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Medical and surgical treatment management in open angle glaucoma patients of Asian descent: A narrative review

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Abstract

Glaucoma represents a progressive optic neuropathy characterized by optic nerve head damage, retinal nerve fiber layer thinning and visual field loss. There are significant disparities in the diagnosis, disease progression and treatment outcomes of glaucoma patients. Primary open angle glaucoma (OAG) patients of African descent have been found to have earlier and more severe disease than those of European descent. In 2020, half of the worldwide glaucoma patient population resided in Asia, where normal-tension and angle-closure glaucoma are more prevalent. The significant prevalence and diversity of OAG in Asia necessitates a better understanding of medical, laser, and surgical management in this growing population. PubMed and Embase database searches were conducted for all pertinent articles and abstracts published between January 1990 through January 2024 and review of the literature yielded 1,237 potential articles, from which 104 met the inclusion/exclusion criteria. The current literature suggests that prostaglandin analogues are efficacious and safe in OAG Asian patients, however little is known

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on other classes of hypotensive drugs. Published data on the laser and surgical management of glaucoma in Asian populations describe differences in outcomes between Asian and Caucasian populations including from minimally invasive glaucoma surgery. Longitudinal studies specifically designed to investigate treatment impact while accounting for access to care in the increasing global aging Asian population are warranted.

Keywords

GLAUCOMA; glaucoma incisional surgery; glaucoma medical therapies; laser surgery; tube shunts

Introduction

Glaucoma represents a group of progressive optic neuropathies characterized by retinal ganglion cell loss and nerve fiber layer thinning, optic nerve head alterations and progressive visual field loss. The disease is both irreversible and poorly understood in terms of individual and population-based risk factors. Open angle glaucoma (OAG) is a disease with significant disparities, with patients of African descent having an outsized burden compared to those of European descent.¹ The prevalence of glaucoma is projected to accelerate with an aging global population with an increasing burden projected to fall upon Asian countries. Specifically, half of the worldwide OAG patient population has been described as residing in Asia as of 2020.² Additionally, Asian populations have a higher prevalence of angle-closure glaucoma (ACG) secondary to anatomical characteristics²⁻⁶ and are at a much higher risk for undergoing glaucoma progression with low to normal intraocular pressures (IOP), which has been termed normal-tension glaucoma (NTG).^{7,8}

Although IOP is an established OAG risk factor in Asian and other populations,⁸⁻¹⁰ other well-established risk factors for OAG include family history,⁸ older age,⁹ systemic hypertension,^{8,11} African descent,^{7,12,13} myopia,^{8,10} vascular dysfunction,^{10,12,14-16} ocular perfusion pressure (OPP),^{17,18} circadian variations in blood pressure and OPP,^{19,20} genetics,^{6,21} and structural characteristics including cup-to-disc ratio and central corneal thickness.⁹ Currently, IOP is the only medically approved modifiable risk factor to prevent the onset of primary OAG (POAG) and/or to delay its progression.^{22,23} However, many persons with low to normal IOP or medically reduced IOP continue to be diagnosed with OAG or to progress in the disease pointing to the need for alternative therapeutic approaches. It is also important to highlight that the therapeutic goal of glaucoma treatment goes beyond IOP lowering, as it ultimately aims to slow disease progression and prevent vision loss. The significant prevalence of NTG in Asian populations also highlights the need for more tailored treatments and increased access to alternative diagnostic methods. Asian populations are known to have higher rates of ACG as well with established risk factors for this disease including older age, Inuit or Asian ethnicity, genetics, and anatomical characteristics such as smaller anterior chamber and shorter axial length.⁴

Currently, the medical and surgical management of OAG are poorly understood in relation to Asian specific populations. Previous work,^{1,6,12,13,21,24,25} has described differences in OAG disease rates and burden, IOP levels, ocular hemodynamics, visual field damage, genetics,

and differences in treatment outcomes in African and European descent populations. However, similar comparative literature regarding the treatment of glaucoma in Asian populations is currently missing.^{1,6} In fact, some of the most fundamental studies regarding NTG, including the Collaborative Normal-Tension Glaucoma Study Group which established that lowering IOP in NTG patients produced favorable outcomes and is a basis of current treatment, did not elaborate on data from Asian populations.²⁶ Herein we provide a comprehensive narrative review of the medical and surgical management of OAG in Asian populations. This demographic is growing in both Asian and Western countries and a better understanding of differences in treatment outcomes will both help clarify the disease pathophysiology and elucidate new clinical management strategies. Here we critically review the available literature on the differential medical and surgical management of OAG in Asian populations to raise awareness for this growing, at-risk population and identify gaps in knowledge for future targeted research. An important consideration is that the terminology of the “Asian” is used to represent a very broad category of persons, including individuals who may have potentially different genetics, varied access to care, and diverse environmental and lifestyle characteristics. Therefore, when possible, in this narrative review studies from different regions within Asia have been sub-categorized to increase the specificity of findings and to help reveal the generalizability of results to other Asian populations.

