INTRODUCTION:
Glaucoma is an eye disease in which the optic nerve is damaged in a characteristic pattern. This can permanently damage vision in the affected eye(s) and lead to blindness if left untreated. It is normally associated with increased fluid pressure in the eye (aqueous humour). The term "ocular hypertension" is used for people with consistently raised intraocular pressure (IOP) without any associated optic nerve damage. Conversely, the term 'normal tension' or 'low tension' glaucoma is used for those with optic nerve damage and associated visual field loss, but normal or low IOP. The nerve damage involves loss of retinal ganglion cells in a characteristic pattern. The many different subtypes of glaucoma can all be considered to be a type of optic neuropathy. Raised intraocular pressure (above 21 mmHg or 2.8 kPa) is the most important and only modifiable risk factor for glaucoma. However, some may have high eye pressure for years and never develop damage, while others can develop nerve damage at a relatively low pressure. Untreated glaucoma can lead to permanent damage of the optic nerve and resultant visual field loss, which over time can progress to blindness.²

Types of glaucoma:
There are several types of glaucoma. The two major types of glaucoma are chronic or primary open-angle glaucoma (POAG) and acute angle-closure glaucoma. The "angle" in both cases refers to the drainage angle inside the eye that controls aqueous outflow. Other variations include normal-tension glaucoma, pigmentary glaucoma, secondary glaucoma and congenital glaucoma.

(1) Primary open-angle glaucoma:
It is the most common form of glaucoma, accounting for at least 90% of all glaucoma cases:
- Is caused by the slow clogging of the drainage canals, resulting in increased eye pressure
- Has a wide and open angle between the iris and cornea
- Develops slowly and is a lifelong condition
- Has symptoms and damage that are not noticed.
This inherited form of glaucoma is present at birth; with 80 percent of cases diagnosed by age one. These children are born with narrow angles or some other defect in the drainage system of the eye. It’s difficult to spot signs of congenital glaucoma, because children are too young to understand what is happening to them. If notice a cloudy, white, hazy, enlarged or protruding eye in child, consult eye doctor. Congenital glaucoma typically occurs more in boys than in girls.

(7) Other Types of Glaucoma:

- Variants of open-angle and angle-closure glaucoma include:
  - Pseudoeosfoliative Glaucoma
  - Neovascular Glaucoma
  - Irido Corneal Endothelial Syndrome (ICE)
  - Traumatic Glaucoma

Causes:

Of the several causes for glaucoma, ocular hypertension (increased pressure within the eye) is the most important risk factor in most glaucoma, but in some populations, only 50% of people with primary open-angle glaucoma actually have elevated ocular pressure. Dietary

No clear evidence indicates vitamin deficiencies cause glaucoma in humans. It follows, then, that oral vitamin supplementation is not a recommended treatment for glaucoma. Caffeine increases intraocular pressure in those with glaucoma, but do not appear to affect normal individuals.

Ethnicity and gender

Many people of East Asian descent are prone to developing angle closure glaucoma due to shallower anterior chamber depths, with the majority of cases of glaucoma in this population consisting of some form of angle closure. Inuit also have a 20 to 40 times higher risk of developing primary angle closure glaucoma. Women are three times more likely than men to develop acute angle closure glaucoma due to their shallower anterior chambers. People of African descent are three times more likely to develop primary open angle glaucoma.

Genetics

Positive family history is a risk factor for glaucoma. The relative risk of having primary open angle glaucoma (POAG) is increased approximately 2-4 fold for individuals who have a sibling with glaucoma. Glaucoma, particularly primary open angle glaucoma, is associated with mutations in several different genes, although most cases of glaucoma do not involve these genetic mutations. Normal tension glaucoma, which comprises one-third of POAG, is also associated with genetic mutations.

Various rare congenital/genetic eye malformations are associated with glaucoma. Occasionally, failure of the normal third trimester gestational atrophy of the hyaloid canal and the tunica vasculosa lentis is associated with other anomalies. Angle closure-induced ocular hypertension and glaucomatous optic neuropathy may also occur with these anomalies, and modelled in mice. Other factors can cause glaucoma, known as "secondary glaucomas", including prolonged use of steroids (steroid-induced glaucoma); conditions that severely restrict blood flow to the eye, such as severe diabetic retinopathy and central retinal vein occlusion (neovascular glaucoma); ocular trauma (angle recession glaucoma); and uveitis (uveitic glaucoma). In a large study in the UK, glaucoma patients had a 29% increased incidence of systemic hypertension compared to age- and sex-matched controls. For reasons that doctors don’t fully understand, increased pressure within the eye (intraocular pressure) is usually, but not always, associated with the optic nerve damage that characterizes glaucoma. This pressure is due to a buildup of a fluid (aqueous humor) that flows in and out of your eye. This fluid normally exits your eye through a drainage system at the angle where the iris and cornea meet. When the drainage system doesn’t work properly, the fluid can’t filter out of the eye at its normal rate, and pressure builds within your eye.

