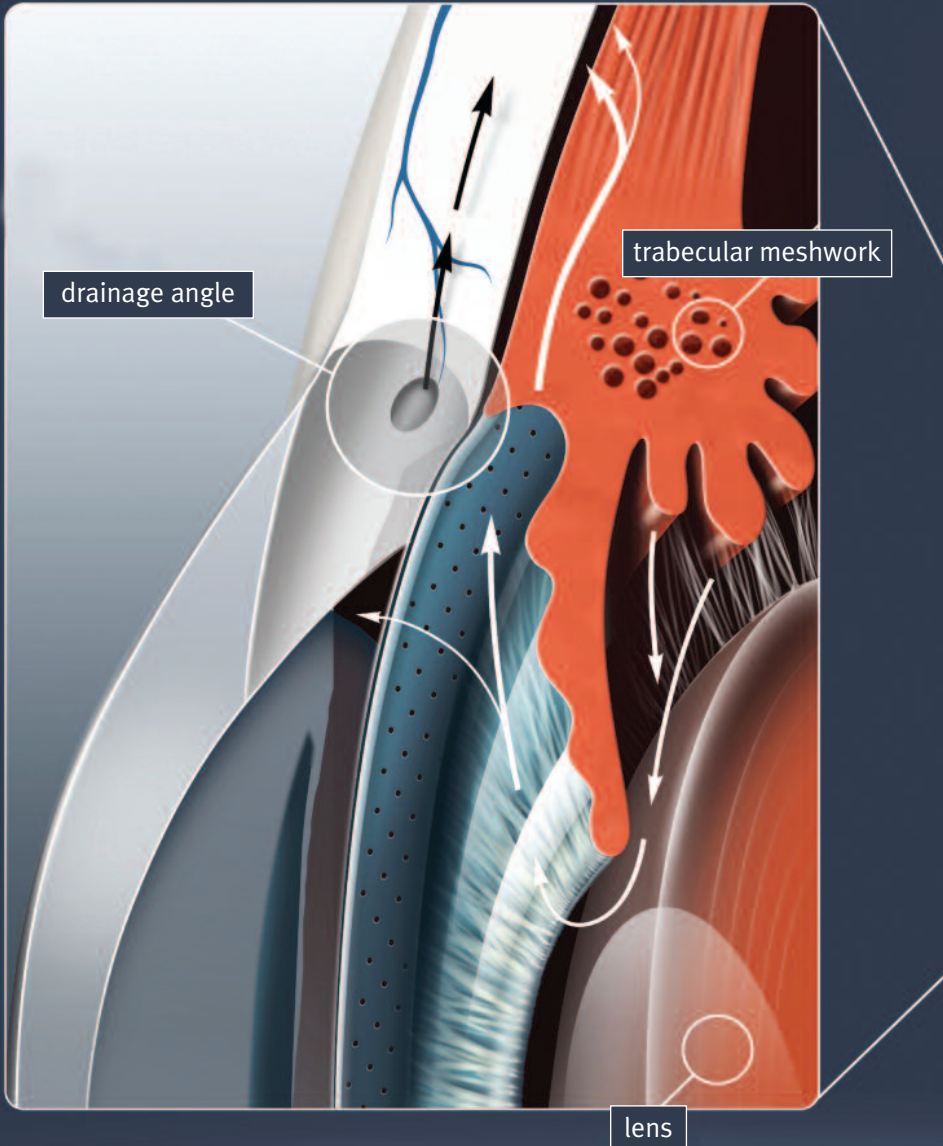
The lens, located immediately behind the iris, adjusts its shape and thickness to focus the light rays onto the retina. (Often, as we get older, the lens gets discolored or hazy, and it is then called a cataract. A cataract can affect the ability of the lens to focus.) The retina, lining the back of the eye, then delivers the image as nerve impulses via the optic nerve to the brain, which processes these signals into a visual image.

The space in the eye that is behind the cornea and in front of the iris is called the anterior chamber. It is filled with a water-like fluid called the aqueous humor, which nourishes the cornea and the lens, providing oxygen and vital nutrients. The aqueous humor also provides the necessary pressure to help maintain the shape of the eye. We call this intraocular pressure or IOP. As you will read, maintaining the right amount of pressure within the eye is very important to protecting your vision. Measuring the IOP is one of the ways your eye doctor tests for glaucoma.



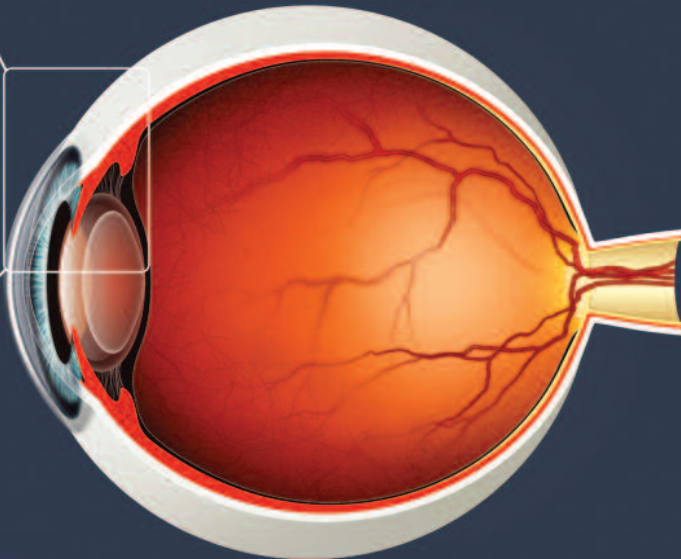
What is Glaucoma?