Materials and methods

PubMed and Embase searches were conducted for all pertinent articles and abstracts published between January 1990 through January 2024. Key words utilized in varying combinations include glaucoma, Asian, race, glaucoma, open-angle glaucoma, normal-tension glaucoma, trabeculectomy, laser trabeculoplasty, tube implant, drainage implant, filtration, surgery, surgical management, medical management, topical medication, prostaglandin, rho kinase inhibitor, beta blocker, and alpha agonist. Articles were screened for relevance and analyzed for inclusion in the paper by the authors. Inclusion criteria included Asian race and utilization of medical and/or procedural intervention as defined by the underlying outline. Exclusion criteria include but are not limited to all studies that did not define both of the inclusion criteria and lack of methodologic interpretation of Asian subgroup if both above criteria were present. Review of the literature yielded 1,237 potential articles, from which 104 met inclusion/exclusion criteria and were not duplicate articles (Figure 1).

Medical management

Topical IOP-lowering medications

Prostaglandin analogues. Prostaglandin analogues increase outflow through the uveoscleral pathway and additionally enhance scleral compliance in patients with POAG. Their efficacy and safety profile have been well-defined generally, but there are reported differences in treatment outcomes of glaucoma between patients of African and European descent.¹ The data in Asian populations is clear in terms of IOP reduction, however, longitudinal comparative studies between Asian and other population groups are missing.

Within the literature, in a major Korean cohort study of previously treated Korean patients with OAG or ocular hypertension (OHT), it was found that switching their treatment to bimatoprost 0.01% reduced IOP significantly from baseline mean measurements of 17.0 ± 5.7 mmHg to 14.6 ± 3.8 mmHg after just 6 weeks and to 14.7 ± 3.7 mmHg after 12 weeks.²⁷ Similarly, a major Japanese study composed of Japanese glaucoma patients showed that latanoprost reduced IOP by over 10% at each annual time point between 6 months and 5 years in 70% of eyes.²⁸ Latanoprostene bunod, a newer medication that is metabolized to latanoprost and donates a nitric oxide molecule, has also been shown to significantly lower IOP in a population of healthy Japanese subjects when dosed for 14 days.²⁹ Another newer medication, benzalkonium chloride-optimized tafluprost, has also been shown to be safe and efficacious in Asian populations. Its unique formulation has been shown to increase mean tear break up time as compared to controls and other prostaglandin analogues.³⁰ Furthermore, it is comparable to latanoprost and travoprost in both its IOP reduction efficacy and hyperemia score.^{30,31} Additionally, a study comparing travoprost and pilocarpine found that both groups significantly reduced IOP from baseline.³² However, pilocarpine was dosed four times daily while travoprost was dosed once daily, which is clinically important in regard to patient adherence and safety. Although outside the scope of this review, latanoprost monotherapy has also been shown to be highly effective for patients with ACG.^{33–35}

The PRESSURE study compared the efficacy and safety of prostaglandin analogues by race and found that latanoprost, bimatoprost, and travoprost were all highly effective for lowering IOP and there were no significant differences between drugs or racial groups.³⁶ However, another study found that Asian and Mexican patients displayed greater differences in their reduction in mean diurnal IOP using latanoprost or timolol than European and United States patients.³⁷ Interestingly, a study looking at gene variants of PTGS1, PTGFR, and MRP4 and the response of IOP to latanoprost found that certain variants identified in Chinese POAG patients showed greater reductions in IOP.³⁸

It is important to note that several studies have established adverse events associated with this class of medications, including ocular hyperemia, discomfort, and blurred vision.³⁵ In addition, several studies have described deepening of the upper eyelid sulcus with topical use of prostaglandin analogues, and these effects may be more prominent in Asian populations due to anatomical differences in upper lid sulcus.^{39–42} The incidence of this adverse effect was found to be significantly higher in older patients but was not associated with sex, refraction, or IOP at any timepoint.⁴¹ Also, while many of the studies emphasize reducing IOP as a marker for efficacy, treatments achieving similar IOP reductions have also been shown to have different VF progression rates.⁴³ It is important to remember that loss of vision and not IOP reduction ultimately determines the course of OAG and the quality of life patients experience during their lifetime with the disease.

