

Glaucoma: The Silent Thief of Vision

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Abstract: *Glaucoma is one of the leading causes of irreversible blindness worldwide. Glaucoma is gradual loss of retinal ganglion cells which result in damage to the optic nerve and visual field loss. Glaucoma is an age related disease with a strong genetic basis. Glaucoma is more prevalent in middle aged to elderly population and family history is a major risk factor. The important risk factors for glaucoma are raised intraocular pressure, high degree of refraction errors, diabetes, high myopia, hypotension, hypertension, migraines and medications such as antidepressants, antihistamines and corticosteroids. Fruits and vegetables are rich in antioxidants and several studies have evaluated fruit and vegetable consumption along with the constituent antioxidants in relation to glaucoma risk. There has been no compelling evidence to suggest a relationship between dietary supplementation with vitamins A or E and glaucomatous disease in the large population-based study. There was, however, weak evidence that supplemental vitamin C intake may perhaps be associated with decreased odds of glaucoma.*

Keywords: *Glaucoma, intraocular pressure, vitamins, risk factors, myopia, antidepressants.*

Glaucoma is an optic neuropathy characterized by a progressive typical pattern of optic neurodegeneration and visual field loss [1]. Glaucoma is a condition that causes damage to eye's optic nerve which gets worse over time. It is often associated with a buildup of pressure inside the eye [2]. The increased pressure called intraocular pressure can damage the optic nerve, which transmits images to the brain. If damage to the optic nerve from high eye pressure continues glaucoma will cause permanent loss of vision. Without treatment, glaucoma can cause total permanent blindness within a few years. Worldwide glaucoma is the commonest cause of irreversible blindness [3].

Glaucoma can be classified as being primary, secondary or congenital. These groups can be further categorized to be "open-angle" and "closed-angle" (or "angle closure") glaucoma depending on the anterior chamber angle. The angle refers to the area between the iris and cornea, through which fluid must flow to escape via the trabecular meshwork. In closed angle glaucoma the angle between iris and cornea is closed resulting in obstruction of aqueous humor flow. Closed-angle glaucoma can appear suddenly and is often painful; visual loss can progress quickly. Primary open angle glaucoma (POAG) is a common type of glaucoma where iridocorneal angle is unobstructed. Elevated intraocular pressure (IOP) is a major risk factor of developing POAG. Primary open angle, chronic glaucoma tends to progress at a slower rate and patients may not notice they have lost vision until the disease has progressed significantly [4].

Secondary glaucoma may occur due to eye trauma, inflammation, and tumor, diabetes, advanced cataract or steroid use. Pigmentary and exfoliative glaucoma are two specific types of secondary glaucoma [1]. Pigment dispersion syndrome and pigmentary glaucoma represent a spectrum of disease characterized by excessive pigment release from the iris that is distributed throughout the anterior segment of the eye. These pigment granules flow throughout the aqueous drainage pathways and accumulate thus reducing the outflow facility of the eye. This results in increased intraocular pressure and optic nerve damage with associated visual field loss. Exfoliative syndrome and exfoliative glaucoma represent a spectrum of disease characterized by deposition of a proteinaceous dandruff like exfoliation material within the anterior segment of the eye that is released from the outer layer of the lens. Similarly, this material obstructs aqueous outflow thus raising the intraocular pressure and causing optic nerve damage with associated visual field loss.

When the scleral venous sinus is blocked to where aqueous humor is not reabsorbed at a faster rate than it is being secreted, elevated pressure within the eye occurs. Pressure in the anterior and posterior chambers pushes the lens back and puts pressure on the vitreous body. The vitreous body presses the retina against the choroid and compresses the blood vessels that feed the retina. Without a sufficient blood supply, retinal cells will die and the optic nerve may atrophy, causing blindness. Typically, the nerves furthest from the focal point fail first because of their distance from the central blood supply to the eye; thus, vision loss due to glaucoma tends to start at the edges with the peripheral visual field, leading to progressively worse tunnel vision [5].

