

Review Article

A review on glaucoma: causes, symptoms, pathogenesis & treatment

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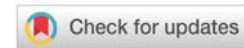
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Abstract

If glaucoma is not treated, it can worsen and cause irreparable vision loss. It results from elevated intraocular pressure that gradually deteriorates the optic nerve. It is unclear exactly what causes this build-up of pressure, but several factors, including age, genetics, and specific medical disorders, may be involved. Glaucoma frequently has mild symptoms that take time to manifest and may not be apparent until considerable harm has already been done. Early detection and treatment can help prevent additional vision loss, which is why routine eye exams are so crucial. In order to reduce intraocular pressure, glaucoma is usually treated with medication or surgery. Eye drops, tablets, or a mix of the two can be prescribed. Traditional filtration surgery is one of the surgical options or more recently less invasive techniques. Glaucoma is a dangerous eye condition that needs to be closely watched over and managed. Although early diagnosis and therapy can help protect vision and prevent additional impairment, there is currently no treatment for the disease. People who are at elevated risk for glaucoma, including those who have a family history of the condition or who are older than 60, should make an appointment for regular checkups with an ophthalmologist to be checked for glaucoma symptoms. The article's summary will aid researchers in their efforts to improve glaucoma treatment.

Introduction

Glaucoma is a complex and multifactorial eye disease that affects millions of people worldwide. It is characterized by progressive optic nerve damage and visual field loss, which can ultimately lead to irreversible blindness if left untreated [1-5]. Despite its prevalence, glaucoma remains a significant public health challenge due to its insidious onset, asymptomatic nature, and lack of effective treatments for advanced stages of the disease. In this review, we will provide an overview of glaucoma, including its etiology, pathophysiology, diagnosis, treatment, and management [6-9].

Etiology

The exact cause of glaucoma is not fully understood, but it is believed to result from a combination of genetic and

environmental factors. Studies have shown that individuals with a family history of glaucoma are at a higher risk of developing the disease, suggesting a strong genetic component. However, environmental factors such as aging, Intraocular Pressure (IOP), and oxidative stress also play a role in the pathogenesis of glaucoma [10-16].

Aging is a well-established risk factor for glaucoma, with the incidence of the disease increasing with age. This may be due to age-related changes in the optic nerve and Retinal Ganglion Cells (RGCs), which are the neurons that transmit visual information from the eye to the brain. Oxidative stress is another important factor in glaucoma pathogenesis, as it can lead to RGC death and optic nerve damage. Oxidative stress is thought to result from an imbalance between Reactive Oxygen Species (ROS) production and antioxidant defenses in the eye [17-25].

IOP is perhaps the most widely recognized risk factor for glaucoma. Elevated IOP is associated with increased optic nerve damage and visual field loss in individuals with glaucoma. However, the relationship between IOP and glaucoma is complex and multifactorial, as IOP fluctuations are common in both healthy individuals and those with glaucoma. Moreover, some individuals with normal IOP levels may still develop glaucoma, suggesting that other factors besides IOP may contribute to the disease [26–28].

Pathophysiology

The pathophysiology of glaucoma involves complex interactions between various cell types in the eye, including RGCs, astrocytes, microglia, and endothelial cells. The exact mechanisms underlying optic nerve damage and RGC death in glaucoma are not fully understood, but several theories have been proposed [29–31]. One widely accepted theory suggests that increased IOP leads to mechanical stress on the optic nerve head (ONH), which results in RGC death through apoptosis (programmed cell death). This theory is supported by studies showing that increased IOP can lead to structural changes in the ONH and optic nerve atrophy [32]. However, other factors besides IOP may also contribute to RGC death in glaucoma, such as oxidative stress, inflammation, neurotrophic factor deficiency, and mitochondrial dysfunction [33–35].

Diagnosis

The diagnosis of glaucoma involves a comprehensive eye examination that includes measurements of IOP, visual field testing, and optic nerve evaluation using ophthalmoscopy or imaging techniques such as Optical Coherence Tomography (OCT). These tests are used to detect early signs of optic nerve damage and visual field loss that may indicate the presence of glaucoma. IOP measurements are an essential component of glaucoma diagnosis and management because elevated IOP is a well-established risk factor for the disease [36,37]. However, normal IOP levels do not exclude the possibility of glaucoma because some individuals with normal IOP may still develop the disease due to other factors besides IOP. Therefore, it is crucial to consider other risk factors besides IOP when making a diagnosis of glaucoma [38].