Beta blockers and comparative findings. Timolol is the primary beta blocker that is used topically for IOP reduction by reducing the production of aqueous humor. Overall, previous literature has well-established the efficacy and safety of beta blocker topical medications, and current research is focused on its comparative efficacy with prostaglandin analogues. For example, a study comparing the dosing of timolol 0.1% gel and 0.5% drops found that both significantly reduced IOP but did not differ in efficacy.⁴⁴ Furthermore, morning dosing

of timolol gel was found to have a greater mean IOP reduction than evening dosing in Asian patients.⁴⁵ It is important to highlight that, as a beta blocker, topically applied timolol may also seep into the systemic circulation and potentially result in a reduction of blood pressure and ultimately ocular perfusion pressure. This may be especially important in Asian populations where both NTG and systemic hypotension are common.

In a comparative study within the Chinese population, once-daily administration of latanoprost was shown to be significantly more effective in decreasing IOP as compared to twice-daily administration of timolol across all visits.⁴⁶ A combination treatment of bimatoprost-timolol has also been trialed and has been found to be efficacious and tolerable in Chinese patients.⁴⁷ The literature strongly suggests that prostaglandin analogues are more efficacious in Asian patients, even if they do carry a greater risk for ocular adverse events. This follows the general clinical understanding of starting all patients with elevated pressures on a prostaglandin analogue as first-line therapy in the treatment of OAG.

Alpha agonists. Brimonidine, an alpha agonist that decreases aqueous humor formation, has been studied scarcely in Asian populations. A study of Asian eyes with glaucoma found that brimonidine reduced IOP by approximately 20% in both groups without any serious ocular or systemic adverse effects.⁴⁸ With so little data available, further research is needed to better understand the comparative use of this class of medications in Asian patients.

Rho kinase inhibitors. Rho kinase inhibitors are the newest class of medications approved for the management of OAG and exert their IOP-lowering effect by increasing aqueous humor outflow and reducing production as well as by reducing episcleral venous pressure (EVP). Netarsudil has been approved in the United States and shown to be superior to placebo in a Japanese patient population, showing a mean reduction in IOP of 19.8%, 23.5%, and 23.8% at the 0.01%, 0.02%, and 0.04% dosing ranges respectively.⁴⁹ EVP has been shown to be an important contributor to the glaucomatous process with past work showing significantly elevated EVP measurements in POAG and NTG patients as compared to controls.⁵⁰ Furthermore, the EVP/IOP ratio was significantly different in NTG patients as compared to POAG patients.⁵⁰ Thus, reducing IOP may not be sufficient for adequately controlled disease processes in NTG, which may open the door for the increased use of this class of medication in Asian populations to better address the glaucomatous pathophysiologic processes afflicting their eyes.

Other classes. OAG is a multifactorial disease, and vascular diseases are widely recognized as contributing factors for the onset and progression of glaucoma.⁵¹ Both topical and systemic medications may alter the ocular vasculature, including ocular hypertensive therapies, which have been associated with glaucomatous changes to the optic disc in non-glaucomatous persons.⁵² The use of multiple classes of antihypertensive medications has also been associated with a loss of structural markers indicating the health of retinal ganglion cells in a multiethnic Asian population.⁵³ This provides continued evidence for vascular-linked insult in OAG development and progression, and vascular dysfunction may be potentially elevated in Asian OAG patients who typically have lower IOP throughout the course of their disease.

Patients' adherence to medical management. A study comparing adherence rates by race found that White Americans and Australians had significantly higher adherence to topical eye drops over 6 months than African Americans or Singaporeans.⁵⁴ However, the complete adherence rate of both White Americans and Australians was just 65.4% and 67.7%, indicating that almost one-third of all patients in the most compliant demographics were still not adherent.⁵⁴ Adherence is an important factor to consider as more compliant cohorts have been shown to have better outcomes.⁵⁵ A Korean study composed of Korean patients with glaucoma found that the patient's knowledge of glaucoma was the only factor associated with their self-evaluation of compliance while forgetfulness was the most common reason related to non-adherence.⁵⁶ This is incredibly important in understanding the differences in dosing patterns between classes of medications: the advantage of prostaglandin analogues in not only their superior efficacy but also ease of use with their once daily dosing patterns. In addition, several sustained release therapies are also being developed to overcome these barriers associated with topical medications.⁵⁷ There is a need for further study of the application of sustained release therapies in the Asian population to improve rates of adherence and treatment efficacy.

Laser and surgical management: Differences in the laser and surgical management of glaucoma for Asian populations versus other populations are not well understood. Access to current interventions is highly limited to a vast amount of the Asian population, especially in rural and poor population centers. The protocol for OAG involves initial medications with a more recent focus on subsequent minimally invasive surgeries to further control IOP.^{58,59} The clinically established glaucoma laser procedures and surgeries include selective laser trabeculoplasty (SLT), trabeculectomy, tube shunts and other implants, cataract surgery, canaloplasty, sclerectomy, and cyclophotocoagulation (Table 1). Overall, comparative outcomes are lacking between racial and ethnic groups. Prior work has shown differences in interventional outcomes between patients of African and European descent, and similar review are needed for those of Asian descent.¹

