Section: Ophthalmology

Systematic Review

MEDICAL MANAGEMENT OF GLAUCOMA: A SYSTEMATIC REVIEW

Rucha Harish Gulhane[1], Rutika Raghunath Khadse[2]

[1]Associate Professor at Department of Ophthalmology Dr. Panjabrao Alias Deshmukh Memorial Medical College & Hospital, Amravati, Maharashtra, India.
[2]Assistant Professor at Department of Ophthalmology Dr Rajendra Gode Medical College, Amravati, Maharashtra, India

Received *: 19/04/2025*
Received in revised form *: 08/06/2025*
Accepted *: 30/06/2025*

Corresponding Author:
Dr. Rucha Harish Gulhane,
Associate Professor at Department of Ophthalmology Dr. Panjabrao Alias Deshmukh Memorial Medical College & Hospital, Amravati, Maharashtra, India.
Email: drruchagulhane@gmail.com

DOI: 10.70034/ijmedph.2025.3.98

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (3); 536-542

ABSTRACT

Background: Glaucoma is a progressive optic neuropathy and a leading cause of irreversible blindness, primarily managed by lowering intraocular pressure with topical medications. This systematic review evaluates the effectiveness, safety, and tolerability of current medical treatments, including prostaglandin analogues, beta-blockers, alpha agonists, and carbonic anhydrase inhibitors.

Materials and Methods: The present systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A comprehensive literature search was carried out across major electronic databases to identify relevant analytical studies and full-text articles related to the treatment of glaucoma. The risk of bias in the included studies was assessed using standardized and validated methodological tools.

Results: This systematic review included eight eligible studies after screening 691 records and excluding duplicates, irrelevant articles, and incomplete data. The studies varied in design and interventions but all focused on glaucoma treatment. Quality assessment was performed using RevMan and the Cochrane risk of bias tool. Among the included studies, 27.08% had a high risk, 35.42% had a low risk, and 37.50% had an unclear risk of bias in outcome assessor blinding. Overall, the included studies were of moderate to good quality, supporting the reliability of the review findings.

Conclusion: Glaucoma treatment focuses on lowering intraocular pressure using eye drops. Success depends on patient adherence. Statins and some blood pressure medications may help, but their role is still unclear. Managing overall health and improving compliance are key to preventing vision loss.

Keywords: Glaucoma, intraocular pressure, eye drops, medical management, patient compliance, statins, antihypertensives, vision loss prevention, ocular hypotensive drugs, treatment adherence.

INTRODUCTION

One of the main causes of permanent blindness in the world is glaucoma, a progressive optic neuropathy marked by structural damage to the optic nerve and a concomitant loss of visual field.[1] The two most common clinical types of glaucoma are angle-closure glaucoma and primary open-angle glaucoma (POAG).[2] Glaucoma is the second most common cause of visual loss and eventual blindness worldwide.[3] In 2020, it affected over 76 million individuals, and its prevalence is expected to rise sharply as the population ages and diagnostic capabilities advance.

One of the primary modifiable risk factors for the progression of glaucoma is elevated intraocular pressure (IOP). Globally, glaucoma risk factors include non-demographic traits like thin cornea, low ocular perfusion pressure, and pseudoexfoliation, as well as demographic traits including age, gender, race, smoking, and genetic predisposition.[3-5] Consequently, the mainstay of glaucoma treatment is centered on reducing IOP to halt or delay optic nerve damage. Medical therapy, which includes a range of pharmacological drugs such prostaglandin analogs, beta-blockers, carbonic anhydrase inhibitors, alpha agonists, and more recent developments like rho-kinase inhibitors, is usually the first line of treatment,

especially in the early stages of the condition.[6,7] These medications differ in efficacy, side effect profiles, dosing regimens, cost-effectiveness, and patient adherence, necessitating a nuanced approach to individualized treatment.[8]

Given the rapid advancements in therapeutic strategies and the growing availability of fixed-dose combinations and preservative-free formulations, it has become increasingly important to undertake a comprehensive and systematic evaluation of the current landscape of medical treatments for glaucoma. The dynamic nature of treatment options necessitates an updated synthesis of evidence to guide optimal patient care. This review is therefore designed to critically analyze and consolidate the most recent and robust data on the efficacy, safety, and tolerability of pharmacological agents employed in the management of glaucoma.