Primary open-angle glaucoma:

In primary open-angle glaucoma, the drainage angle formed by the cornea and the iris remains open, but the drainage channels (trabecular meshwork) in the angle are partially blocked, causing the fluid to drain out of the eye too slowly. This causes fluid to back up in your eye, and pressure gradually increases within your eye. Damage to the optic nerve doesn’t cause symptoms or pain, and it happens so slowly that you may lose an extensive amount of...
vision before you’re even aware of a problem. The exact cause of primary open-angle glaucoma remains unknown.

**Angle-closure glaucoma:**

Angle-closure glaucoma, also called closed-angle glaucoma, occurs when the iris bulges forward to narrow or block the drainage angle formed by the cornea and the iris. As a result, fluid can’t adequately flow through and exit your eye, and your eye pressure may increase abruptly. Angle-closure glaucoma usually occurs suddenly (acute angle-closure glaucoma), but it can also occur gradually (chronic angle-closure glaucoma). Some people with an abnormally narrow drainage angle may be at risk of developing angle-closure glaucoma. If any have a narrow drainage angle, sudden dilation of your pupils may trigger acute angle-closure glaucoma.

**Normal-tension glaucoma:**

In normal-tension glaucoma, optic nerve becomes damaged. However, eye pressure remains within the normal range. Doctors don’t understand why this occurs. If anyone have a sensitive optic nerve, or may have less blood being supplied to your optic nerve. This lack of blood supply could be caused by atherosclerosis — an accumulation of fatty deposits (plaques) in the arteries — or another condition limiting your blood circulation.

**Developmental glaucoma:**

Some infants or children may be diagnosed with glaucoma. Rarely, some children may be born with glaucoma (congenital glaucoma), develop glaucoma in the first few years of life (infantile glaucoma) or develop glaucoma after age 4 or 5 (juvenile glaucoma). Children usually won’t have any symptoms. However, they have optic nerve damage, which may be caused by angle blockages or malformations (primary infantile glaucoma), or it could develop as the result of other conditions (secondary glaucoma).

**Pigmentary glaucoma:**

In pigmentary glaucoma, pigment granules from your iris build up in the drainage channels (trabecular meshwork), slowing or blocking fluid exiting your eye. Physical activities, such as jogging, sometimes stir up the pigment granules, depositing them on the trabecular meshwork and causing intermittent pressure elevations.

**Risk factor:**

Because elevated chronic forms of glaucoma can destroy vision before any signs or symptoms are apparent, be aware of these factors:

- Elevated internal eye pressure (intraocular pressure). If internal eye pressure (intraocular pressure) is higher than normal, it is increased risk of developing glaucoma, though not everyone with elevated intraocular pressure develops the disease.
- Age. Persons are at a higher risk of glaucoma if they older than age 60, particularly for Mexican-American. Person may be at higher risk of angle-closure glaucoma if he/she older than age 40. For certain groups such as African-Americans, however, the risk of developing glaucoma is much higher and occurs at a younger age than that of other groups.
- Ethnic background. African-Americans older than age 40 have much higher risk of developing glaucoma than do whites (Caucasians). African-Americans also are more likely to experience permanent blindness as a result of glaucoma. People of Asian descent have an increased risk of developing acute angle-closure glaucoma. People of Japanese descent may be more likely to have normal-tension glaucoma.
- Family history of glaucoma. If person have a family history of glaucoma, he/she have a greater risk of developing it. Glaucoma may have a genetic link, meaning there’s a defect in one or more genes that may cause certain individuals to be more susceptible to the disease. A form of juvenile open-angle glaucoma has been clearly linked to genetic abnormalities.
- Medical conditions. Several conditions may increase risk of developing glaucoma, including diabetes, heart diseases, high blood pressure and hypothyroidism.
- Other eye conditions. Severe eye injuries can cause increased eye pressure. Other eye conditions that could cause increased risk of glaucoma include eye tumors, retinal detachment, eye inflammation and lens dislocation. Certain types of eye surgery also may trigger glaucoma. Also, being near sighted or farsighted may increase risk of developing glaucoma.
- Long-term corticosteroid use. Using corticosteroid medications, especially eyedrops for a long period of time may increase risk of developing secondary glaucoma.

**Complication:**

If left untreated, glaucoma will cause progressive vision loss, normally in these stages:

- Blind spots in your peripheral vision
- Tunnel vision
- Total blindness

**Symptoms:**

Glaucoma often is called the “silent thief of sight,” because most types typically cause no pain and produce no symptoms until noticeable vision loss occurs. For this reason, glaucoma often progresses undetected until the optic nerve already has been irreversibly damaged, with varying degrees of permanent vision loss. The most common types of glaucoma — primary open-angle glaucoma and angle-closure glaucoma — have completely different symptoms.