Selective laser trabeculoplasty. SLT is a powerful non-invasive option for reducing IOP in glaucoma patients. A review of 190 articles including patients from a Hong Kong Chinese population found variable success rates based on an IOP reduction of greater than 20%. The success rate was lowest in OAG patients at 47%, followed by 54% to 60% in ACG patients, and 60% in NTG patients.⁶⁰ Interestingly, the mean IOP reduction was greatest in OAG patients compared to the other groups.⁶⁰ The study also found that the number of glaucoma medications remained unchanged after SLT. The use of three or more medications was associated with a higher likelihood of a failed procedure.^{60,61} Higher pre-laser IOP was associated with a greater success rate.^{60,61} Additionally, the use of a topical carbonic anhydrase inhibitor, thinner retinal nerve fiber layer, and lower day 1 IOP were also positive predictors of success.⁶¹ Another study conducted in Chinese OAG or OHT patients showed not statistically significant difference in the IOP reduction between SLT and medical therapy alone, however, the SLT group did have significantly lower number of glaucoma medications at 5-year follow-up.⁶² This may present an advantage of this procedure, as reduced medications may improve patient adherence and thus outcomes in clinical settings. Additionally, greater IOP reduction may be attained with higher SLT energy.^{60,63} Overall,

SLT is a very effective procedure for IOP and medication reduction and has a strong safety profile in Asian populations, yet comparative data is lacking on its efficacy in relation to African and European descent populations and further studies specifically emphasizing sufficient sample sizes for statistical comparison are necessary.

Trabeculectomy. Trabeculectomy is a mainstay of initial OAG treatment in Asia and is known to be highly effective in reducing IOP.⁹⁷ A study of 114 trabeculectomies in 105 eyes of 90 patients, including both OAG and ACG, found an overall success rate of 73.7%.⁶⁴ Another study also found that the probability of reducing IOP to less than or equal to 21 mmHg was 0.94 at 5 years and 0.88 at 10 years in both OAG and ACG eyes.⁶⁵ When combined with a canalectomy procedure, the success rate was described to rise above 90% at follow-up visits up to 24 months post-surgery.⁶⁶ Furthermore, the qualified success rate of the procedure also remained above 80% 15 years post-surgery.⁴³ More commonly, trabeculectomy procedures are combined with phacoemulsification procedures due to both convenience and a larger body of evidence suggesting improved IOP control. A study of both OAG and ACG eyes found qualified and complete success rates of 88.4% and 79.0%, 79.3% and 70.9%, and 52.5% and 51.1% at 3-years post-operatively based off of the IOP guidelines of less than 21, 18, and 15 mmHg respectively.⁶⁷ In addition, the mean number of medications was significantly reduced, and visual acuity significantly improved in both groups.⁶⁷ Interestingly, the study found that the IOP reduction was significantly greater in ACG eyes than in OAG eyes.⁶⁷

Additionally, combined phacoemulsification-trabeculectomy has been shown to be more effective than the XEN45 implant with phacoemulsification in Asian eyes with significantly greater success rates, fewer postoperative interventions, and higher reduction of IOP and number of glaucoma medications.⁶⁹ It is important to note that the combined procedure does have complications which include hypotony, hyphema, and shallow anterior chamber.⁷⁰ In regards to failed filtration surgeries, the bleb needling is a safe and effective secondary option that significantly decreased IOP.⁷¹ However, the procedure did have a higher failure rate in younger patients according to univariate regression analysis.⁷¹ Several studies have also focused on the use of 5-fluorouracil (5-FU) to replace mitomycin-c in these procedures. Largely, they have concluded that 5-FU is safe and can routinely be used in Asian patients with no significantly increased incidence of anatomical or visual field changes, adverse events, or differences in IOP when compared to placebo.⁷²⁻⁷⁵

Comparing trabeculectomy among races, studies have previously described poorer success rates in Asian populations as compared to Caucasian populations.^{74,98} It is theorized that Asian eyes may display a different fibrotic response that is similar to that of Caucasian patients but differs from that of African descent patients.⁹⁸ Further studies are necessary to directly compare the response of different racial and ethnic groups within the context of a single study to better control for a variety of confounding variables, including access to care, surgical techniques, and environmental factors, and to develop an understanding of the anatomical and physiological differences between these groups.