Glaucoma is a number of different eye diseases, many of which are characterized by increased pressure within the eye. This high IOP is caused by a backup of fluid in the eye, resulting in damage to the optic nerve. Damage to the optic nerve is the common end result of all glaucomas. Through early detection, diagnosis and treatment, you and your doctor can help to preserve your vision.



The aqueous fluid in the eye is constantly circulating through the anterior chamber. It is produced by a tiny gland, called the ciliary body, situated behind the iris. Aqueous humor flows between the iris and the lens and, after nourishing the cornea and lens, flows out through a very tiny spongy tissue called the trabecular meshwork. Only one-fiftieth of an inch wide, this spongy tissue is located in the angle where the iris and cornea meet and functions like a drain. When the drain becomes clogged, aqueous can not leave the eye as fast as it is produced, causing the fluid to back up. This causes increased pressure to build up within the eye.

As explained earlier, the optic nerve is the part of the eye which carries visual information to the brain. It consists of a bundle of about one million nerve cells, each about one twenty-thousandth of an inch in diameter. When the pressure in the eye builds, the nerve cells become compressed, causing them to become damaged and eventually to die. This cell death results in permanent visual loss. Early diagnosis and treatment of glaucoma can help prevent this process of damage from happening.



Types of Glaucoma

Primary Open-Angle Glaucoma (POAG)

Approximately one percent of all Americans have this type of glaucoma. It occurs mainly in the over-50 age group and is the most common form of glaucoma in the United States.

The term refers to the specific way in which the iris meets the cornea, forming an angle that is wide open. There are typically no symptoms associated with early POAG. The pressure in the eye slowly rises and the cornea adapts without swelling. Because it is painless, patients often do not realize they are slowly losing vision until the later stages of the disease. By the time vision is impaired, the damage is irreversible.

In POAG, there is no visible abnormality of the trabecular meshwork. It is believed that something is wrong with the ability of the cells in the trabecular meshwork to carry out their normal function, or there may be fewer cells present, as a natural result of aging, inflammation or damage. Some believe it is due to

a structural defect of the eye's drainage system. Others believe there is an enzymatic problem. Genetic factors are also known to contribute. These theories, and others, are currently being studied at research centers across the country.

Elevated intraocular pressure (IOP) is the most important risk factor for glaucoma. Eye pressure is measured in millimeters of mercury (mm Hg). The average IOP in a normal population is 14-16 millimeters of mercury. But pressure up to 21 mm Hg may be within normal range. A pressure of 22 is considered suspicious and possibly abnormal. However, not all patients with elevated IOP develop glaucoma-related eye damage. Conversely, some patients will develop glaucoma with normal pressures. What causes one person to develop damage while another does not is another topic of active research.

POAG is a chronic, progressive disease. Once a sufficient number of optic nerve cells are destroyed, blind spots begin to form in the field of vision. These blind spots usually develop first in the

peripheral field of vision, the outer sides of the field of vision. In later stages, central vision is affected. Once visual loss occurs, it is irreversible because to date optic nerve cells can not be restored. So it's crucial that your eye doctor detect glaucoma in its earliest stages – before any visual damage occurs. The treatment for POAG is to lower the IOP, initially by medication. Keeping the IOP under control is the key to preventing loss of vision from glaucoma.

Normal-Tension Glaucoma

Normal-tension glaucoma, also known as low-tension glaucoma, is characterized by progressive optic nerve damage and visual field loss with IOP levels that are usually considered to be within the normal range (10-21 mm Hg). It should be noted that the level of IOP often does not correlate with the degree of optic nerve damage or visual field abnormality.

Normal-tension glaucoma is being increasingly diagnosed, and may account for as many as one-third of all cases of open-angle glaucoma in the United States. It is thought to be related, in part, to

poor blood flow to the optic nerve, which leads to death of the cells which carry impulses from the retina to the brain. In addition, these eyes appear to be susceptible to pressure-related damage even in the high normal range, and therefore a pressure lower than normal is often necessary to prevent further visual loss. Studies suggest that sleep apnea and low blood pressure at night might be additional risk factors for normal tension glaucoma. Research is ongoing in the field of optic nerve blood flow and its role in glaucoma.

Angle-Closure Glaucoma

Angle-closure glaucoma affects nearly half a million people in the United States. There is a tendency for this disease to be inherited, and several members of a family will often be afflicted. It is most common in people of Asian descent and people who are far-sighted. However, people of any race can be affected. Worldwide, this is the most common type of glaucoma because it is so common among persons of Asian descent.