Visual field testing is another critical component of glaucoma diagnosis because it can help detect early signs of visual field loss that may indicate the presence of glaucoma. Visual field testing involves presenting visual stimuli at different locations in the visual field while monitoring the patient's responses using specialized equipment such as perimeter devices or computer-based programs. The results of visual field testing can provide valuable information about the location and severity of visual field loss in individuals with glaucoma [39]. Optic nerve evaluation using ophthalmoscopy or imaging techniques such as OCT can also provide valuable information about optic nerve structure and function in individuals with glaucoma. OCT uses light waves to create high-resolution images of the retina and optic nerve head that can help detect early signs of optic nerve damage in individuals with glaucoma before they become clinically apparent. OCT can

also be used to monitor changes in optic nerve structure over time in response to treatment or disease progression [40].

Treatment and management

The treatment and management of glaucoma involve a multidisciplinary approach that includes medical therapy, surgical intervention, lifestyle modifications, and regular monitoring by healthcare providers such as ophthalmologists or optometrists [41–43]. Medical therapy for glaucoma typically involves medications such as beta-blockers, prostaglandin analogues, Carbonic Anhydrase Inhibitors (CAIs), or miotics that are used to lower IOP levels or improve outflow facility from the eye. These medications can be administered topically or systemically depending on their mechanism of action and side effect profile. Surgical interventions for glaucoma include traditional filtration surgery or newer minimally invasive procedures such as Selective Laser Trabeculoplasty (SLT) or canaloplasty that aim to lower IOP levels by improving outflow facility from the eye or reducing aqueous humour production within it [44,45]. Lifestyle modifications for individuals with glaucoma include regular exercise, and a healthy diet rich in antioxidants such as vitamins C and E [46].

Conclusion

In summary, glaucoma is a complex and multifactorial eye disease that affects millions of people worldwide. Its aetiology involves a combination of genetic and environmental factors, with aging, elevated intraocular pressure (IOP), and oxidative stress as the most widely recognized risk factors. The pathophysiology of glaucoma involves mechanical stress on the Optic Nerve Head (ONH) resulting in RGC death through apoptosis, as well as other factors such as oxidative stress, inflammation, neurotrophic factor deficiency, and mitochondrial dysfunction. Diagnosis of glaucoma involves a comprehensive eye examination including measurements of IOP, visual field testing, and optic nerve evaluation using ophthalmoscopy or imaging techniques such as Optical Coherence Tomography (OCT). Treatment and management of glaucoma involve a multidisciplinary approach that includes medical therapy using medications such as beta-blockers, prostaglandin analogues, Carbonic Anhydrase Inhibitors (CAIs), or miotics to lower IOP levels or improve outflow facility from the eye, surgical interventions such as traditional filtration surgery or newer minimally invasive procedures such as Selective Laser Trabeculoplasty (SLT) or canaloplasty to lower IOP levels by improving outflow facility from the eye or reducing aqueous humour production within it, and lifestyle modifications including regular exercise and a healthy diet rich in antioxidants such as vitamin C and E to reduce oxidative stress and inflammation in the eye. Despite significant progress in our understanding of glaucoma, further research is needed to develop more effective treatments for advanced stages of the disease and to identify new risk factors and biomarkers for early diagnosis and intervention. The review article will help researchers in a comprehensive study of glaucoma as well as prospects in the field of glaucoma management including advancements in diagnostic techniques, treatment options, and research on potential preventive measures. Some areas of focus include:

Improved diagnostic tools

Researchers are working on developing more accurate and sensitive methods for detecting glaucoma at its earliest stages. This includes the use of advanced imaging technologies and genetic testing.

Novel treatment options

Ongoing research aims to develop new medications, surgical techniques, and devices to control better Intraocular Pressure (IOP), a major risk factor for glaucoma progression.

Neuroprotection

Scientists are exploring various neuroprotective strategies to prevent or slow down the damage to the optic nerve caused by glaucoma. This includes investigating the role of antioxidants, anti-inflammatory agents, and other therapeutic approaches.