Tube shunts and other implants. The usage of drainage tube shunts and implants is a main option for controlling IOP in OAG patients. The primary tube shunts used are the

Baerveldt and Ahmed tubes. In a study of an Asian population using both implants, a decrease in IOP of 56.6% and 65.9% by the Baerveldt and Ahmed tube groups, respectively, was observed.⁷⁶ Additionally, over 80% of all patients maintained or improved visual function.⁷⁶ Looking specifically at the Baerveldt tube, a study in Asian patients showed a complete success rate of 54% and failure rate of 24%.⁷⁷ The study identified postoperative complications in 34.7% of eyes and further intervention or revision in 17%.⁷⁷ The study did demonstrate significant decreases in IOP and the number of medications, indicating the tube shunt is effective in Asian patients.⁷⁷ Another study using Molteno and Baerveldt implants similarly found successful IOP control in 73.5% of patients and visual acuity maintenance or improvement in 85.5%.⁷⁸ The Ahmed tube also independently displayed significant reduction in IOP and number of glaucoma medications with a failure rate of 23.9% at 3 years.⁷⁹ A study of Chinese eyes showed a success rate of 73.8% as defined by IOP control less than 22 mmHg using the Ahmed tube.⁸⁰ However, encapsulated blebs formed in 24.6% of cases and transient hypotony occurred in 10.8%.⁸⁰ The success rate was described to be comparable to that reported in non-Asian populations.⁸⁰ Another study of the Ahmed tube shunt found the cumulative probability of success dropped off from 74% at 12 months to 43% at 2 years, indicating that perhaps the treatment may be effective in the short-term but lack long-term control of IOP.⁸¹ Following keratoplasty, however, the success rates of IOP control were much higher and remained elevated at 2 years.⁸² Other shunts have also been studied including the White pump shunt for neovascular glaucoma in an Asian population. The procedure was found to be effective in reducing IOP in this group.⁸³ Furthermore, combined tube implant and phacoemulsification procedures have been trialed and shown to decrease IOP and the number of glaucoma medications.⁸⁴ This success in Asian populations is encouraging as tube shunts remain a top option for surgical IOP management, but demonstrations of their efficacy alongside other racial groups may help better inform management decisions.

Minimally invasive glaucoma surgery. Minimally invasive glaucoma surgery (MIGS) is a novel and fast-growing area of glaucoma disease management. MIGS encompasses a group of less invasive procedures which serve as a surgical alternative to traditional surgeries in patients with OAG.⁵⁸ By utilizing an ab interno approach and minimizing scleral dissection and conjunctival manipulation, MIGS has been shown to provide a decreased surgery time and higher safety profile compared to current glaucoma surgeries.⁵⁸ As part of the shift towards MIGS, micro-stents such as iStent[®], Hydrus, CyPass[®], and XEN have all been studied to quantify their lowering-IOP effect.⁵⁹ The subconjunctival XEN45 implant has been studied in the greatest detail in Asian populations. Its decreased efficacy in comparison to the trabeculectomy procedure has been previously described; however, it remains an important option for IOP control.⁶⁹ A non-inferiority study showed the implant to be comparable to trabeculectomy in medically uncontrolled glaucoma at 24 months.⁸⁵ The stent has been shown to reduce both IOP and number of medications with 66.7% of East Asian patients becoming medication-free by the end of the follow-up period.⁸⁶ However, in 61.9% of eyes, bleb intervention was required post-operatively.⁸⁶ In a study of medically uncontrolled OAG patients who received the stent, the mean IOP was found to be reduced significantly from 21.7 ± 7.7 mmHg to 15.0 ± 2.0 mmHg after 12 months, and the mean number of medications was shown to be reduced significantly from 3.4 ± 0.9 to 1.3 ± 1.5 .⁸⁷

Overall, the XEN implant and the tube shunt implants have been shown to be incredibly efficacious, but their success profiles are undermined by trabeculectomy.

Survey studies of Singaporean Chinese patients found that sustained drug delivery devices in the form of subconjunctival, intracameral, and punctal plug routes were all very acceptable alternatives to topical medications for most of the individuals.^{99,100} While many of these devices are still in their early stages, they represent an exciting potential for the future of glaucoma management, and their strong acceptance in this population is an important consideration.

Cataract surgery. Cataract extraction via phacoemulsification is a surgical procedure that is very commonly performed alongside other OAG procedures including trabeculectomy and tube shunt implantation.^{67,68,70,71,84} Independently, cataract extraction has been found to reduce IOP in non-glaucomatous eyes and reduce IOP to a greater degree in eyes with higher pre-operative pressures.⁸⁸ Additionally, the decrease in IOP was not affected by the type of surgery that was performed.⁸⁸ Cataract extraction is thus an effective procedure for reducing IOP, especially alongside other pressure reducing surgeries, to maximally reduce IOP and limit the number of procedures a patient must undergo.

Canaloplasty. A study of 40 eyes from 40 Asian OAG patients found that suture-assisted canaloplasty significantly decreased mean IOP from 26.2 ± 6.9 mmHg at baseline to 14.5 ± 2.7 mmHg at 12-month follow-up.⁸⁹ The number of medications significantly decreased from 3.2 ± 0.6 to 0.5 ± 0.8 over the time period.⁸⁹ Furthermore, visual acuity and cup-to-disk ratio did not show progression at follow-up.⁸⁹ Importantly, increased age and baseline IOP both decreased the success rate significantly.⁸⁹ While the procedure is shown to be effective in this population, further research is needed before it may become established as an initial option in the surgical management of glaucoma.