Types of Glaucoma *continued*

As mentioned earlier, the trabecular meshwork, which functions as the eye's drain, is situated in the angle formed where the cornea meets the iris. In most people, this angle is about 45 degrees. In primary angle-closure glaucoma, the angle is smaller than normal. The narrower the angle, the closer the iris is to the trabecular meshwork. The ability of aqueous humor to pass between the iris and the lens on its way to the anterior chamber decreases, causing fluid and pressure to build up behind the iris, which further narrows the angle. If the pressure becomes sufficiently high, the iris is forced against the trabecular meshwork, blocking drainage, similar to putting a stopper over the drain of a sink. When this space becomes completely blocked, an angle-closure glaucoma attack (acute glaucoma) results.

Acute Angle-Closure Attack

Unlike POAG, where the IOP increases slowly, in acute angle-closure, it increases suddenly. This rapid rise can occur within a

matter of hours and become very painful. Symptoms of acute angle-closure glaucoma may include headaches, eye pain, nausea, vomiting, halos around lights at night, and very blurred vision.

An acute attack is a medical emergency. If treatment is delayed, damage to the optic nerve may occur quickly and cause permanent vision loss. Scarring of the trabecular meshwork may also occur and result in chronic glaucoma which is much more difficult to control. Cataracts may also develop.

Many of these sudden attacks occur in darkened rooms, such as movie theaters, or in other darkened environments which cause the pupil to dilate, or increase in size. When this happens, there is maximum contact between the eye's lens and the iris, further narrowing the angle. The pupil also dilates when one is excited or anxious, so these attacks can occur during periods of stress. Medications that dilate the pupil (for example, anti-depressants, cold medications, antihistamines, and some

medications to treat nausea) can also lead to an attack.

An acute attack may be stopped with a combination of drops which constrict the pupil and help reduce the eye's fluid production. Soon after the IOP has dropped to a safe level, your ophthalmologist will perform a laser iridotomy to make a small opening in the iris allowing the fluid to flow more freely. Since it is common for both eyes to suffer from narrowed angles, operating on the unaffected eye is done as a preventive measure.

With routine examinations using a technique called gonioscopy, patients with narrow angles can be warned of early symptoms so that they can seek immediate treatment.

Pigmentary Glaucoma

Pigmentary glaucoma is a type of inherited open-angle glaucoma which develops more frequently in men than women. White people are more susceptible than other races and it most often begins in individuals in their 20s and 30s. This is the only type of glaucoma that may actually dissipate as we

age. Nearsighted patients are more typically afflicted and the anatomy of the eye appears to play a key role.

Myopic (nearsighted) eyes have a concave-shaped iris which creates an usually wide angle. This causes the pigment layer of the iris to rub on the lens, causing the iris pigment to shed into the aqueous humor and onto neighboring structures, such as the trabecular meshwork. When pigment is released into the anterior chamber, the condition is called pigment dispersion syndrome. Most patients with pigment dispersion will not develop pigmentary glaucoma. However, the pigment may plug the pores of the trabecular meshwork, causing it to clog, and thereby increasing the IOP. If the IOP is high and the optic nerve is damaged, then pigmentary glaucoma is diagnosed.

Medical therapy and laser trabeculoplasty are often effective in lowering the pressure in these patients. Laser iridotomy is currently being used in some centers to change the

Types of Glaucoma *continued*

configuration of the iris and slow the release of pigment. This preventative step will change the anatomy of the iris but has not yet been shown to be effective in treating pigmentary glaucoma.

Exfoliation Syndrome

Exfoliation syndrome (XFS) is an age-related systemic disease characterized by the production and progressive accumulation of a whitish material in many ocular tissues and is the most common identifiable cause of open-angle glaucoma worldwide. XFS is a cause of open-angle glaucoma, angle-closure glaucoma, and cataract. It is accompanied by an increase in serious complications at the time of cataract extraction. This exfoliation material is rubbed off the lens by movement of the iris and at the same time, pigment and exfoliation material clog the trabecular meshwork, leading to IOP elevation, sometimes to very high levels.

About 25 percent of persons with XFS develop elevated IOP and one-third of these develop glaucoma. However, if you have XFS syndrome, your chances of

developing glaucoma are about six times higher than if you don't. Exfoliation glaucoma behaves more aggressively than open-angle glaucoma and can be more difficult to control.

The exfoliation material often appears in one eye long before the other. If you have glaucoma in one eye only, this is most likely the cause. It can be detected before the glaucoma develops, so you can be more carefully observed and minimize your chances of vision loss.

An increasing list of associations with cardiovascular and cerebrovascular diseases makes XFS a condition of general medical importance. Recently described associations include stroke, cardiovascular dysfunction, Alzheimer's disease, and hearing loss. The recently discovered genetic abnormalities in the lysyl oxidase gene, which is responsible for the formation and maintenance of elastic tissue, might turn out to explain these other links.

Trauma-Related Glaucoma

A blow to the eye, chemical burn, or penetrating injury may all lead to the development of glaucoma, either acute or chronic. This can be due to a mechanical disruption or physical change within the eye's drainage system. It is therefore crucial for anyone who has suffered eye trauma to have their eyes examined at regular intervals throughout their life.