Patient education and awareness

Efforts are being made to increase public awareness about glaucoma, its risk factors, and the importance of regular eye examinations. Early detection and timely treatment can significantly improve outcomes for individuals with glaucoma.

References

- Jayaram H, Kolko M, Friedman DS, Gazzard G. Glaucoma: now and beyond. *Lancet*. 2023 Nov 11;402(10414):1788-1801. doi: 10.1016/S0140-6736(23)01289-8. Epub 2023 Sep 21. PMID: 37742700.
- Saccà SC, Cutolo CA, Rossi T. Glaucoma: an overview. *Handbook of Nutrition, Diet, and the Eye*. 2019 Jan 1:167-87.
- Shamsher E, Davis BM, Yap TE, Guo L, Cordeiro MF. Neuroprotection in glaucoma: Old concepts, new ideas. *Expert Review of Ophthalmology*. 2019 Mar 4;14(2):101-13.
- Roshan HS. Prevalence and Risk Factors in Primary Open Angle Glaucoma of Patients Attending Ophthalmology OPD at Kims Hubli (Doctoral dissertation, Rajiv Gandhi University of Health Sciences (India)).
- Hayreh SS. Progress in the understanding of the vascular etiology of glaucoma. *Current Opinion in Ophthalmology*. 1994 Apr 1;5(2):26-35.
- Călugăru D, Călugăru M. Etiology, pathogenesis, and diagnosis of neovascular glaucoma. *Int J Ophthalmol*. 2022 Jun 18;15(6):1005-1010. doi: 10.18240/ijo.2022.06.20. PMID: 35814894; PMCID: PMC9203485.
- Duke-Elder SS, Duke-Elder LA. Etiology of glaucoma. *Archives of Ophthalmology*. 1934 Jan 1;11(1):49-57.
- Kim KE, Park KH. Update on the Prevalence, Etiology, Diagnosis, and Monitoring of Normal-Tension Glaucoma. *Asia Pac J Ophthalmol (Phila)*. 2016 Jan-Feb;5(1):23-31. doi: 10.1097/APO.000000000000177. PMID: 26886116.
- Shazly TA, Latina MA. Neovascular glaucoma: etiology, diagnosis and prognosis. *Semin Ophthalmol*. 2009 Mar-Apr;24(2):113-21. doi: 10.1080/08820530902800801. PMID: 19373696.
- Suri F, Yazdani S, Elahi E. Glaucoma in iran and contributions of studies in iran to the understanding of the etiology of glaucoma. *J Ophthalmic Vis Res*. 2015 Jan-Mar;10(1):68-76. doi: 10.4103/2008-322X.156120. PMID: 26005556; PMCID: PMC4424722.
- Petrov SY, Sherstneva LV, Vostruhin SV. Primary glaucoma etiology: current theories and researches. *Ophthalmology Journal*. 2015 Jun 15;8(2):47-56.
- Leske MC. Open-angle glaucoma -- an epidemiologic overview. *Ophthalmic Epidemiol*. 2007 Jul-Aug;14(4):166-72. doi: 10.1080/09286580701501931. PMID: 17896292.
- Carter CJ, Brooks DE, Doyle DL, Drance SM. Investigations into a vascular etiology for low-tension glaucoma. *Ophthalmology*. 1990 Jan;97(1):49-55. doi: 10.1016/s0161-6420(90)32627-1. PMID: 2314843.
- VAIL D. Primary glaucoma: etiology and general considerations. *Am J Ophthalmol*. 1956 Feb;41(2):207-31. doi: 10.1016/0002-9394(56)92015-3. PMID: 13292484.