MATERIALS AND METHODS

Protocol: This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P) guidelines to ensure methodological rigor and transparency. The protocol was developed prior to data extraction, and any subsequent amendments were documented and justified in the final manuscript.

Search Strategy: The following electronic databases were used to conduct a thorough literature search: PubMed, Scopus, Web of Science, Wiley Online Library, Google Scholar, Embase, MEDLINE, and Science Direct. Articles published from January 2016 and March 2024 was included in the search.

For ensuring comprehensive retrieval of relevant research, both free-text phrases and Medical Subject Headings (MeSH) were used. Intraocular pressure, medical therapy, prostaglandin analogs, beta-blockers, fixed-combination therapy, Rho kinase inhibitors, IOP-lowering medications, glaucoma, and systematic treatment of glaucoma were the main search phrases.

Boolean operators (AND, OR) were utilized appropriately to combine and refine search terms. Filters were applied to include only English-language literature. Additional screening included manual checks of references from relevant articles to identify any studies not captured in the database queries.

Only articles with full-text availability were included. The scope of the search encompassed full-text original research articles, literature reviews, case studies, and case series that investigated or evaluated medical interventions for glaucoma management.

Inclusion Criteria

1. Articles with full-text availability.
2. Studies published in the English language.
3. Publications dated from January 2016 to March 2024.
4. Studies that focused on medical (non-surgical) management of glaucoma, including pharmacological treatments and comparative analyses.

Exclusion Criteria

1. Conference abstracts, letters to the editor, editorials, and commentaries.
2. Duplicate publications or copyrighted material with restricted access.
3. Studies lacking sufficient data for qualitative or quantitative synthesis.

Table 1: characteristics' of the studies included in this systematic review

Sr. No.	First Author (Year)	Study Design	Sample Size	Type of Glaucoma	Intervention (Drug/Class)	Outcome Measures	Key Findings
1	Muir KW et al,[9] (2022)	Randomized controlled trial	Intervention Count=100 control =100			Compared to the control group, the intervention group's percentage of prescribed dosages taken on time was considerably greater (0.85 vs. 0.62, P < 0.0001). When companion status, dosage frequency, and race were taken into account in regression models, this difference persisted. According to the longitudinal model, the intervention group's adherence was higher in the first month and remained so for the full six months	Ophthalmologists and patients require practical strategies for effective glaucoma self-management. A personalized approach, like the one tested in this study, can help patients overcome barriers to adherence.

						(month by treatment interaction, P = 0.003).	
2	Gupta PR et al,[10] (2022)	Cross-sectional, descriptive, questionnaire based study	290	primary and secondary open angle glaucoma	CMC 0.5%	The nature and course of glaucoma were explained to about 88 (30.34%) of the patients. Forty (13.79%) patients received an explanation of punctal occlusion, and twenty-five (8.62%) received assistance with instillation. Approximately 62 patients, or 70.45%, were educated about the condition. In the OPD, 244 patients (84.14%) saw a TV. 53 (18.28%) patients received instructions on tight control of related systemic illness, and 67 (23.1%) patients were advised to have family screenings.	Proper patient education on glaucoma and its treatment is essential. Most patients were not educated on the correct method of eye drop instillation, which is crucial for achieving target intraocular pressure (IOP), minimizing side effects, and reducing treatment costs. Family screening and control of associated systemic conditions were often overlooked by ophthalmologists, but these factors are important for comprehensive care.
3	Pappelis K et al,[11] (2019)	A Retrospective study	250	primary open-angle glaucoma	Statins, diuretics, ARBs, ACEIs, CCBs, beta blockers, and PPIs.	Systemic medications were not linked to POAG progression in the final models. However, ARBs were associated with slowed progression in older patients (b = 0.014, P = 0.0001). ACEIs and ARBs significantly reduced POAG suspect conversion, with odds ratios (OR) of 0.23 and 0.12, respectively, in both IOP/treatment-adjusted and unadjusted models (P < 0.05).	No overall association between VF progression and systemic medication was found. ARBs delayed progression in older patients, while ACEIs and ARBs were linked to a lower risk of suspect conversion. The underlying pathophysiology of this relationship requires further investigation.
4	Talwar N et al,[12] (2017)	Observational study	25420	open-angle glaucoma	Lovastatin Cerivastatin AtorvastatinRosuvastatin Fluvastatin Pravastatin Simvastatin	In a cohort of 25,420 eligible patients (mean age 66.1 years; 55.5% female), statin use over 2 years was linked to a 21% lower risk of developing glaucoma compared to nonusers, independent of baseline LDL levels. No additional risk reduction was observed with higher statin doses	Even after adjusting for baseline LDL levels, statin use was still linked to a reduced risk of OAG. This study provides guidance on appropriate statin dosage and type for future randomized clinical trials examining the statin-glaucoma association.