**Primary open-angle glaucoma signs and symptoms include:**

- Gradual loss of peripheral vision, usually in both eyes
- Tunnel vision in the advanced stages

**Acute angle-closure glaucoma signs and symptoms include:**

- Intense eye pain
- Nausea and vomiting (accompanying the severe eye pain)
- Sudden onset of visual disturbance, often in low light
- Blurred vision
- Halos around lights
- Reddening of the eye

Both open-angle and angle-closure glaucoma can be primary or secondary conditions. They’re called primary when the cause is unknown and secondary when the condition can be traced to a known cause, such as eye injury, medications, certain eye conditions, inflammation, tumor, advanced cataract or diabetes. In secondary glaucoma, the signs and symptoms can include those of the primary condition as well as typical glaucoma symptoms.

**Pathophysiology:**

The major risk factor for most glaucomas, is increased intraocular pressure, i.e. ocular hypertension. Intraocular pressure is a function of production of liquid aqueous humor by the ciliary processes of the eye, and its drainage through the trabecular meshwork. Aqueous humor flows from the ciliary processes into the posterior chamber, bounded posteriorly by the lens and the zonules of Zinn, and anteriorly by the iris. It then flows through the pupil of the iris into the anterior chamber, bounded posteriorly by the iris and anteriorly by the cornea. From here, the trabecular meshwork drains aqueous humor vi a Schlemm’s canal into scleral plexuses and general blood circulation.

**Fig 5:** Pathology of glaucoma

In open/wide-angle glaucoma, flow is reduced through the trabecular meshwork, due to the degeneration and obstruction of the trabecular meshwork, whose original function is to absorb the aqueous humor. Loss of aqueous humor absorption leads to increased resistance and thus a chronic, painless buildup of pressure in the eye. In close/narrow-angle, the iridocorneal angle is completely closed because of forward displacement of the final roll and root of the iris against the cornea, resulting in the inability of the aqueous fluid to flow from the posterior to the anterior chamber and then out of the trabecular network. This accumulation of aqueous humor causes an acute increase of pressure and pain. The inconsistent relationship of glaucomatous optic neuropathy with ocular hypertension has provoked hypotheses and studies on anatomic structure, eye development, nerve compression trauma, optic nerve blood flow, excitatory neurotransmitter, trophic factor, and retinal ganglion cell/axon degeneration, and glial support cell, immune system, aging mechanisms of neuron loss, and severing of the nerve fibers at the scleral edge.
Screening for glaucoma is usually performed as part of a standard eye examination performed by optometrists, orthoptists and ophthalmologists. Testing for glaucoma should include measurements of the intraocular pressure via tonometry, changes in size or shape of the eye, anterior chamber angle examination or gonioscopy, and examination of the optic nerve to look for any visible damage to it, or change in the cup-to-disc ratio and also rim appearance and vascular change. A formal visual field test should be performed. The retinal nerve fiber layer can be assessed with imaging techniques such as optical coherence tomography, scanning laser polarimetry, and/or scanning laser ophthalmoscopy, also known as Heidelberg retina tomography. Owing to the sensitivity of all methods of tonometry to corneal thickness, methods such as Goldmann tonometry should be augmented with pachymetry to measure central corneal thickness (CCT). A thicker-than-average cornea can result in a pressure reading higher than the ‘true’ pressure, whereas a thinner-than-average cornea can produce a pressure reading lower than the ‘true’ pressure.

Because pressure measurement error can be caused by more than just CCT, it is impossible to ‘adjust’ pressure measurements based only on CCT measurements. The frequency doubling illusion can also be used to detect glaucoma with the use of a frequency doubling technology perimeter. Examination for glaucoma also could be assessed with more attention given to sex, race, history of drug use, refraction, inheritance and family history.

**Test and diagnosis:**

A diagnosis of glaucoma no longer simply relies on the presence of pressure within the eye. Optic nerve damage or a strong suggestion of damage must also be present. This damage can be clearly seen during a dilated eye examination of the optic nerve. In general, the hallmark sign of this condition is a loss of peripheral vision. With peripheral vision loss, a person can see in front of him or herself but has lost the vision to the side. The optic nerve carries the information of vision from the eye to the brain. Because chronic glaucoma has no warning symptoms, half of patients are unaware they have the condition. Early diagnosis is the key to successful treatment of glaucoma and prevention of blindness.

There are several tests to diagnose glaucoma, including:

- **Tonometry and Pressure Tests.** Doctors determine the intracocular pressure of the aqueous humor inside the eye using a painless procedure called tonometry, which measures the force necessary to make an indentation in the eye. A tonometer may be used. There are several methods and the doctor may apply anesthetical eye drops to first numb the eye.
  - In the applanation (Goldman) method, uses a blue-light filter and slit-lamp, which is moved forward toward the patient’s face.
  - Electronic indentation tonometry uses an electronic pen with a digital read-out.
  - The noncontact approach does not use a tonometer. It applies a puff of air to measure the force needed to indent the eye.
  - In the Schiotz method, the doctor presses very lightly against the eye with the tonometer. IOP is measured by the weight needed to flatten the cornea. This method is not considered as accurate as the others.