Steroid-Associated Glaucoma

Several different drugs have the potential to cause the elevation of IOP. Steroid-induced glaucoma is a form of open-angle glaucoma that usually is associated with topical (eye drops and ointments) or periocular (injection into, near or beyond the eyeball) steroid use, but may develop with systemic (oral, inhaled, intravenous, injected) corticosteroid usage or exposure.

This type of glaucoma resembles POAG, but is of a more sudden onset. IOP elevations usually occur within a few weeks of

beginning steroid therapy. In the majority of cases, the IOP lowers spontaneously within a few weeks to months upon stopping the steroid use. The effects of steroids on IOP depend on whether the patient has glaucoma. Individuals with POAG are far more susceptible to steroid-related elevations in IOP than individuals without glaucoma. In steroid induced glaucoma, the IOP increase is usually short term, but the longer the exposure, the greater the chance that the elevation will continue. The bottom line: steroids should be used cautiously and patients should consult their ophthalmologists about their usage and should have their eyes examined and IOP measured regularly.

Childhood Glaucoma

Childhood glaucoma is an unusual eye disease and significant cause of childhood blindness. It is caused by a disease-related abnormal increase in IOP. The multiple potential causes fall into one of two categories and may be

Types of Glaucoma *continued*

primary or secondary to some other disease process. Primary congenital glaucoma results from abnormal development of the ocular drainage system. It occurs in about 1 out of 10,000 births in the United States and is the most common form of glaucoma in infants. Secondary glaucomas result from disorders of the body or eye and may or may not be genetic. Both types may be associated with other medical diseases. Ten percent of primary congenital glaucomas are present at birth, and 80 percent are diagnosed during the first year of life. The pediatrician or family first notices eye signs of glaucoma, including clouding and/or

enlargement of the cornea. The elevated IOP can cause the eyeball itself to enlarge and injury to the cornea. Important early symptoms of glaucoma in infants and children are poor vision, light sensitivity, tearing, and blinking.

Pediatric glaucoma is treated differently than adult glaucoma. Most patients require surgery and this is typically performed early. Approximately 80-90 percent of babies who receive prompt surgical treatment and ongoing care will do well. When childhood glaucoma is not recognized and treated promptly more permanent visual loss will result.

Get Tested

Everyone under 40 should have a comprehensive eye examination every three to four years.

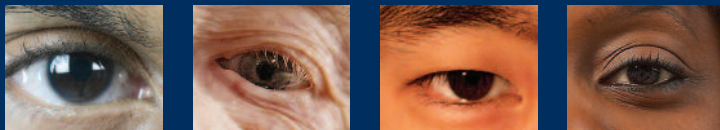
Individuals under 40 with one of the risk factors (on page 13) should get tested every one and a half to two years.

Everyone 40 years or older should have a comprehensive eye examination every one and a half to two years. If you are 40 and have an additional risk factor, get tested annually.

Anyone with high risk factors should be tested every year or two after age 35.

Who is at Risk?

Glaucoma affects people of all ages and all races. Everyone should get regular eye exams because early detection and treatment of glaucoma is the only way to prevent vision impairment and blindness. But some people are at greater risk than others:



- People with elevated IOP. High IOP is the most important risk factor for glaucomatous damage.
- People over the age of 40. While glaucoma can develop in younger patients, it occurs more frequently as we get older.
- People who have a family history of glaucoma. The tendency for developing glaucoma may be inherited. However, just because someone in your family has glaucoma does not mean that you will necessarily develop the disease.
- People of African-American, Hispanic, or Asian-American descent. African-Americans and Hispanics have a greater tendency for developing primary open-angle glaucoma than do people of other races. Asian-Americans are more prone to develop angle-closure glaucoma and normal-tension glaucoma.
- People with thin central corneas.
- People who have been on prolonged high-dose steroid or cortisone use.
- People who have suffered a previous serious eye injury.
- People with high myopia (nearsightedness).
- Mild myopia, diabetes and extremely high or low blood pressures are other potential risk factors.

Diagnosing Glaucoma

Your eye doctor has a variety of diagnostic tools which aid in determining whether or not you have glaucoma – even before you have any symptoms. Here is a summary of these tools and what they do.

The Tonometer

The tonometer measures the pressure in your eye. Your doctor places a numbing eye drop in your eye. Then you sit at a slit-lamp, resting your chin and forehead on a support that keeps your head steady. The lamp, which lets your doctor see a magnified view of your eye, is moved forward until the tonometer, a plastic prism, barely touches the cornea to measure your IOP. The test is quick, easy and painless.

The Pachymeter

The pachymeter measures central corneal thickness (CCT). Like the tonometer, your doctor will first anesthetize your eyes. Then a small probe will be placed perpendicular to the central cornea.

CCT is an important measure and helps your doctor interpret your IOP levels. Some people with thin central corneal thickness will have pressures that are actually higher than when measured by tonometry. Likewise, those with thick CCT will have a true IOP that

is lower than that measured.

Measuring your central corneal thickness is also important since recent studies have found that thin CCT is a strong predictor of developing glaucoma in patients with high IOP.

Visual Field Test

Visual field is an important measure of the extent of damage to your optic nerve from elevated IOP. In glaucoma, it is the peripheral (side) vision that is most commonly affected first. Testing your visual field lets your doctor know if peripheral vision is being lost. There are several methods of examination available to your doctor; visual field testing has advanced significantly in recent years.