Glaucoma has been called the "silent thief of sight" because the loss of vision often occurs gradually over a long period of time, and symptoms only occur when the disease is quite advanced. Once lost, vision cannot normally be recovered, so treatment is aimed at preventing further loss. Worldwide, glaucoma is the second-leading cause of blindness after cataracts [6]. It is also the leading cause of blindness among African Americans. Glaucoma affects one in 200 people aged 50 and younger, and one in 10 over the age of 80. If the condition is detected early enough, it is possible to arrest the development or slow the progression with medical and surgical means. It is estimated that there are more than 60 million cases of glaucoma worldwide and it will increase to 80 million by 2020. According to WHO statistics, the prevalence of glaucoma in India is 2.6 per cent which amounts to 12 million people forming one fifth of the global burden of glaucoma. The National Blindness survey 2001 showed that glaucoma is the third major cause of blindness in India and responsible for 5.9 per cent of blindness. There has been more than threefold increase in proportion of glaucoma blindness compared to that found in National Blindness Survey 1986-1989[3]. The prevalence of POAG in rural South India among 40+ populations was estimated as 1.7 per cent [7] while the prevalence has been comparatively higher in urban South India [8].

SYMPTOMS OF GLAUCOMA

Glaucoma is called sneak thief of sight because this disease does not exhibit any major symptoms initially. The clinical features of glaucoma vary from an absolutely silent eye to an acutely red painful eye. The first sign of glaucoma is often the loss of peripheral or side vision, which can go unnoticed until late in the disease. Patients with open-angle glaucoma and chronic angle-closure glaucoma in general have no symptoms early in the course of the disease. Visual field loss (side vision loss) is not a symptom until late in the course of the disease. Rarely patients with fluctuating levels of intraocular pressure may have haziness of vision and see haloes around lights, especially in the morning. On the other hand, the symptoms of acute angle-closure are often extremely dramatic with the rapid onset of severe eye pain, headache, nausea and vomiting, and visual blurring. Occasionally intraocular pressure can rise to severe levels which can result in sudden eye pain, headache, blurred vision or the appearance of halos around lights [9].

CAUSES OF GLAUCOMA

Glaucoma usually occurs when pressure in eye increases. This can happen when eye fluid i.e. aqueous humor isn't circulating normally in front part of eye. In normal condition the aqueous humor flows out of the eye through a mesh like channel. If the channel becomes blocked, fluid builds up causing glaucoma. The direct cause of this blockage is unknown. Less common causes of glaucoma include a blunt or chemical injury to the eye, severe eye infection, blockage of blood vessels in the eye, inflammatory conditions of eye and occasionally eye surgery to correct another condition. Stress plays a significant role in the occurrence of glaucoma as intraocular pressure can be affected by emotional state of patient. This intraocular pressure is also associated with psycho-physical stress. Glaucoma usually occurs in both eyes but it may involve each eye to a different extent [5].

RISK FACTORS FOR GLAUCOMA

While anyone can get glaucoma but it most often occurs in adults and the risk of glaucoma is increased if following risk factors are there:

➤ Age and Family History

Aging is a major risk factor for developing glaucoma. However, at the physiological level, minimal changes in aqueous humor flow dynamics occur in normal healthy subjects as aging progresses. Using tonography, many studies have observed that aqueous humor outflow facility decreases with age. The risk of developing glaucoma significantly increases after age 40 and those with a positive family

history of glaucoma [10]. It is estimated that the chances of having glaucoma are around 10 times higher in first degree relatives of glaucoma patients [11].

➤ **Diabetes**

Diabetes is associated with a variety of ocular complications, including retinopathy, cataracts, uveitis and neovascularization. Diabetes has been significantly associated with higher risk of glaucoma. Individuals without diabetes but at the higher levels of fasting glucose, fasting insulin, HbA1c and HOMA-IR spectrum may also be at greater risk of glaucoma. Several studies also suggested that diabetes may be associated with an increased risk of glaucoma[12]. The association between diabetes and glaucoma has been evaluated in many studies [13], [14]. An increased risk of glaucoma in persons with diabetes compared to those who did not have diabetes was also observed in the Beaver Dam Eye study, the Blue Mountains Eye study, the Los Angeles Latino Eye Study and several other population-based studies [15], [16].