Sclerectomy. CO₂ laser-assisted sclerectomy surgery (CLASS) has been studied in Asian populations with and without associated phacoemulsification. Following CLASS, visual acuity was shown to improve up to 36 months post-operatively.⁹⁰ Additionally, mean IOP and average number of medications both dropped over this same time period.⁹⁰ The study did not identify a statistically significant difference in these measurements between groups with and without phacoemulsification indicating the independent efficacy of CLASS.⁹⁰ Another 2-year follow-up study of OAG and pseudoexfoliative glaucoma patients also noted reduced IOP over the course of the study.⁹¹ The number of medications administered for each patient also decreased from 3 at baseline to 0 at each annual follow-up.⁹¹ Complete success rates were 62.07% at 1 year and 48.28% at 2 years, while the qualified success rate was 89.66% at both time points.⁹¹ CLASS is a relatively newer management technique but may be safe and effective for multiple etiologies of glaucoma in Asian patients and further studies are needed to fully investigate its safety and efficacy profile.

Cyclophotocoagulation. Cyclophotocoagulation is an important treatment option for OAG. In a study of 29 eyes of 29 Asian patients with OAG, NTG, ACG, neovascular glaucoma, and secondary glaucoma, IOP and the number of glaucoma medications was found to be significantly reduced at 18 and 24 months post-endoscopic cyclophotocoagulation.⁹² The

success rate as defined by an IOP reduction of 20% or greater was 48.3% in this cohort, and it appeared to be worse than previously reported in Caucasian population.⁹² In patients with refractory glaucoma, 56% demonstrated a 30% or greater drop in IOP and approximately 38% demonstrated sustained IOP reduction below 22 mmHg at 18 months post-diode laser cyclophotocoagulation (DLCP).⁹³ A study of Indian patients with uncontrolled glaucoma showed a reduction of 58.5% in IOP after DLCP.⁹⁴ Overall, the success rates of the procedure long-term has been found to be around 40% up to 3 years post-operatively.⁹⁵ Lower energy levels have been found to be more effective in reducing IOP in Asian eyes, which may potentially explain the worse outcomes of the procedure in Asian patients compared to their Caucasian counterparts.⁹⁶

Limitations

This review of Asian populations has several limitations to acknowledge. First, a comprehensive analysis of outcomes is prohibited by the limited available data, especially when considering sub-categorizations of the Asian population. The narrative results of this review are also not as strong as those that would originate from a meta-analysis or systematic review. When such data is available, future reviews should consider quantitative approaches including a meta-analysis to reveal the differential risk factors driving disease disparities. Additionally, the categorization of the Asian populations as a whole is quite broad, as it includes groups of individuals with potentially different genetic, environmental, and lifestyle characteristics, as observed in those of Indian and Chinese descent. This diversity might impact the generalizability of the findings, and the next steps of research may benefit from isolating inclusion criteria to increase specificity and translation of results in Asian populations.

Conclusion

The growing Asian population poses a significant challenge for clinicians seeking to provide tailored glaucoma care for this demographic. Although the prevalence of ACG is notably higher in Asian patients compared to other populations, OAG is more common overall and accounts for the majority of glaucoma cases. Current literature lacks rigorous comparison of various OAG treatment outcomes in Asian patients, with scarce information related to comparable access to high-quality care. Importantly, limited systematic research has been conducted outside of Asia, and Western clinical trials have low rates of Asian participation. Within the available data, comparisons to other populations are also constrained by many confounding variables including access to care, laser/surgical techniques, and environmental factors. Access to care represents an important factor as many Asian countries are still considered developing nations and compared to Western nations, lack the same resources and access to healthcare for large portions of their populations, especially in rural and lower socioeconomic subgroups. While the medical, laser, and surgical treatments in Asian populations are generally reported to be successful, there is a lack of comparative longitudinal progression data between treatments as well as longer prospective follow-up post-interventions. Access to quality of care and lifestyle further differ among OAG patients residing inside and outside of Asian majority countries. The use of Asian populations is also very broad and may not properly represent the differential risk occurring within Asian populations. Properly designed randomized clinical trials that also consider sub-categories

are therefore necessary to identify optimal OAG treatment approaches for an increasingly aging Asian population.