						(80 mg vs. 40 mg; HR 1.03; P = .91). The protective effect was consistent across various statins—including lovastatin, cerivastatin, rosuvastatin, fluvastatin, pravastatin, and simvastatin—with no significant differences compared to atorvastatin (all P > .05).	
5	Liu J et al,[13] (2022)	Randomized trial	Ncase = 4737, Ncontrol = 458,196		ANBs, α-blockers, ACEIs, ARBs, β-blockers, CCBs, CAAs, LDs, PSDs	LDSC showed a weak genetic correlation between glaucoma and both SBP and DBP. However, Mendelian randomization found no evidence that genetically higher BP or antihypertensive drug use increases glaucoma risk.	Overall, controlling blood pressure may not prevent or treat glaucoma, and antihypertensive drugs do not appear to have an effect on glaucoma progression.
6	Yuan Y et al,[14] (2022)	case-control study	Cases=6748, 13 496 controls		Antihypertensive	In a study of 6,748 glaucoma cases and 13,496 controls, overall antihypertensive use was not significantly linked to the onset of glaucoma. However, the use of beta-blockers and diuretics was associated with a reduced risk of developing glaucoma.	The study found no link between antihypertensive use and glaucoma onset, though reduced risk with BBAs and diuretics needs further confirmation.
7	Asefa NG et al,[15] (2020)	Prospective study	86,841		β-blockers, Diuretics, ACEIs, ARBs, CCBs Other medications	Low HRV, high systolic BP and pulse pressure, hypertension, and use of ACE inhibitors or calcium-channel blockers were all linked to increased glaucoma risk.	Low HRV, high SBP, high PP, and hypertension were linked to glaucoma. Longitudinal studies are needed to determine if autonomic dysfunction and elevated BP predict glaucoma onset.
8	Caprioli et al,[16] (2016)	Retrospective, comparative, longitudinal cohort study.	74 eyes of 64 patients	open-angle glaucoma		In the Trab group, visual fields were tracked for ~5 years before and after surgery. The rate of visual field (VF) decay significantly slowed post-surgery (from -2.5% to -0.1%/year). Postoperatively, 44% of VF locations improved	Trabeculectomy slows perimetric decay and shows long-term visual function improvement in glaucoma, suggesting possible reversal of retinal ganglion cell dysfunction.

						vs. 30% pre-surgery. Greater IOP reduction was linked to more improving VF areas. Overall, 57% of eyes showed improvement in ≥10 VF locations.	

Note: ACEIs – Angiotensin-Converting Enzyme Inhibitors, α-blockers – Alpha-adrenoceptor blockers, ANBs – Adrenergic Neuron Blockers, ARBs – Angiotensin II Receptor Blockers, β-blockers – Beta-adrenoceptor blockers / Beta blockers, CCBs – Calcium Channel Blockers, CAAs – Centrally Acting Antihypertensives, CMC – Carboxy Methyl Cellulose, LDs – Loop Diuretics, PPIs – Proton Pump Inhibitors, PSDs – Potassium-Sparing Diuretics.

RESULTS

In this systematic review, a total of 691 records were initially identified through database searching for studies related to brain tumors, along with an additional 30 records obtained through other sources such as cross-referencing. After removing 237 duplicate records, 484 published studies remained for screening. Of these, 358 studies were excluded—263 were deemed irrelevant and 56 were excluded due to missing key parameters necessary for this review. Based on the inclusion criteria, 39 full-text articles were assessed for eligibility. Among these, 31 articles were excluded for being incomplete. Ultimately, 8 studies met all the inclusion criteria and were included in the qualitative analysis.