In computerized visual field testing you will be asked to place your chin on a stand which appears before a concave computerized screen. Whenever you see a flash of light, appear you press a buzzer. At the end of this test, your doctor will receive a printout of your field of vision.

New software has been developed to help your doctor analyze these tests as well as monitor progression of visual field loss over successive tests.

Ophthalmoscopy

Using an instrument called an ophthalmoscope, your eye doctor can look directly through the pupil at the optic nerve. Its color and appearance can indicate whether or not damage from glaucoma is present and how extensive it is. This technique remains the most important in diagnosing and monitoring glaucoma.

Imaging Technology

A number of new and highly sophisticated image analysis systems are now available to evaluate the optic nerve and retinal nerve fiber layer, the areas of the eye damaged by glaucoma. These devices include scanning laser tomography (e.g. HRT₃), laser polarimetry (e.g. GDx), and ocular coherence tomography (e.g. older time-domain OCT or newer spectral-domain OCT). These instruments can help your doctor by giving a quantitative measure of the anatomical structures in the eye. Photographs of the optic nerve can also be useful to follow the progression of damage over time. Large

databases have been established to compare an individual's anatomic structures to those of other patients in the same age group. This software and technology are developing rapidly and show great promise. However, they have not yet evolved to replace ophthalmoscopy, where the doctor looks directly at the optic nerve.

Gonioscopy

Your doctor may perform a gonioscopy to closely examine the trabecular meshwork and the angle where fluid drains out of the eye. After dilating and numbing the eye with anesthetic drops, the doctor places a special type of hand-held contact lens, with mirrors inside, on the eye. The mirrors enable the doctor to view the interior of the eye from different directions. In this procedure, the doctor can determine whether the angle is open or narrow. As explained earlier, individuals with narrow angles have an increased risk for a sudden closure of the angle, which can cause an acute glaucoma attack. Gonioscopy can also determine if anything, such as abnormal blood vessels or excessive pigment, might be blocking the drainage of the aqueous humor out of the eye.

Treating Glaucoma

Glaucoma can be treated with eye drops, pills, laser surgery, traditional surgery or a combination of these methods. The goal of any treatment is to prevent loss of vision, as vision loss from glaucoma is irreversible. The good news is that glaucoma can be managed if detected early, and that with medical and/or surgical treatment, most people with glaucoma will not lose their sight.

Taking medications regularly, as prescribed, is crucial to preventing vision-threatening damage. That is why it is important for you to discuss side effects with your doctor. While every drug has some potential side effects, it is important to note that many patients experience no side effects at all. You and your doctor need to work as a team in the battle against glaucoma. Your doctor has many options.



EYE DROPS

It is important to take your medications regularly and exactly as prescribed if you are to control your eye pressure. Since eye drops are absorbed into the bloodstream, tell your doctor about all other medications you are currently taking. Ask your doctor and/or pharmacist if the medications you are taking together are safe. Some drugs can be dangerous when mixed with other medications. To minimize absorption into the bloodstream and maximize the amount of drug absorbed in the eye, close your eye for one to two minutes after administering the drops and press your index finger lightly against the inferior nasal corner of your eyelid to close the tear duct which drains into the nose. While almost all eye drops may cause an uncomfortable burning or stinging sensation at first, the discomfort should last for only a few seconds.

Class of Drug

Prostaglandin Analogs

Generic & Brand Names

Bimatoprost (Lumigan®),
Latanoprost (Xalatan®)
Travaprost (Travatan® & Travatan Z®)

Function

This is the newest class of drug and acts differently from other glaucoma drops. IOP is lowered by the drug opening up a new pathway by which fluid flows out of the eye. The drug needs to be taken only once a day.

Possible Side Effects

May cause redness of the eyes (often prescribed at night). With long term use, may darken the color of the iris (for example, from green to brown), as well as the skin around the eyes. This class of drug may also cause the eye lashes to grow darker, longer and thicker. This drug is used with

caution in patients with active inflammation of the eye.

Class of Drug

Beta-Blockers

Generic & Brand Names

Betaxolol (Betoptic®), Carteolol (Ocupress®), Levobunolol (Betagan®), Timolol (Timoptic®) or (Istalol®)

Function

Reduces aqueous humor production within the eye.

Possible Side Effects

This class of drug may worsen pulmonary disease (e.g. asthma), cause difficulty breathing, slow the pulse, lower blood pressure and heart rate, cause dizziness, fatigue, hallucination, insomnia, memory loss and difficulty with strenuous exercise. Uncommon side effects include impotence, depression, hair loss and decreased libido. You should

advise your doctor if you have asthma, emphysema, chronic obstructive pulmonary disease or other lung or heart diseases before starting this class of medicine. This class of medicine may be taken twice a day and in most patients is more effective in the morning. Note: Specific beta-1-blockers, such as betaxolol, are safer for patients who suffer from pulmonary diseases.

Class of Drug

Alpha-2 Adrenergic Agonists

Generic & Brand Name

Apraclonidine (Iopidine®)

Function

This drug is used at the time of laser treatment to prevent a sudden rise in IOP.