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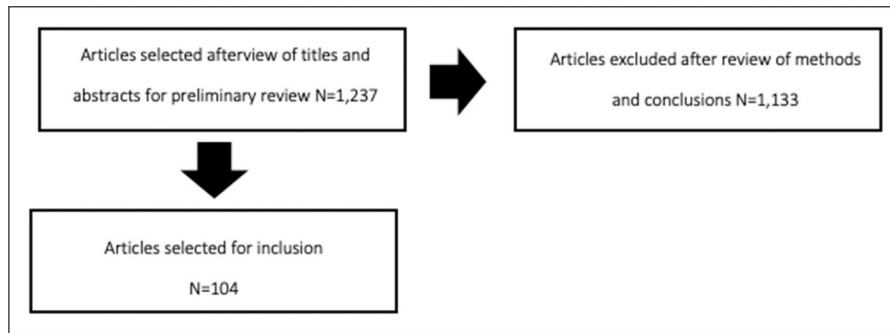


Figure 1.

Flowchart of article selection process. The figure above displays the article selection process for our narrative review. Article were selected through PubMed and Embase searches between January 1990 through January 2024. The review of the literature yielded 1,237 potential articles, from which 1,133 articles were excluded, and 104 met inclusion/exclusion criteria, were not duplicate articles and therefore were included in this narrative review.

Table 1.

Summary of interventional management of glaucoma in Asian populations.

Intervention	Reference	Population Studied	Main Finding
<i>Selective Laser Trabeculoplasty</i>	Lee and Lai, 2016 ⁶⁰	Hong Kong Chinese	Success rate of the procedure was lowest in open-angle glaucoma patients, followed by angle-closure glaucoma and normal-tension glaucoma patients respectively.
	Lee et al., 2014 ⁶¹	Chinese	The positive predictors of procedural success included a higher pre-op IOP, use of topical carbonic anhydrase inhibitor, thinner retinal nerve fiber layer, and lower post-op IOP.
	Lai et al., 2004 ⁶²	Chinese	IOP reduction was similar between the procedure and medical therapy alone.
	Lee et al., 2015 ⁶³	Chinese	Higher energy was associated with greater IOP reduction.
	Tham et al., 2006 ⁶⁴	Chinese	The procedure had a success rate of 73.7% at last follow-up.
	Sihota, Gupta, and Agarwal, 2004 ⁶⁵	Asian	The overall probability of success due to this procedure in reducing IOP to 21 mmHg or below was 0.94 and 0.88 at 5 and 10 years, respectively.
	Xie et al., 2020 ⁶⁶	Chinese	The success rate of this procedure exceeded 90% at 24 month follow up and had minimal complications.
	Hsu et al., 2018 ⁶³	Taiwanese	After surgery, a significant reduction in IOP and number of glaucoma medications was observed, with a qualified success rate above 80% 15 years after.
	Koh et al., 2017 ⁶⁷	Singapore	The qualified success rate at 3-year follow-up for the procedure was 88.4, 79.3, and 52.5% for IOP of less than 21, 18, and 15 mmHg.
	Tow et al., 2001 ⁶⁸	Singapore	The procedure achieved success in 81% of eyes and qualified success in 17% of eyes.
<i>Trabeculectomy</i>	Kee et al., 2021 ⁶⁹	Singapore	The combined phacoemulsification-trabeculectomy procedure demonstrated complete success in 83.5% of eyes while the phacoemulsification-Xen implantation procedure demonstrated complete success in 52.2% of eyes at 12 months.
	Chen et al., 2015 ⁷⁰	Singapore	The procedure was demonstrated to be safe with 77% of postoperative complications occurring within the first month only.
	Das et al., 2022 ⁷¹	Indian	Bleb needling showed a statistically significant IOP reduction at 1, 3, and 6 months postoperatively.
	Wong et al., 2009 ⁷²	East Asian	Trabeculectomy with 5-fluorouracil showed greater success rates than the procedure with placebo, however, uveitis did occur more often in the 5-fluorouracil group.
	Wong et al., 2013 ⁷³	East Asian	Trabeculectomy with and without 5-fluorouracil showed no significant difference in IOP 8 years postoperatively.
	Wong et al., 1998 ⁷⁴	Asian	Intraoperative 5-fluorouracil for trabeculectomy significantly improved survival of the surgery.
	Law et al., 2007 ⁷⁵	Asian American	Intraoperative mitomycin C with trabeculectomy showed similar efficacy and probability of survival between Asian American and Caucasian patients.
	Wang et al., 2004 ⁷⁶	Singapore	Both the Baerveldt and Ahmed drainage tubes showed similar reductions in IOP, maintenance or improvement in visual function, and low rates of complications or failure.
	Seah, Gazzard, and Aung, 2003 ⁷⁷	Singapore	The Baerveldt tube shunt showed a significant reduction in IOP and the number of glaucoma medications from preoperatively to last follow-up.
	Aung and Seah, 1998 ⁷⁸	Singapore	Baerveldt and Molteno tube shunts achieved successful IOP control in 73.5% of eyes, and 85.5% of eyes showed stable or improved visual acuity.
<i>Tube Shunts</i>			