In general, normal IOP is usually maintained at measurements of 10 - 20 mmHg. Intraocular pressure over 21 mmHg indicates a potential problem. The test is not completely accurate, however. Only about 10% of people with IOP levels of 21 - 30 mmHg will actually develop glaucoma and optic nerve damage. On the other hand, many people with glaucoma have normal pressure, at least for part of the time. Changes in posture may also affect IOP. A recent study indicated that IOP increases during sleep or when a person is laying down. As IOP tests are generally given in a doctor’s office when a patient is sitting up, they may not provide an accurate evaluation of eye pressure.

**Test for optic nerve damage.** To check for damage in your optic nerve, your eye doctor uses instruments to look directly through the pupil to the back of your eye. This can reveal slight changes that may indicate the beginnings of glaucoma.

**Visual field test.** To check whether your visual field has been affected by glaucoma, your doctor uses a special test to evaluate your side (peripheral) vision.

- **Visual acuity.** Doctor will test ability to see from a distance.
- **Measuring corneal thickness (pachymetry).** Eyes are numbed for this test, which determines the thickness of each cornea, an important factor in diagnosing glaucoma. If person have thick corneas, his/her eye-pressure reading may read higher than normal even though you may not have glaucoma. Similarly, people with thin corneas can have normal pressure readings and still have glaucoma.

**Other tests.** To distinguish between open-angle glaucoma and angle-closure glaucoma, eye doctor may use a technique called gonioscopy in which a special lens is placed on eye to inspect the drainage angle. Other tests, such as imaging tests, have been developed and may sometimes be used.

**Treatment and drugs:**

The goal of glaucoma treatment is to lower pressure in eye (intraocular pressure). To treat condition, doctors may lower eye pressure, improve drainage of fluid in eye or lower the amount of fluid produced in eye.

Glaucoma can’t be cured, and damage caused by the disease can’t be reversed, but treatment and regular checkups can prevent vision loss in people with early glaucoma. If vision loss has already occurred, treatment can slow or prevent further vision loss.

**Eyedrops:**

Glaucoma treatment often starts with medicated eyedrops. Be sure to use the drops exactly as prescribed. Otherwise, optic nerve damage could get even worse. If doctor prescribes more than one type of eyedrop, make sure to ask how long to wait between applications and to take the drops for as long as doctor has prescribed. Because some of the eyedrops are absorbed into bloodstream, it may experience some side effects unrelated to eyes. To minimize this absorption, close eyes for one to two minutes after putting the drops in. Press lightly at the corner of eye near your nose to close the tear duct for one or two minutes, and wipe off any unused drops from eyelid.

Most commonly prescribed eyedrops include:

- **Prostaglandins:** Prostaglandins are hormone-like substances that help open blood vessels. Drugs that resemble prostaglandins increase outflow of aqueous humor (the watery substance in the eye). Drainage of aqueous humor helps reduce intraocular pressure. Latanoprost (Xalatan) and unoprostone (Rescula) are the standard brands. Latanoprost was the first prostaglandin to be approved as first-line treatment for elevated eye pressure. Two newer prostaglandins, travoprost (Travatan) and bimatoprost (Lumigan), may help some patients who do not respond to

*Patel et al. EJPDCR, 2013; 2: 112-120*
latanoprost. These drugs may also benefit patients with normal-tension glaucoma.

**Side Effects:** These drugs do not slow down the heart rate and also appear to be safe for people with asthma. Side effects include itching, redness, and burning during administration. Muscle and joint pain may also occur. All of these drugs may permanently change eye color from blue or green to brown.

- **Beta blockers:** Topical beta adrenoceptor blockers (commonly called beta-blockers) are the drugs most often prescribed to treat glaucoma. They lower the pressure inside the eye by inhibiting the production of aqueous humor. These drugs are categorized as either nonselective or selective beta-blockers:
  - Nonselective beta blockers such as timolol (Timoptic, Betimol) have the standard beta-blocker properties of wider use. The nonselective drugs include levobunolol (Betagan), carteolol (Ocupress), and metipranolol (Optipranolol). A few studies suggest some are more beneficial than timolol with similar side effects.
  - Selective beta-adrenoceptor blockers. Betaxolol (Betoptic) and levobetaxolol (Betason) are selective beta-blockers. These drugs appear to have fewer adverse effects on the heart than the nonselective beta-blockers, although they still have widespread effects. Studies also suggest that they slow progression more than timolol, although timolol is more effective at lowering IOP. Selective beta-blockers may also have nerve-protecting properties. All beta-blockers work well and generally well tolerated. Because they cause less eye irritation than other glaucoma medications, they are often prescribed for patients who also have cataracts.