➤ **Myopia (Nearsightedness)**

Myopia is associated with an increased risk of pathological ocular complications and may lead to blinding disorders such as premature cataracts, glaucoma, retinal detachment, and macular degeneration. Studies shows that, high myopia is a major cause of legal blindness in many developed countries. It has been found that myopic patients had two to three fold increased risk of glaucoma compared with that of non-myopic independent of other glaucoma risk factors and IOP[17].

➤ **Medications**

Medications such as Antidepressants, major classes of antidepressants that cause angle closure are tricyclic antidepressants (TCAs) and serotonin-specific reuptake inhibitors (SSRIs). It has been suggested that nebulized administration of bronchodilator medications either α_2 -adrenergic agonists or anticholinergic medications for Asthma and chronic obstructive airway disease allows a significant dose to be absorbed over the conjunctiva and cornea. The British National Formulary lists 'glaucoma' as a contraindication to use of anticholinergic for urinary incontinence and as antispasmodics, although it makes no distinction between open-angle glaucoma and angle-closure glaucoma, nor between patients who have had previous laser treatment for their occludable anterior chamber angles. There have been several case series of patients suffering AAC (acute angle closure) after general anesthesia and have resulted in permanent visual loss from glaucomatous optic neuropathy. Many over-the-counter cold and cough remedies contain constituents, included as antihistamines or decongestants, which also have marked sympathomimetic or anticholinergic effects [18].

DIET AND GLAUCOMA

There has been longstanding interest in the potential impact of environmental or lifestyle factors such as diet composition on glaucoma development and progression, either via an effect on IOP, or through more direct mechanisms such as modification of retinal ganglion cell apoptosis. There is a strong link between proper nutrition and optimal ocular and visual health. Inadequate, unbalanced or excessive food intake has been linked to dry eye, vascular ocular disease, diabetic retinopathy, age related macular degeneration, cataract and glaucoma formation. There is growing interest in the role of dietary factors in glaucoma because modification would be possible by changing eating habits or by supplementation [19]. The discovery of dietary factors that modify the risk of glaucoma may provide insight into glaucoma pathogenesis and serve as a primary preventive measure. The effects of nutrients with anti-oxidant activity are of great interest, especially because the intake of nutrients is modifiable. It has been shown that differences in intake of anti-oxidants may influence the course of an eye disease (e.g., age-related macular degeneration), even in the western world without apparent malnutrition [20].

ANTIOXIDANTS INTAKE

Nutrition and the respective antioxidant constituents may be important in the development of eye disease. It has been reported that oxidative stress plays significant role in glaucoma [21]. Oxidative damage to DNA in the trabecular meshwork may compromise outflow and increase intraocular pressure. Free radicals generated in the anterior chamber may escape the antioxidant buffer system and spill into the posterior segment where they interact with incident light to damage retinal ganglion cells. Antioxidants have been suggested to protect retinal ganglion cells damaged by glaucomatous optic neuropathy [22].

Common nutrients with anti-oxidant activity are carotenoids (present in most fruits and vegetables), retinol equivalents, vitamins B, C and E, and polyphenolic flavonoids (present in tea, especially green tea, and coffee) [23]. These foods were identified as good sources of nutrients important for eye health:

Vitamin C: Citrus fruits, berries, tomatoes and broccoli.

Vitamin E: Vegetable oils, wheat germ, nuts and legumes.

Lutein and zeaxanthin: Kale, spinach, broccoli, peas, corn, colored bellpeppers.

Beta-carotene: Carrots, pumpkin, sweet potato and spinach.

Zinc: Oysters, beef and other meats, nuts.

Omega-3 fatty acids: Salmon and other cold-water fish [24].

Vitamin E is an important natural antioxidant with additional putative antiproliferative properties, which may potentially be beneficial in the treatment of glaucoma. In the eye, vitamin E is regenerated through reactions with vitamin C, another antioxidant found in the aqueous humor [25]. The epidemiologic studies, which focused on dietary risk factors for glaucoma, did not yield consistent associations between glaucomatous disease and the intake of antioxidants and vitamin nutrients with subsequent research relating glaucoma to serum vitamin levels being confined to small clinic-based case-control studies [26, 27, and 28].