Quality Evaluation of Included Studies

The quality of the included RCTs in this investigation was assessed using RevMan software, which was based on the Cochrane Collaboration risk of bias assessment technique. Reporting bias (selective outcome reporting), attrition bias (incomplete outcome data), performance bias (participants and staff), selection bias (random sequence generation), and other potential sources of bias were among the bias domains that were the focus of the assessment.

For every study, the risk of bias in each category was categorized as low, unclear, or high. [Figure 2] compiles the overall risk of bias assessments for the eight included studies. Specifically, in terms of blinding outcome assessors, 27.08% of the studies were deemed to have a high risk of bias, 35.42% a moderate risk, and 37.50% an uncertain risk [Figure 3].

Outcomes of the treatment modalitieas used in this study: In the study by Pappelis K et al,[11] (2019) 250 glaucoma patients and 112 glaucoma suspects were assessed to identify factors influencing disease progression and conversion. Faster visual field deterioration was significantly associated with older age, male sex, lower BMI, lower baseline IOP, and the use of multiple glaucoma medications. Prolonged statin use showed a tendency toward faster progression, while angiotensin II receptor blockers (ARBs) were linked to slower progression, especially in older patients. Among glaucoma suspects, 53 converted to glaucoma over a median period of 15 years. Notably, the use of ARBs and ACE inhibitors significantly lowered the risk of conversion, independent of IOP control, suggesting a possible protective role beyond their effect on intraocular pressure.

The study by Asefa NG et al,[15] (2020) highlighted the link between cardiovascular factors and glaucoma risk, showing that reduced HRV, elevated BP, and the use of antihypertensives, especially ACE inhibitors and calcium channel blockers, may contribute to glaucoma development, despite excluding patients on laser or surgical treatments.

Registering studies to identify them Registers and databases

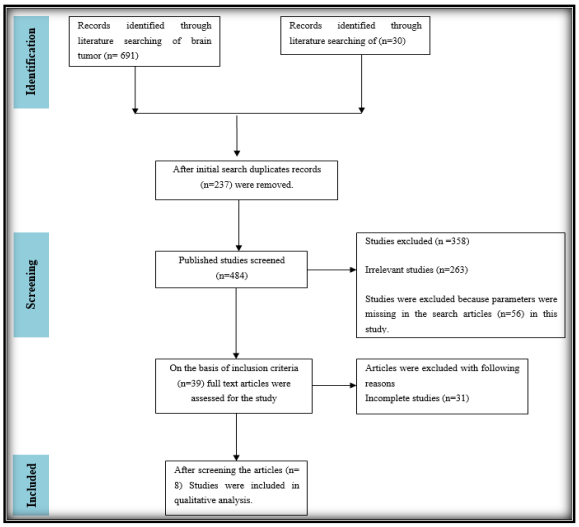

Figure 1: A flowchart illustrates a systematic review that involved databases and registered searches. (PRISMA)

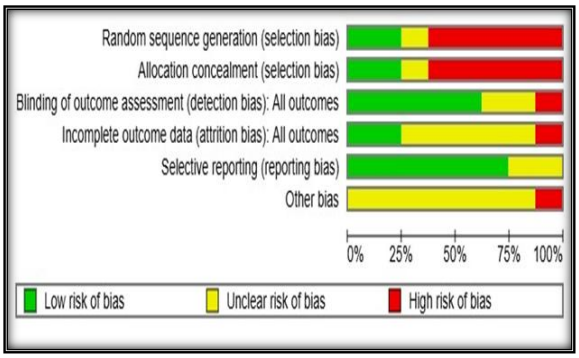

Figure 2: Percentage distribution of review authors' assessments for each risk of bias item across all included studies.