Generic & Brand Names

Brimonidine (Alphagan®)
(Alphagan®P)

Function

Is a highly selective alpha-2 adrenoceptor agonist. Reduces aqueous humor production and increases drainage of intraocular fluid.

Possible Side Effects

This class of drug may produce allergic reactions and itching in the eyes. Brimonidine should be avoided in infants and young children since the drug may cause

excessive drowsiness and lethargy in these patients. Advise your doctor if you are currently taking monoamine oxidase inhibitors or tricyclic antidepressants.

Class of Drug

Miotics

Generic & Brand Names

Pilocarpine (Isoptocarpine®, Pilocar®)

Function

This class of drug helps open the eye's drain and increase the rate of fluid flowing out of the eye. Different concentrations are available.

Possible Side Effects

May cause pain around/inside the eye or brow ache for the first few days of use. Blurred vision and extreme nearsightedness are most common in younger patients. As miotics reduce pupil size and prevent normal dilation, dim vision, especially at night or in dark rooms, may occur. Stuffy nose, sweating, increased salivation, and occasional gastrointestinal problems may occur with stronger miotics.

Class of Drug

Topical Carbonic Anhydrase Inhibitors

Generic & Brand Names

Brinzolamide (Azopt®),
Dorzolamide (Trusopt®)

Function

Decreases production of
intraocular fluid.

Possible Side Effects

May have side effects similar to
those of the pills (see below), but
with much lower frequency and
severity.

Class of Drug

Sympathomimetic Nonselective

Generic and Brand Name

Dipivefrin (Propine®)

Function

Decreases the rate of aqueous
humor production and increases
its outflow.

Possible Side Effects

May cause redness, burning,
stinging, blurred vision. Also,
increased heart rate and
palpitations.

Class of Drug

Fixed Combination Glaucoma Drugs

Function

Decreases production of
intraocular fluid. Because many
patients require more than one
type of medication to control IOP,
a few companies have produced

combination drops that include
two different medicines in the
same bottle.

Generic & Brand Names

Brimonidine & Timolol
(Combigan®)

Possible Side Effects

Side effects of Combigan® include
the symptoms of alpha agonists
and beta-blockers.

Generic & Brand Names

Dorzolomide & Timolol (Cosopt®)

Possible Side Effects: Side effects
of Cosopt® include the symptoms
of topical carbonic anhydrase
inhibitors and beta-blockers.

Class of Drug

Cholinesterase Inhibitor

Generic & Brand Name

Echothiophate (Phospholine
Iodide®)

Function

Reduces pressure in the eye by
increasing the amount of fluid that
drains from the eye.

Possible Side Effects

Can make the pupil very small.
Some patients get headache and
eye ache. It can cause cataracts
and is not used in patients unless
they have had cataract extraction.
In the latter patients, it is an
extremely effective and useful
drug.

PILLS

Sometimes, when eye drops don't sufficiently control IOP, pills may be prescribed in addition to drops. These pills, which have more systemic side effects than drops, also serve to turn down the eye's faucet and lessen the production of fluid. These medications are usually taken from two to four times daily. It is important to share this information with all your other doctors so they can prescribe medications for you which will not cause potentially dangerous interactions. The following are some commonly prescribed carbonic anhydrase inhibitors and their more common side effects.

Class of Drug

Oral Carbonic Anhydrase Inhibitors

Generic and Brand Names

Acetazolamide (Diamox®),
Methazolamide (Neptazane®)

Function

Pills will reduce fluid flow into the eye. These should be taken with meals or milk to reduce side effects. Bananas or apple juice should be added to the diet to minimize potassium loss.

Possible Side Effects

Frequent urination, tingling sensation in the fingers and toes. These symptoms often disappear

after a few days. Kidney stones may occur. A rare but serious side effect is aplastic anemia. Rashes are not uncommon. Potassium loss may occur when these drugs are taken with digitalis, steroids, or cholorothiazide diuretics. Depression, fatigue, and lethargy are common. Gastrointestinal upset, metallic taste to carbonated beverages, impotence, and weight loss are other potential side effects.

SURGICAL PROCEDURES

When medication does not achieve the desired results, or has intolerable side effects, your ophthalmologist may suggest surgery.

LASER SURGERY

Laser surgery has become increasingly popular as an intermediate step between drugs and traditional surgery though the long-term success rates are variable. The most common type performed for open-angle glaucoma is called trabeculoplasty. This procedure takes between 10 and 15 minutes, is painless, and can be performed in either a doctor's office or an outpatient facility. The laser beam (a high energy light beam) is focused upon the eye's drain. Contrary to what many people think, the laser does not burn a hole through the eye. Instead, the eye's drainage system is changed in very subtle ways so that aqueous fluid is able to pass more easily out of the drain, thus lowering IOP.

You may go home and resume your normal activities following surgery. Your doctor will likely check your IOP one to two hours following laser surgery. After this procedure, many patients respond well enough to be able to avoid or delay surgery. While it may take a few weeks to see the full pressure-lowering effect of this procedure, during which time you may have to continue taking your medications,

many patients are eventually able to discontinue some of their medications. This, however, is not true in all cases. Your doctor is the best judge of determining whether or not you will still need medication. Complications from laser are minimal, which is why this procedure has become increasingly popular and some centers are recommending the use of laser before drops in some patients.