- Challa P. Glaucoma genetics. *Int Ophthalmol Clin*. 2008 Fall;48(4):73-94. doi: 10.1097/IIO.0b013e318187e71a. PMID: 18936638; PMCID: PMC2637520.
- Sugar HS. The mechanical factors in the etiology of acute glaucoma. *American Journal of Ophthalmology*. 1941 Aug 1;24(8):851-73.
- Bruns HD. Etiology of Glaucoma. Operations for the Relief of Tension. *American Journal of Ophthalmology*. 1925 Jan 1;8(1):23-31.
- Gao F, Wang J, Chen J, Wang X, Chen Y, Sun X. Etiologies and clinical characteristics of young patients with angle-closure glaucoma: a 15-year single-center retrospective study. *Graefes Arch Clin Exp Ophthalmol*. 2021 Aug;259(8):2379-2387. doi: 10.1007/s00417-021-05172-6. Epub 2021 Apr 19. Erratum in: *Graefes Arch Clin Exp Ophthalmol*. 2021 Jul 2; PMID: 33876278; PMCID: PMC8352827.
- SUGAR HS. Place of hemorrhagic glaucoma in etiologic classification of glaucoma. *Archives of Ophthalmology*. 1942 Challa P. Glaucoma genetics: advancing new understandings of glaucoma pathogenesis. *Int Ophthalmol Clin*. 2004 Spring;44(2):167-85. doi: 10.1097/00004397-200404420-00011. PMID: 15087735.
- Freddo TF, Gong H. ETIOLOGY OF IOP ELEVATION IN PRIMARY OPEN ANGLE GLAUCOMA. *Optom Glaucoma Soc E J*. 2009 Jul;4(1):ogs_0709.htm#article3. PMID: 22957318; PMCID: PMC3432647.
- Medert CM, Sun CQ, Vanner E, Parrish RK 2nd, Wellik SR. The influence of etiology on surgical outcomes in neovascular glaucoma. *BMC Ophthalmol*. 2021 Dec 20;21(1):440. doi: 10.1186/s12886-021-02212-x. PMID: 34930191; PMCID: PMC8690523.
- Dumbrăveanu L, Cușnir V, Bobescu D. A review of neovascular glaucoma. Etiopathogenesis and treatment. *Rom J Ophthalmol*. 2021 Oct-Dec;65(4):315-329. doi: 10.22336/rjo.2021.66. PMID: 35087972; PMCID: PMC8764420.
- Siegfried CJ, Shui YB, Holekamp NM, Bai F, Beebe DC. Oxygen distribution in the human eye: relevance to the etiology of open-angle glaucoma after vitrectomy. *Invest Ophthalmol Vis Sci*. 2010 Nov;51(11):5731-8. doi: 10.1167/iov.10-5666. Epub 2010 Aug 18. PMID: 20720218; PMCID: PMC3061509.
- Leopold IH, Duzman E. Observations on the pharmacology of glaucoma. *Annu Rev Pharmacol Toxicol*. 1986;26:401-26. doi: 10.1146/annurev.pa.26.040186.002153. PMID: 2872854.
- Lusthaus J, Goldberg I. Current management of glaucoma. *Med J Aust*. 2019 Mar;210(4):180-187. doi: 10.5694/mja2.50020. Epub 2019 Feb 14. PMID: 30767238.
- Coleman AL. Advances in glaucoma treatment and management: surgery. *Invest Ophthalmol Vis Sci*. 2012 May 4;53(5):2491-4. doi: 10.1167/iov.12-9483l. PMID: 22562849.
- Alward WL. Medical management of glaucoma. *N Engl J Med*. 1998 Oct 29;339(18):1298-307. doi: 10.1056/NEJM199810293391808. PMID: 9791148.
- Schwartz K, Budenz D. Current management of glaucoma. *Curr Opin Ophthalmol*. 2004 Apr;15(2):119-26. doi: 10.1097/00055735-200404000-00011. PMID: 15021223.