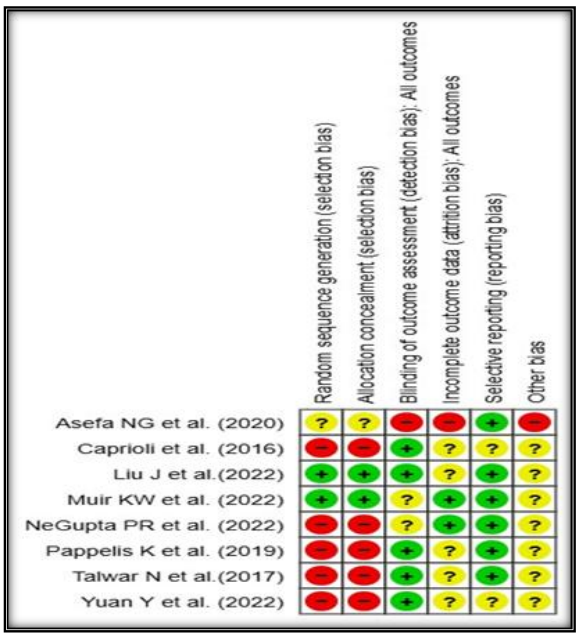

Figure 3: Risk of Bias Summary: Assessment of each included study's risk of bias for individual items.

DISCUSSION

Glaucoma remains a major cause of irreversible blindness globally, with medical therapy being the first-line approach for most patients. This review highlights the range of available pharmacological options, each with varying efficacy, side effect profiles, and patient suitability. Prostaglandin analogs, beta-blockers, alpha-agonists, and carbonic anhydrase inhibitors remain commonly used, while fixed-dose combinations and preservative-free formulations are increasingly favored for improving tolerability and treatment compliance.

The randomized trial by Muir KW et al,[9] (2022) demonstrated that personalized support significantly improved patients' adherence to prescribed medications over a six-month period. This underscores the importance of patient education and individualized care plans in optimizing treatment outcomes. Similarly, Gupta PR et al,[10] (2022) highlighted persistent gaps in glaucoma care, particularly regarding difficulties with proper eye drop administration and a lack of awareness about the need for family screening. Despite the widespread availability of effective intraocular pressure-lowering medications, their benefits can be compromised when patients are not adequately informed or supported. Without clear guidance, treatment effectiveness diminishes, at-risk relatives may go undiagnosed, and the overall burden of the disease continues to rise.

From a pharmacological perspective, the review pointed to statins as potentially protective against glaucoma. Both Talwar N et al,[12] (2017) and Pappelis K et al,[11] (2019) found that long-term statin use was linked to a reduced risk of developing POAG. Talwar et al. noted a significant risk reduction regardless of the type or dosage of statin, while Pappelis et al. also suggested potential benefits from angiotensin receptor blockers (ARBs) and ACE inhibitors, particularly in older adults. These findings hint at a possible neuroprotective or vascular-modulating effect of systemic medications—an area that warrants deeper investigation through mechanistic research and prospective trials.

On the other hand, not all systemic medications appeared to offer benefits. Studies by Liu J et al,[13] (2022) and Yuan Y et al,[14] (2022) found no strong link between antihypertensive use and either the onset or progression of glaucoma. While beta-blockers and diuretics showed a slight reduction in risk in certain subgroups, these effects were not consistent. This underscores the complex nature of glaucoma's underlying mechanisms and suggests that managing systemic blood pressure alone may not be enough for effective glaucoma care.

Asefa NG et al,[15] (2020) added valuable insight by identifying low heart rate variability (HRV) and elevated systolic blood pressure (SBP) as possible risk factors for glaucoma. These findings lend support to the idea that autonomic dysfunction and impaired vascular regulation may contribute to glaucomatous optic nerve damage, underscoring the importance of long-term studies that explore how systemic autonomic factors affect eye health.

Although most of the reviewed studies emphasized medical treatment, the work of Caprioli et al,[16] (2016), which focused on surgical intervention through trabeculectomy—provided meaningful evidence on visual field improvement and the possible reversibility of retinal ganglion cell dysfunction after significant IOP reduction. These results indirectly reinforce the importance of effective IOP control, including aggressive medical management in appropriate cases, to protect visual function.

In summary, effective glaucoma management requires a personalized approach combining optimal IOP-lowering therapy, improved patient education, and awareness of systemic influences. Ongoing research is important to enhance treatment strategies and reduce the global burden of this irreversible condition.

CONCLUSION

Effective medical management of glaucoma requires a multifaceted approach focusing on IOP control, patient adherence, and systemic health. Topical medications remain the first-line treatment, but their success depends heavily on patient education and compliance. Statins and certain systemic drugs like ARBs and ACEIs may have protective roles, especially in older adults, while the benefits of antihypertensive therapy are still unclear. Personalized strategies, including support tools and counseling, can improve adherence. Comprehensive glaucoma care should also consider cardiovascular health, as systemic factors like blood pressure and heart rate variability influence disease risk and progression.