**Side effects and complications:** After the beta-blocker is administered, only a tiny amount of the drug is absorbed by the cornea. Most of it enters in the bloodstream. These drugs, therefore, can cause side effects in parts of the body other than the eyes. Systemic side effects may include reduced sexual drive, fatigue, depression, anxiety, and breathing difficulties. Beta-blockers affect the heart. They lower heart rate and reduce blood pressure. Beta-blockers can worsen severe asthma or other lung diseases. A patient switching to a beta-blocker from other glaucoma medication may feel a sudden rise in eye pressure. It is important that the pressure be checked shortly after the other drug has been withdrawn. When beta-blockers are used to treat one eye, the other (contralateral) eye also experiences a lesser, but still significant reduction in IOP.

**Interactions with other medications:** The effects of the eye medication can interact with other oral medications, such as oral beta-blockers, calcium-channel blockers, or the antiarrhythmic drug quinidine. People with diabetes who take insulin or hypoglycemic medications should realize that these medications may mask the symptoms of hypoglycemia (low blood sugar). Alpha-adrenergic agonists: Adrenergic agonists activate muscles in the eye that dilate pupils and, therefore, increase outflow of aqueous fluid. Newer variations called alpha-2-adrenergic agonists reduce production of aqueous humor and also increase outflow through the uveoscleral pathway (the alternative channel to the trabecular meshwork). Apraclonidine (Lopidine) and brimonidine (Alphagan) are alpha 2-adrenergic agonists. These are generally been used before glaucoma surgery, but may be useful as primary therapy when used in combination with beta-blockers or other standard drugs. Brimonidine is proving to be particularly effective for long-term therapy. Apraclonidine is used for the short term. It also may have nerve-protection properties and may be safer than other drugs during pregnancy and for patients with asthma. The most common side effects of brimonidine and apraclonidine are dry mouth and altered taste. They also commonly trigger an allergic reaction that causes red and itching eyes and lids. Brimonidine causes less of an allergic response than apraclonidine. Unlike apraclonidine, however, it can cause lethargy and mild low blood pressure.

**Carbonic anhydrase inhibitors:** These are rarely used; Carbonic anhydrase inhibitors (CAIs) decrease eye pressure by reducing the fluid in the chambers of the eye (aqueous humor). These drugs are used for glaucoma when other drugs do not work. They may be combined with other medications. CAIs may also improve blood flow in the retina and optic nerve (beta-blockers do not). Improving blood flow can keep the disease from getting worse.

Brands and Side Effects. CAIs are available in the following forms:

- **Eye-drops:** CAIs include dorzolamide (Trusopt) and brinzolamide (Azopt). About 10% of patients report fatigue, stinging in the eye, and loss of appetite due to dorzolamide. Taste changes can occur. Brinzolamide is a newer medication that may cause less stinging than dorzolamide.

- **Forms taken by mouth (oral):** include acetazolamide (Diamox), methazolamide (Neptazane), and dichlorphenamide (Daranide). Although they are more effective than eye drops, they have significantly more side effects and are rarely used for long-term treatment. The oral forms have very unpleasant side effects, including frequent urination, depression, stomach problems, fatigue, weight loss, sexual dysfunction, and, in infants, failure to thrive. Long-term use of the oral forms, in rare cases, can cause serious anemia and kidney problems, including the risk for stones. They can also produce a toxic reaction when taken with large doses of aspirin.

- **Miotic or cholinergic agents:** Miotics, also called cholinergic agonists, narrow the iris muscles and constrict the pupil. This action pulls the iris away from the trabecular meshwork and allows the aqueous humor to flow out through the drainage channels, reducing the pressure inside the front of the eye. Pilocarpine (Pilocar, Adasorbcarpine, Almancorine, Isoptocarpine, and Ourosurf) was the most widely used antiglaucoma drug before timolol was introduced. It is the preferred miotic. Because pilocarpine is used up by the body fairly quickly, however, patients must take it several times a day; many people, therefore, fail to take their medication regularly. A combination of timolol and latanoprost with pilocarpine is more effective than either drug used alone. Carbachol is another miotic. Epinephrine and its derivatives are the older anticholinergics. Epinephrine is now rarely prescribed because of side effects. Dipivefrin (Dipivefrin), a newer form of epinephrine, remains inactive until it reacts with enzymes in the cornea. It is effective in low doses and causes few systemic side effects.

**Side effects include:**

- teary eyes, dry, achy, eye pain, and allergic reactions.

- A miotic narrows the pupil and so can cause nearsightedness. Vision can also become dim and it may difficult to see in darkened rooms or at night, when driving could be hazardous.

- Anticholinesterase miotics increase the risk of cataract development and are therefore used mostly in patients in whom cataracts have already been removed. Retinal detachment is an uncommon but dangerous side effect in susceptible individuals. Excessive use of these miotics may cause toxic reactions, including convulsions, muscular paralysis, and even death from respiratory failure.