29. McKinnon SJ, Goldberg LD, Peeples P, Walt JG, Bramley TJ. Current management of glaucoma and the need for complete therapy. *Am J Manag Care*. 2008 Feb;14(1 Suppl):S20-7. PMID: 18284312.
30. Stein JD, Khawaja AP, Weizer JS. Glaucoma in Adults-Screening, Diagnosis, and Management: A Review. *JAMA*. 2021 Jan 12;325(2):164-174. doi: 10.1001/jama.2020.21899. PMID: 33433580.
31. Parikh RS, Parikh SR, Navin S, Arun E, Thomas R. Practical approach to medical management of glaucoma. *Indian J Ophthalmol*. 2008 May-Jun;56(3):223-30. doi: 10.4103/0301-4738.40362. PMID: 18417824; PMCID: PMC2636120.
32. Butt NH, Ayub MH, Ali MH. Challenges in the management of glaucoma in developing countries. *Taiwan J Ophthalmol*. 2016 Jul-Sep;6(3):119-122. doi: 10.1016/j.tjo.2016.01.004. Epub 2016 Apr 20. PMID: 29018725; PMCID: PMC5525615.
33. Singh K, Shrivastava A. Medical management of glaucoma: principles and practice. *Indian J Ophthalmol*. 2011 Jan;59 Suppl(Suppl1):S88-92. doi: 10.4103/0301-4738.73691. PMID: 21150040; PMCID: PMC3038497.
34. Wagner IV, Stewart MW, Dorairaj SK. Updates on the Diagnosis and Management of Glaucoma. *Mayo Clin Proc Innov Qual Outcomes*. 2022 Nov 16;6(6):618-635. doi: 10.1016/j.mayocpiqo.2022.09.007. PMID: 36405987; PMCID: PMC9673042.
35. Marquis RE, Whitson JT. Management of glaucoma: focus on pharmacological therapy. *Drugs Aging*. 2005;22(1):1-21. doi: 10.2165/00002512-200522010-00001. PMID: 15663346.
36. Supuran CT. The management of glaucoma and macular degeneration. *Expert Opin Ther Pat*. 2019 Oct;29(10):745-747. doi: 10.1080/13543776.2019.1674285. PMID: 31566015.
37. Cohen LP, Pasquale LR. Clinical characteristics and current treatment of glaucoma. *Cold Spring Harb Perspect Med*. 2014 Jun 2;4(6):a017236. doi: 10.1101/cshperspect.a017236. PMID: 24890835; PMCID: PMC4031956.
38. Lee DA, Higginbotham EJ. Glaucoma and its treatment: a review. *Am J Health Syst Pharm*. 2005 Apr 1;62(7):691-9. doi: 10.1093/ajhp/62.7.691. PMID: 15790795.
39. Lim R. The surgical management of glaucoma: A review. *Clin Exp Ophthalmol*. 2022 Mar;50(2):213-231. doi: 10.1111/ceo.14028. Epub 2022 Jan 17. PMID: 35037376.
40. Borrás T. Advances in glaucoma treatment and management: gene therapy. *Invest Ophthalmol Vis Sci*. 2012 May 4;53(5):2506-10. doi: 10.1167/iov.12-9483o. PMID: 22562852.
41. Delgado MF, Abdelrahman AM, Terahi M, Miro Quesada Woll JJ, Gil-Carrasco F, Cook C, Benharbit M, Boisseau S, Chung E, Hadjlat Y, Gomes JA. Management Of Glaucoma In Developing Countries: Challenges And Opportunities For Improvement. *Clinicoecon Outcomes Res*. 2019 Sep 27;11:591-604. doi: 10.2147/CEOR.S218277. PMID: 31632107; PMCID: PMC6776288.
42. Jutley G, Luk SM, Dehabadi MH, Cordeiro MF. Management of glaucoma as a neurodegenerative disease. *Neurodegener Dis Manag*. 2017 Apr;7(2):157-172. doi: 10.2217/nmt-2017-0004. Epub 2017 May 22. PMID: 28540772.
43. Mohan N, Chakrabarti A, Nazm N, Mehta R, Edward DP. Newer advances in medical management of glaucoma. *Indian J Ophthalmol*. 2022 Jun;70(6):1920-1930. doi: 10.4103/ijo.IJO_2239_21. PMID: 35647957; PMCID: PMC9359258.
44. De Moraes CG, Cioffi GA, Weinreb RN, Liebmann JM. New Recommendations for the Treatment of Systemic Hypertension and their Potential Implications for Glaucoma Management. *J Glaucoma*. 2018 Jul;27(7):567-571. doi: 10.1097/IJG.0000000000000981. PMID: 29750712; PMCID: PMC6028320.
45. Remis LL, Epstein DL. Treatment of glaucoma. *Annu Rev Med*. 1984;35:195-205. doi: 10.1146/annurev.me.35.020184.001211. PMID: 6426371.

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