A significant relation was found between consumption of carotenoids, vitamin C, vitamin E and the risk of developing primary open angle glaucoma. It has been reported that a higher intake of certain fruits and vegetables rich in vitamin A, C, B₂ and carotenoids by 1155 older white women was associated with a decreased risk of glaucoma among them [29]. It also been reported that higher intake of vitamin A and C and carotenoids may be associated with decreased likelihood of glaucoma among 662 older African-American women [30]. There has been no compelling evidence to suggest a relationship between dietary supplementation with vitamins A or E and glaucomatous disease in the large population-based study. There was, however, weak evidence that supplemental vitamin C intake may perhaps be associated with decreased odds of glaucoma [31].

Diet for glaucoma patients should be based on food namely seeds, nuts, grains, vegetables and fruits with special emphasis on vitamin C as well as vitamin E rich foods, fresh fruits and vegetables. Diet rich in minerals (zinc and calcium) and antioxidants like vitamins C, A, E and Selenium is very important for prevention and cure of glaucoma. Foods that contain bioflavonoid known as anthocyanin should be consumed on regular basis since it helps to fight off the free radicals in the body. Studies also indicate that regular consumption of green tea can help protect the eyes from further damage from glaucoma. New research indicates that leafy greens may be even healthier than we thought. While veggies like spinach, kale and collard greens may not be able to cure glaucoma, eating them regularly may help protect you against ever developing the most common form of the disease, known as primary open angle glaucoma (POAG) [10].

ALCOHOL CONSUMPTION

According to study, Alcohol consumption < 30 g/day did not influence POAG risk: compared with non-drinkers, the pooled RRs were 0.99 (95% Confidence Interval [CI]: 0.83–1.19) for drinking < 10 g/day, 0.96 (95% CI: 0.76–1.22) for 10–19 g/day, and 0.95 (95% CI: 0.68–1.33) for 20–29 g/day. Although there were suggestive inverse associations with drinking > 30 g/day (RR = 0.71), this was not significant (95% CI: 0.49–1.04), and no significant linear associations were detected. Alcohol intake reduces intraocular pressure, a risk factor for primary open-angle glaucoma (POAG) [32]. Multivariable logistic regression analysis also confirmed that family history, hypertension, cigarette smoking and T353I in the myocilin gene are risk factors for POAG. Alcohol consumption, however, has been found to have a protective effect [33].

COFFEE / TEA CONSUMPTION

The studies identified a positive cross-sectional association between coffee consumption/higher caffeine intakes and elevated intraocular pressure among participants with POAG [34]. There has also been observed a positive association between heavier coffee consumption and increased risk of exfoliation glaucoma or becoming an exfoliation glaucoma suspect. However, no association between

coffee or caffeine consumption and higher IOP was found in participants with ocular hypertension (OH) and those without open-angle glaucoma[35].

FAT CONSUMPTION

A diet high in n-6 and low in n-3 polyunsaturated fats has been found to be associated with a reduced occurrence of POAG, particularly high-tension POAG. There is a high inverse correlation with the relative tissue concentrations of highly unsaturated n-6 fatty acids such as arachidonic acid. Greater dietary n-6 fat intake leads to greater availability of the n-6 prostaglandins (such as prostaglandin F_{2α}), which may help to maintain IOP at levels that are less harmful to the optic nerve and thereby reduce the occurrence of POAG. Whereas prostaglandins have been valued mostly as therapeutic agents for glaucoma patients [36], these results suggest that alterations in the endogenous production or variations in the physiologic concentrations of ocular prostaglandins in healthy populations may be related to the likelihood of developing glaucoma [37].

CONCLUSIONS

- The prevalence of glaucoma in India is 2.6 per cent which amounts to 12 million people forming one fifth of the global burden of glaucoma.
- The important risk factors for glaucoma are age above 40 years, family history, raised intraocular pressure, high degree of refraction errors, diabetes, high myopia, hypotension, hypertension, migraines and medications such as antidepressants, antihistamines and corticosteroids.
- Diet rich in minerals (zinc and calcium) and antioxidants like vitamins C, A, E and Selenium is very important for prevention and cure of glaucoma.
- Alcohol consumption, however, has been found to have a protective effect

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