- Epinephrine can produce burning in the eyes, enlarged pupils, and allergic reactions. Occasionally it can cause anxiety and headaches. Rare side effects include high blood pressure and disturbances in heart rhythm. It is rarely prescribed now. Although dipivefrin, the newer form of epinephrine, has fewer systemic side effects, it still causes problems in the eyes similar to those of epinephrine.

**Combined medications:** Sometimes doctors may prescribe a combined medication, such as a beta blocker and alpha adrenergic agonist, or a beta blocker and carbonic anhydrate inhibitor.

**Oral medications:**

- If eyedrops alone do not bring your eye pressure down to the desired level, doctor may also prescribe an oral medication, usually in the form of a carbonic anhydrate inhibitor, to reduce your eye pressure. This medication may cause side effects including frequent urination, a tingling sensation in the fingers and toes, depression, stomach upset, and kidney stones.

**Surgery:**

The goal of standard glaucoma surgery is to reduce pressure in the eye by increasing the outflow of the aqueous fluid. Two methods are commonly used:

- Filtration surgery (trabeculectomy). This uses standard surgical instruments to open a passage in the eye for draining fluid.
- Laser trabecuoplasty. This procedure uses a laser to burn tiny holes in the drainage area.

Both are effective, but certain patient groups may respond to one more than the other. For example, African-Americans may do better with laser surgery while trabeculectomy may be a better choice for Caucasians without serious medical problems. In general, surgery is a last resort. Doctors may, however,
recommend surgery before drug therapies for patients unlikely to comply with difficult drug regimens or for patients who may have severe reactions from the glaucoma drugs. Surgery does not cure glaucoma, and over half of patients will need medication within 2 years. Surgeries that may be performed to treat glaucoma include:

**Filtration Surgery (Trabeculectomy):**

Filtration surgery has been used for more than 100 years with only minor modifications. It uses conventional surgical techniques known as full-thickness filtering surgery or guarded filtering surgery (trabeculectomy).

- The surgeon creates a sclerostomy, 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 without deflating the eyeball.
- The surgeon may also remove a tiny piece of the iris (called an iridectomy) so that fluid can flow backward into the eye.
- A small bubble called a bleb nearly always forms over the opening, which is a sign that fluid is draining out. Although surgeons aim for a thick bleb, which poses less risk than a thin one for later leakage, paradoxically the ideal operation would have no bleb at all.

The procedure has a high success rate. About 50% of patients no longer need medication after surgery. Thirty-five to 40% of those who still need medication have better control of their glaucoma. A newer instrument called a trabectome has allowed for a less invasive type of trabeculectomy surgery. The trabectome procedure appears to be a safe and simple way to lower eye pressure. It can be performed before a traditional trabeculectomy, if needed.

**Side Effects:** Many of the serious side effects or complications that occur with filtration surgery involve blebs (blisters-like bumps).

- Bleb Leaks and Infections. Blebs, particularly thin ones, commonly leak. Leakage can occur early on or sometimes as late as months or years after surgery. Untreated, such leaks can be serious and even cause blindness. Late-onset leakage significantly increases the risk for infection as well as a number of other serious conditions, including bleeding, a flattening of the eye ball, and harmful inflammation. Surgical repair is the most effective way of managing leaking blebs, although drug therapies, pressure patching, and other nonsurgical techniques may be tried first. Due to the dangers of leaking blebs, doctors recommend lifelong monitoring after surgery. Unfortunately, the incidence of late-onset leaking blebs is increasing due to the use of drugs used in filtration surgery to prevent scarring, another complication.

- Scarring. In up to 20% of cases, scars from around the incision, closing up the drainage channels and causing pressure to rebuild. Scarring is a particular problem in young patients, African-Americans, and patients who have taken multiple drugs, have had an inflammatory disease, or have had cataract surgery. Releasing the surgical stitches used in the procedure may help prevent scarring and pressure build-up. A second procedure called bleb neoding sometimes can open up the scarred area and restore drainage. With this technique, the tip of a very fine hypodermic needle is used carefully to cut loose the particles closing off the drainage area.

- Cataracts. The procedure is highly associated with the development of cataracts over time. Because cataracts are associated with glaucoma anyway, it is not entirely clear whether the cataracts are caused by the surgery or would develop in any case.

Supportive Medication for Preventing Scarring. Specific drugs, usually mitomycin C, are often used in conjunction with the procedure to prevent scarring and closure. A large review of studies of mitomycin C supported its effectiveness in increasing surgical success in nearly all patients. Fluorouracil (5-FU) appears to be similar in effectiveness but has a high risk for complications and is not used as often as in the past.

**Laser Trabeculoplasty:**

Laser trabeculoplasty involves the following steps:

- The procedure uses an instrument, usually a YAG laser, to burn 80 - 100 tiny holes in the drainage area.
- A tiny scar forms, which increases fluid outflow.
- The procedure takes 15 minutes, causes almost no discomfort, and has very few complications.

Laser surgery is not a cure. Patients still need to take anti-glaucoma eye drop medications every day.