Argon Laser Trabeculoplasty (ALT) — for open-angle glaucoma

The laser treats the trabecular meshwork of the eye, increasing the drainage outflow, thereby lowering the IOP. In many cases, medication will still be needed. Usually, half the trabecular meshwork is treated first. If necessary, the other half can be treated as a separate procedure. This method decreases the risk of increased pressure following surgery. Argon laser trabeculoplasty has successfully lowered eye pressure in up to 75 percent of patients treated. This type of laser can be performed only two to three times in each eye over a lifetime.

Selective Laser Trabeculoplasty (SLT) — for open-angle glaucoma

SLT is a newer laser that uses very low levels of energy. It is termed “selective” since it leaves portions of the trabecular meshwork intact. For this reason, it is believed that SLT, unlike other types of laser surgery, may be safely repeated. Some authors have reported that a second repeat application of SLT or SLT after prior ALT is effective at lowering IOP.

Laser Peripheral Iridotomy (LPI) — for angle-closure glaucoma

This procedure is used to make an opening through the iris, allowing aqueous fluid to flow from behind the iris directly to the anterior chamber of the eye. This allows the fluid to bypass its normal route. LPI is the preferred method for managing a wide variety of angle-closure glaucomas that have some degree of pupillary blockage. This laser is most often used to treat an anatomically narrow angle and prevent angle closure glaucoma attacks.

Cycloablation

Two laser procedures for open-angle glaucoma involve reducing the amount of aqueous humor in the eye by destroying part of the ciliary body, which produces the fluid. These treatments are usually reserved for use in eyes that either

have elevated IOP after having failed other more traditional treatments, including filtering surgery, or those in which filtering surgery is not possible or advisable due to the shape or other features of the eye.

Transscleral cyclophotocoagulation uses a laser to direct energy through the outer sclera of the eye to reach and destroy portions of the ciliary processes, without causing damage to the overlying tissues. With *endoscopic cyclophotocoagulation (ECP)*, the instrument is placed inside the eye through a surgical incision, so that the laser energy is applied directly to the ciliary body tissue.

TRADITIONAL SURGERY

Trabeculectomy

When medications and laser therapies do not adequately lower eye pressure, doctors may recommend conventional surgery. The most common of these operations is called a trabeculectomy, which is used in both open-angle and closed-angle glaucomas. In this procedure, the surgeon creates a passage in the sclera (the white part of the eye) for draining excess eye fluid. A flap is created that allows fluid to escape, but which does not deflate the eyeball. A small bubble of fluid called a “bleb” often forms over the opening on the surface of

the eye, which is a sign that fluid is draining out into the space between the sclera and conjunctiva. Occasionally, the surgically created drainage hole begins to close and the IOP rises again. This happens because the body tries to heal the new opening, as if it was an injury. Many surgeons perform trabeculectomy with an anti-fibrotic agent that is placed on the eye during surgery and reduces such scarring during the healing period. The most common anti-fibrotic agent is Mitomycin-C. Another is 5-Fluorouracil, or 5-FU.

About 50 percent of patients no longer require glaucoma medications after surgery for a significant length of time. Thirty-five to 40 percent of those who still need medication have better control of their IOP. A trabeculectomy is usually an outpatient procedure. The number of post-operative visits to the doctor varies, and some activities, such as driving, reading, bending and heavy lifting must be limited for two to four weeks after surgery.

Drainage Implant Surgery

Several different devices have been developed to aid the drainage of aqueous humor out of the anterior chamber and to lower IOP. All of these drainage devices

share a similar design which consists of a small silicone tube that extends into the anterior chamber of the eye. The tube is connected to one or more plates, which are sutured to the surface of the eye, usually not visible. Fluid is collected on the plate and then absorbed by the tissues in the eye. This type of surgery is thought to lower IOP less than trabeculectomy but is preferred in patients whose IOP cannot be controlled with traditional surgery or who have previous scarring.

Nonpenetrating Surgery

Newer nonpenetrating glaucoma surgery, which does not enter the anterior chamber of the eye, shows great promise in minimizing postoperative complications and lowering the risk for infection. However, such surgery often requires greater surgical acumen and generally does not lower IOP as much as trabeculectomy. Furthermore, long term studies are needed to assess these procedures and to determine their role in the clinical management of glaucoma patients.

SOME PROMISING SURGICAL ALTERNATIVES

The ExPress mini glaucoma shunt is a stainless steel device that is inserted into the anterior chamber of the eye and placed under a scleral flap. It lowers IOP by diverting aqueous humor from the anterior chamber. The ExPress offers the glaucoma surgeon an alternative to either repeating a trabeculectomy or placing a more extensive silicone tube shunt in those patients whose IOP is higher than the optic nerve can tolerate.

The Trabectome is a new probe-like device that is inserted into the anterior chamber through the cornea. The procedure uses a small probe that opens the eye's drainage system through a tiny incision and delivers thermal energy to the trabecular meshwork, reducing resistance to outflow of aqueous humor and, as a result, lowering IOP.