Intervention	Reference	Population Studied	Main Finding
	Choo et al., 2018 ⁷⁹	Singapore	Ahmed tube shunts showed a significant reduction in IOP and number of glaucoma medications at 3 years, with an absolute failure rate of 23.9%.
	Lai et al., 2000 ⁸⁰	Chinese	Ahmed tube shunts showed successful control of IOP under 22 mmHg in 73.8% of eyes.
	Tai et al., 2010 ⁸¹	Asian	Ahmed tube shunts showed a cumulative probability of success of 74% at 12 months and 43% at 2 years.
	Tai et al., 2012 ⁸²	Asian	Ahmed tube shunts showed improved survival with early implantation with penetrating keratoplasty.
	Chihara et al., 1992 ⁸³	Asian	The White pump shunt showed a success rate of 53.0% at 3 years as defined by IOP less than or equal to 26 mmHg.
	Chung et al., 2004 ⁸⁴	Singapore	Combined phacoemulsification and tube shunt implantation (Baerveldt and Ahmed) showed complete and qualified success in 75% and 12.5% of eyes, respectively.
<i>Other Implants</i>	Kee et al., 2021 ⁶⁹	Singapore	The combined phacoemulsification-trabeculectomy procedure demonstrated complete success in 83.5% of eyes while the phacoemulsification-XEN implantation procedure demonstrated complete success in 52.2% of eyes at 12 months.
	Wanichwecharungruang et al., 2021 ⁸⁵	Southeast Asian	XEN implants showed comparable reduction in glaucoma medications with trabeculectomy but had higher final IOP and lower mean IOP reduction.
	Hu, Ang, and Yip, 2020 ⁸⁶	East Asian	XEN implantation showed significant reduction in IOP and number of glaucoma medications.
	Chao et al., 2021 ⁸⁷	East Asian	At 12 months postoperatively, XEN implantation showed significantly reduced mean IOP and mean number of glaucoma medications.
<i>Cataract Surgery</i>	Koh et al., 2017 ⁶⁷	Singapore	The qualified success rate at 3-year follow-up for the procedure was 88.4, 79.3, and 52.5% for IOP of less than 21, 18, and 15 mmHg.
	Tow et al., 2001 ⁶⁸	Singapore	The procedure achieved success in 81% of eyes and qualified success in 17% of eyes.
	Chen et al., 2015 ⁷⁰	Singapore	The procedure was demonstrated to be safe with 77% of postoperative complications occurring within the first month only.
	Das et al., 2022 ⁷¹	Indian	Bleb needling showed a statistically significant IOP reduction at 1, 3, and 6 months postoperatively.
	Chung et al., 2004 ⁸⁴	Singapore	Combined phacoemulsification and tube shunt implantation (Baerveldt and Ahmed) showed complete and qualified success in 75% and 12.5% of eyes, respectively.
<i>Canaloplasty</i>	Ngo and Tan, 2016 ⁸⁸	Asian	Cataract surgery showed a significant decrease in IOP at 1 month and 2 years postoperatively.
	Liang et al., 2022 ⁸⁹	Asian	Canaloplasty showed a significantly reduced IOP and number of glaucoma medications at 12 months postoperatively, with a qualified success rate of 97.2%.
<i>Sclerectomy</i>	Ho et al., 2021 ⁹⁰	Asian	This procedure showed improvement in BCVA, and reduction in IOP and number of glaucoma medications at 6, 12, 24, and 36 months.
	Zhang and Cheng, 2020 ⁹¹	Chinese	This procedure showed significantly reduced IOP at 6, 12, and 24 months from baseline, with complete postoperative success of 62.07% and 48.28% at 12 and 24 months and qualified success rates of 89.66% at both time intervals.
<i>Cyclophotocoagulation</i>	Yip et al., 2009 ⁹²	Asian	The success rate of the procedure was 48.3% based on the criteria of IOP reduction of 20% or greater, which was worse than previously described in Caucasian populations, but a significant reduction in IOP and number of glaucoma medications was reported.

Intervention	Reference	Population Studied	Main Finding
	Wong et al., 1997 ⁹³	Asian	This procedure showed a drop of 30% or more in IOP in 56% of patients, and 38% of patients had sustained IOP below 22 mmHg at 18 months.
	Singh, Jain, and Veerwal, 2017 ⁹⁴	Indian	Qualified success defined as IOP of 20 mmHg or less was achieved in 70% of eyes.
	Lim et al., 2021 ⁹⁵	Asian	This procedure showed a significant reduction in IOP and mean number of glaucoma medications at 1, 2, and 3 years postoperatively.
	Kaushik et al., 2008 ⁹⁶	Indian	This procedure showed an 87.8% response rate of IOP under 22 mmHg at 1 year postoperatively.