**Complications:** In about 35% of patients, pressure increases after surgery. In most cases it is temporary, but in rare cases the increased pressure is permanent and vision loss can occur. Use of the drug apraclonidine (Iopidine) or pilocarpine can help prevent this elevated pressure. About a third of patients also develop adhesive-like substances called peripheral anterior synecchia that cause the iris to stick to part of the cornea.

**Drainage Implants (Tube Shunts):**

Drainage implants may be used to drain fluid in certain cases, such as if glaucoma is not responsive to any standard procedure or is caused by certain conditions.

 Drainage implants may be used in the following conditions:

- Glaucoma caused by swelling in the iris
- Glaucoma caused by abnormal vessel formations
- Iridocorneal endothelial (ICE) syndrome

In general, the procedure involves:

- An implant, most commonly a 1/2 inch silicone tube, is inserted into the eye’s front chamber (anterior).
- The tube drains the fluid onto a tiny plate that is sewn to the side of the eye.
- Fluid collects on the plate and then is absorbed by the tissues in the eye.

**Complications:**

- Hypotony (very low eye pressure) is a serious complication that has been reduced using better techniques and improved implants.
- Cataracts, detached retina, breakdown of the cornea, and bleeding are potentially significant complications.
- There is also a risk for eye movement disorders, such as strabismus (crossed eyes) or diplopia (double-vision). The implant often becomes blocked, and additional surgery may be needed.
Noninvasive Glaucoma Surgery (NGS) is a relatively new approach to treating glaucoma. It involves the use of medications, such as antihistamines and certain antiviral agents, to reduce the pressure in the eye. This approach is often recommended for patients who have failed to respond to medical treatment or who have contraindications to conventional surgery.

The treatment involves the use of a medication that is placed on the eye, such as a drop or ointment. The medication works by reducing the production of aqueous humor, the fluid that flows from the eye to the back of the eye. This reduces the pressure in the eye and helps to slow the progression of the disease.

Noninvasive glaucoma surgery has several advantages over conventional surgery. It is less invasive, requires no incision, and has a lower risk of complications. It is also less expensive, with fewer hospitalizations and shorter recovery times.

Another advantage of noninvasive glaucoma surgery is that it can be used in combination with other treatments, such as a trabeculectomy. A trabeculectomy is a surgical procedure that involves creating a new drainage channel in the eye to reduce the pressure.

Noninvasive glaucoma surgery is also effective for patients who have had a previous trabeculectomy. In this case, the medication is placed on the eye to help reduce the pressure and prevent further damage to the eye.

Despite its many advantages, noninvasive glaucoma surgery is not a cure for glaucoma. It is a management strategy that helps to control the disease and prevent vision loss. It is important for patients to continue using the medication as directed and to have regular follow-up appointments to monitor the effectiveness of the treatment.

In conclusion, noninvasive glaucoma surgery is a valuable tool in the treatment of glaucoma. It offers a safe, less invasive, and less expensive alternative to conventional surgery. It is effective for patients who are not candidates for surgery or who have failed to respond to conventional treatment.

For more information on noninvasive glaucoma surgery, please visit the American Glaucoma Society website at www.amerglaucoma.org.
Practicing yogic exercise on a daily basis improves the general health and blood circulation in the body, which is also beneficial for eyes.

- Take sufficient exposure to sunlight.
- Take breaks for sometimes at regular interval to relax the eyes during the work and avoid giving much strain to the eyes while watching TV, computers, driving and reading.
- Daily meditation relaxes the nerves of the body and reduces the strain from eyes.
- Ayurveda provides an effective treatment without any side effect and is safe. The remedies give long term and permanent relief.

Lifestyle and home remedies:25, 19

In elevated intraocular pressure or glaucoma, follow these lifestyle tips.

- Eat a healthy diet. Eating a healthy diet can help you maintain your health, but it won’t prevent glaucoma from worsening. Several vitamins and nutrients can help improve your vision.
- Exercise safely. Regular exercise may reduce eye pressure in open-angle glaucoma. Talk to your doctor about an appropriate exercise program.
- Limit your caffeine. Drinking high amounts of caffeine may increase your eye pressure.
- Sip fluids frequently. Drink only moderate amounts of fluids at any given time during the course of a day. Drinking a quart or more of any liquid within a short time may temporarily increase eye pressure.