Canaloplasty, a recent advancement in non-penetrating surgery, is designed to improve the aqueous circulation through the trabecular outflow process, thereby reducing IOP. Unlike traditional trabeculectomy, which creates a small hole in the eye to allow fluid to drain out, canaloplasty has been compared to an ocular version of angioplasty, in which the physician uses an extremely fine catheter to clear the drainage canal.

Newer implants (e.g. Gold Shunt) have been designed to drain aqueous fluid from the anterior chamber to the suprachoroidal space, thereby lowering IOP. These implants are very thin and are placed through a single micro-incision in the sclera.

It can not be stressed enough! Regular eye exams are vital to protect the health of your eyes.

If your ophthalmologist or optometrist detects glaucoma, early treatment can help prevent the loss of your vision. Talk to your doctor and don't be afraid to ask questions. Together, you can tailor a treatment regimen that suits your needs and that you can comply with on a regular basis.



While there is still no cure for glaucoma, **The Glaucoma Foundation** continues to fund research world-wide to discover new treatments and procedures and to better understand this disease so that eventually a cure may be found. **If you would like to help The Glaucoma Foundation in this quest, please contact us by phone at 212-285-0080 or by email at info@glaucomafoundation.org.**

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GLOSSARY

Anterior chamber

Space in the front portion of the eye between the cornea and the iris. It is filled with a clear fluid called aqueous humor.

Aqueous humor

Watery fluid produced by a structure alongside the lens called the ciliary body that nourishes the cornea and the lens and provides necessary pressure (different from tears that are produced outside the eye).

Conjunctiva

White-colored outer skin of the eye that contains some blood vessels (covers the sclera).

Cornea

The outer, transparent dome-like structure that covers the iris and pupil. Light rays enter the eye through the cornea.

Glaucoma

A number of different eye diseases, many of which are characterized by elevated intraocular pressure and all of which result in damage to the optic nerve. Can lead to blindness if left untreated.

Gonioscopy

Exam that is used to closely examine the angle where fluid drains out of the eye. Exam is used to detect which type of glaucoma a person may have.

Intraocular pressure (IOP)

The pressure within the eye. High IOP is the most important risk factor for glaucoma.

Iris

Pigmented portion of the eye that regulates the amount of light entering the eye by adjusting the size of the pupil.

Lens

The part of the eye immediately behind the iris that performs delicate focusing of light rays upon the retina.

Ophthalmoscope

Medical device used to view the interior of the eye, including the optic nerve head.

Optic nerve

Bundle of nerve fibers that take the information from the retina as electrical signals and deliver them to the brain, where the information is interpreted as a visual image.

Pachymetry

Test that measures the thickness of a person's central corneal thickness.

Posterior chamber

The space in the eye behind the iris and in front of the lens. Filled with aqueous humor, a watery fluid, which then flows forward through the pupil into the anterior chamber of the eye.

Pupil

Dark opening in the center of the colored iris that controls how much light enters the eye.

Retina

The innermost layer of the eye that lines the back of the eye. Contains the nerve cells that capture and transmit visual images through the optic nerve to the brain.

Sclera

The white outer surface of the eye.

Slit-lamp exam

Microscope with a high-intensity light source used to evaluate the inside and outside of the eye.

Tonometry

A standard eye test that determines the fluid pressure inside the eye.

Trabecular meshwork

Spongy, mesh-like drainage structure inside the front part of the eye through which the aqueous fluid leaves the eye. Proper drainage helps keep eye pressure at a normal level; failure of this system leads to a rise in intraocular pressure, as in certain types of glaucoma.

Trabeculectomy

Filtering surgery that increases the outflow of aqueous humor, lowering IOP.

Visual field

The entire area you can see while looking at a fixed point. With glaucoma, the visual field often shrinks, beginning with the peripheral (side) vision.

THE GLAUCOMA FOUNDATION

Funding Cutting-Edge Research and Educating the Public

The mission of The Glaucoma Foundation (TGF) is to fund groundbreaking research and to educate the public about the disease and the importance of early detection to prevent blindness. Founded in 1984 by Dr. Robert Ritch, TGF is one of the premier not-for-profit organizations dedicated to eradicating blindness from glaucoma through vital research and education.

- Over the past 10 years The Foundation's Grant-in-Aid Program has awarded more than \$3 million dollars in seed money for cutting-edge research projects. Preliminary data from these projects have frequently been used to support proposals for larger grants from entities such as the National Institutes of Health.
- Since 1994 The Glaucoma Foundation's interdisciplinary Annual International Scientific Think Tank has brought together some of the world's top scientists and clinicians. These gatherings continue to be a catalyst for setting the course to find new treatments and cures for glaucoma.
- TGF serves patients across the globe through its website, www.glaucomafoundation.org, on-line support groups and local chapters in Greater Chicago, Long Island (NY), New England, and New York City.
- The organization's "Eye to Eye" newsletter keeps more than 30,000 households worldwide informed about research news and other developments.

TGF relies on the public's generous support to carry out these and other important initiatives. The Glaucoma Foundation is a 501 (c)(3) organization and contributions to it are tax-deductible.





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