REFERENCES

1. Weinreb RN, Aung T, Medeiros FA. The pathophysiology and treatment of glaucoma: a review. JAMA. 2014; 311(18):1901-1911.
2. Banik S, Ghosh A, Debi H. The Prevalence Trend of Glaucoma by Age and Sex Difference in South Asia: A Systematic Review and Meta-Analysis of Population-Based Studies. Health Sci Rep. 2025; 8(3):e70542.
3. Allison K, Patel D, Alabi O. Epidemiology of glaucoma: the past, present, and predictions for the future. Cureus. 2020 Nov 24; 12(11).
4. Plateroti P, Plateroti AM, Abdolrahimzadeh S, Scuderi G. Pseudoexfoliation syndrome and pseudoexfoliation glaucoma: a review of the literature with updates on surgical management. Journal of ophthalmology. 2015; 2015(1):370371.
5. Cvenkel B, Kolko M. Current Medical Therapy and Future Trends in the Management of Glaucoma Treatment. J Ophthalmol. 2020; 2020:6138132.
6. Wu X, Yang X, Liang Q, Xue X, Huang J, Wang J, Xu Y, Tong R, Liu M, Zhou Q, Shi J. Drugs for the treatment of glaucoma: Targets, structure-activity relationships and clinical research. European Journal of Medicinal Chemistry. 2021; 226:113842.
7. Schuster AK, Erb C, Hoffmann EM, Dietlein T, Pfeiffer N. The Diagnosis and Treatment of Glaucoma. Dtsch Arztebl Int. 2020; 117(13):225-234. doi:10.3238/arztebl.2020.0225
8. Li X, Balas M, Mathew DJ. A Review of Ocular and Systemic Side Effects in Glaucoma Pharmacotherapy. Journal of Clinical & Translational Ophthalmology. 2025; 3(1):2.
9. Muir KW, Rosdahl JA, Hein AM, Woolson S, Olsen MK, Kirshner M, Sexton M, Bosworth HB. Improved glaucoma medication adherence in a randomized controlled trial. Ophthalmology Glaucoma. 2022;5(1):40-6.
10. Gupta PR, Vats VA, Kakkar AS, DHAWAN A, SHAKEEL T, JAIN M. Knowledge, attitude and practice in medical management of glaucoma: a cross-sectional study from a tertiary care hospital at Uttarakhand, India. J Clin Diag Res. 2022;16.
11. Pappelis K, Loiselle AR, Visser S, Jansonius NM. Association of Systemic Medication Exposure With Glaucoma Progression and Glaucoma Suspect Conversion in the Groningen Longitudinal Glaucoma Study. Invest Ophthalmol Vis Sci. 2019;60(14):4548-4555.
12. Talwar N, Musch DC, Stein JD. Association of Daily Dosage and Type of Statin Agent With Risk of Open-Angle Glaucoma. JAMA Ophthalmol. 2017;135(3):263-267. doi:10.1001/jamaophthalmol.2016.5406
13. Liu J, Li S, Hu Y, Qiu S. Repurposing Antihypertensive Drugs for the Prevention of Glaucoma: A Mendelian Randomization Study. Transl Vis Sci Technol. 2022;11(10):32. doi:10.1167/tvst.11.10.32
14. Yuan Y, Wang W, Shang X, et al. Use of antihypertensive medications and the risk of glaucoma onset: Findings from the 45 and Up Study. Clin Exp Ophthalmol. 2022;50(6):598-607.
15. Asefa NG, Neustaeter A, Jansonius NM, Snieder H. Autonomic Dysfunction and Blood Pressure in Glaucoma Patients: The Lifelines Cohort Study. Invest Ophthalmol Vis Sci. 2020;61(11):25.
16. Caprioli J, de Leon JM, Azarbod P, Chen A, Morales E, Nouri-Mahdavi K, Coleman A, Yu F, Afifi A. Trabeculectomy can improve long-term visual function in glaucoma. Ophthalmology. 2016;123(1):117-28.