Home Remedies For Glaucoma:26

1. Take 50 mg of Rutin 3 times a day. This bioflavonoid reduces pain and pressure inside the eye.
2. Vitamin A and carotenoids are needed to keep healthy eyes and to improve night vision.
3. Eat spinach and take Lutein or spinach extract because they contain carotenoid needed for retina and eye tissue and sometimes reverse many eye conditions.
4. Eyebright herb in drops is excellent for glaucoma. This plant can be used internally and is much more effective than commercial eye drops and safer.
5. Take Ginkgo Biloba because it increases the delivery of oxygen and nutrients to the eye and it clears toxins. Mix it with zinc sulphate to slow down progressive vision loss.
6. Cayenne is an anti-inflammatory for the mucous membranes. Use very small amounts, well diluted with water or in eye drop form. It increases blood flow to the eye.
7. Take Vitamin E. It removes particles from the eye lens.
8. Bilberry strengthens and protects veins and blood vessels, protects the retina, reduces pressure in glaucoma and can stop the growth of cataracts.
9. Use Coleus dropped directly into the eye to increase blood flow to the eye and decrease intraocular pressure.
10. Use Fennel. This plant although used in the kitchen for salads are also a very good herb for vision problems. When snakes shed their skin they are temporarily blinded and eat fennel to restore their sight. It can be eaten raw or made as a tea and the tea can be used as eye wash.
11. Jaborandi is an herb that grows in the rainforest. It’s been used for about 120 years in patients with glaucoma because it contains pilocarpine.
12. Although we do not recommend it, many studies have shown that marijuana can help reduce intraocular pressure but it is unknown how marijuana achieves this result.

Natural remedies:27, 19

Doctors will normally recommend surgery to relieve the internal pressure. But this does not remove the cause of the excess fluid. Hence the operation does not guarantee that the trouble does not recur or will not affect the other eye. Go for the natural treatment of the glaucoma, which is the same as that for any other condition arising from toxicity and is directed toward preserving the remaining sight. Person cannot cure glaucoma in the advanced stages but proper nutrition and other natural methods can control the problem and taking care of the remaining sight. If persons are suffering from glaucoma, avoid certain foodstuffs. Coffee is the main food to avoid due to its high caffeine content. Excess caffeine stimulates the vasoconstrictors, elevates blood pressure and increases the blood supply to the eye. Beer and tobacco can cause constriction of the blood vessels and hence should be avoided. Drink moderate amount of tea. Do not take excess fluids like juice, milk or water. Instead have small amounts many times with a gap of one hour.

Diet should be mainly of seeds, nuts and grains, vegetables and fruits. Eat plenty of vitamin C-rich foods, fresh fruits and vegetables. Breakfast should consist of oranges or grapes or any other juicy fruits of the season and a small amount of nuts or seeds. Take raw vegetable salad with olive oil and lemon juice dressing, two or three whole wheat chapattis and a glass of buttermilk for lunch. Steamed vegetables, butter and cottage cheese should form your dinner. Consuming certain nutrients will help condition tremendously. Generally, people with deficiencies of vitamin A, B, C, protein, calcium and other minerals have a higher risk of suffering from glaucoma. Calcium and B-complex relieve the intraocular pressure. Including vitamin C will also reduce this pressure. Taking 7000 mg of ascorbic acid five times a day brought down the pressure within the acceptable limits. Take some calcium along with it to minimize the side effects of the large dose like mild stomach discomfort and diarrhoea. Relax and strengthen your eyes by doing variety of eye and neck exercises. Avoid emotional stress and develop a peaceful and relaxed lifestyle. Do not strain the eyes for the long time like watching television, movies or reading. Do not use sunglasses.28

Relaxation techniques. Stress may trigger an attack of acute angle-closure glaucoma. Find healthy ways to cope with stress, such as meditation and biofeedback.27

Prevention:40, 19

Get regular eye care. Regular comprehensive eye exams can help detect glaucoma in its early stages before irreversible damage occurs. As a general rule, have comprehensive eye exams every three to five years after age 40 and every year after age 60. It may need more frequent screening if person have glaucoma risk factors.

Treat elevated eye pressure. Glaucoma eyeprods can significantly reduce the risk that elevated eye pressure will progress to glaucoma. To be effective, these drops must be taken regularly even if person has no symptoms.

Eat a healthy diet. While eating a healthy diet won’t prevent glaucoma, it can improve physical and mental health. It can also help to maintain a healthy weight and control blood pressure.

Wear eye protection. Serious eye injuries can lead to glaucoma.

Wear eye protection when use power tools or play high-speed racket sports on enclosed courts. Also wear hats and sunglasses.41

REFERENCES:

4. ww.glaucoma.org/glaucoma/types-of-glaucoma.php
5. gloma.emedtv.com/glaucoma/types-of-glaucoma.htmlaucc
12. Online "Mendelian Inheritance in Man" (OMIM) GLAUCOMA, PRIMARY OPEN ANGLE: POAG – 137760
13. Online "Mendelian Inheritance in Man" (OMIM) GLAUCOMA, NORMAL TENSION, SUSCEPTIBILITY TO – 606657
15. Chaum E. "A 5 year old girl who failed her school vision screening. Case presentation of Persistent fetal vasculature (PFV), also called persistent hyperplastic primary vitreous (PHPV)". Digital Journal of Ophthalmology.
34. http://www.ayurvedaforall.com/blog/2008/03/17/id/183
38. http://www.healingtheeye.com/Ant/m/Homeo_glaucama.html