



## **PHACOEMULSIFICATION COMBINED WITH GONIOSYNECHIALYSIS AND GONIOTOMY FOR PRIMARY ANGLE-CLOSURE GLAUCOMA: A MINI SYSTEMATIC REVIEW**

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### **ABSTRACT**

Primary angle-closure glaucoma (PACG) is a major cause of irreversible blindness and is commonly associated with elevated intraocular pressure (IOP). Objective to evaluate the effectiveness and safety of combining phacoemulsification (PEI), goniosynechialysis (GSL) or visco-goniosynechialysis (VGSL), and goniotomy (GT) in the management of PACG. A mini systematic review was conducted using Google Scholar, PubMed, and ProQuest up to March 2025. Eligible studies evaluating combined PEI, GSL/VGSL, and GT in PACG patients were screened independently by two reviewers and analyzed descriptively. Five studies involving 534 eyes from 475 patients were included, comprising two retrospective case series, one randomized clinical trial, and two multicentre observational studies. Follow-up periods ranged from one week to 24 months. Across studies, the combined procedure consistently demonstrated significant reductions in IOP and glaucoma medication use, while reported complications were generally mild and self-limiting. Combined PEI, GSL/VGSL, and GT appears to be a safe and effective surgical option for PACG with coexisting cataract. This review contributes to the growing evidence supporting angle-based surgical interventions for improving IOP control and reducing medication burden in PACG.

**Keywords:** goniotomy; phacoemulsification; primary angle-closure glaucoma; visco-goniosynechialysis

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## **INTRODUCTION**

Primary angle-closure glaucoma (PACG) is one of the leading causes of irreversible blindness worldwide and represents a major public health concern, particularly in Asian populations. Unlike primary open-angle glaucoma, PACG is often associated with a more rapid progression of visual field loss and a greater risk of severe visual impairment if left untreated. Elevated intraocular pressure (IOP) resulting from impaired aqueous humor drainage remains the principal mechanism underlying optic nerve damage in PACG. Over the previous 20 years, the global pooled prevalence of PACG has been estimated at approximately 0.6%, with the highest prevalence reported in Asia at 0.7%. Currently, an estimated 17.14 million adults aged over 40 years are affected by PACG worldwide, including 12.30 million individuals living in Asia. These numbers are expected to increase substantially, reaching 26.26 million globally and 18.47 million in Asia by 2050 due to population growth and aging demographics (N. Zhang et al., 2021). Consequently, identifying effective and sustainable treatment strategies for PACG has become increasingly important.

The pathophysiology of PACG is complex and multifactorial. The disease is characterized by narrowing or closure of the anterior chamber angle, resulting in obstruction of aqueous humor outflow through the trabecular meshwork. Several anatomical factors contribute to angle closure, including a shallow anterior chamber, increased lens thickness, shorter axial length, and crowding of anterior segment structures. Persistent angle closure may lead to the formation of peripheral anterior synechiae (PAS), which permanently obstruct the trabecular meshwork and further

compromise aqueous outflow. As a result, sustained elevation of IOP can cause progressive optic nerve damage, retinal ganglion cell loss, and irreversible visual field defects. Therefore, treatment strategies targeting both the anatomical causes of angle closure and the reduction of IOP are essential in preventing disease progression. (Singh et al., 2024),

Traditional management of PACG includes medical therapy, laser peripheral iridotomy, and filtering surgery. Although these interventions can effectively reduce IOP in selected patients, each approach has limitations. Medical therapy often requires lifelong adherence and may be associated with adverse effects and reduced patient compliance. Laser peripheral iridotomy relieves pupillary block but may not adequately address non-pupillary block mechanisms or extensive PAS. Filtering surgeries such as trabeculectomy can achieve substantial IOP reduction but carry risks of postoperative complications, including hypotony, bleb-related infections, and long-term failure. Consequently, increasing attention has been directed toward surgical approaches that simultaneously address the underlying anatomical abnormalities while minimizing complications. (Singh et al., 2024),

Phacoemulsification (PEI) has emerged as an important treatment option for PACG, particularly in patients with coexisting cataracts. Removal of the crystalline lens decreases lens-induced crowding within the anterior segment, deepens the anterior chamber, widens the iridocorneal angle, and improves aqueous humor circulation. Several studies have demonstrated that PEI alone can significantly reduce IOP and improve angle anatomy in patients with PACG (Singh et al., 2024) (Ghadamzadeh et al., 2022). Moreover, cataract extraction provides additional visual benefits by improving visual acuity and quality of life. These findings have contributed to the growing acceptance of lens extraction as an important component of PACG management. Nevertheless, residual angle closure and persistent PAS may continue to limit aqueous outflow despite successful cataract removal, suggesting that additional angle-based procedures may further improve surgical outcomes. Patients with primary angle-closure disease experienced significant improvements in IOP control and reductions in PAS extent following combined surgery. However, visual acuity outcomes appeared less pronounced. In contrast, the randomized clinical trial conducted by Husain et al. (2019) did not demonstrate a significant additional reduction in IOP when GSL was added to PEI compared with PEI alone. These conflicting findings indicate that the true benefit of adjunctive GSL remains uncertain and warrants further evaluation. (Yao et al., 2023).

Goniosynechialysis (GSL) and visco-goniosynechialysis (VGSL) have therefore been introduced as adjunctive procedures to restore access to the trabecular meshwork. These techniques involve the mechanical separation of PAS from the angle structures, thereby reopening previously closed portions of the drainage angle. By restoring anatomical access to the trabecular meshwork, GSL and VGSL aim to improve aqueous outflow and enhance IOP reduction. Previous studies have reported encouraging results regarding the use of combined PEI and GSL. (Yao et al., 2023).

Several outcomes have been published regarding the effect of combination of PEI and GSL. According to Yao et al. (2023) patients with primary angle-closure disease benefit greatly from PEI and GSL in terms of intraocular pressure and peripheral anterior synechiae, but visual acuity is not considerably affected. In contrast to PEI alone, the randomized clinical trial by Husain et al. (2019) failed to demonstrate that PEI-GSL further reduced IOP in individuals with PACG. These contrast opinions may be benefited from further analysing effort, one being the systemically review.

In recent years, increasing attention has also been directed toward goniotomy (GT) as a minimally invasive glaucoma surgery (MIGS) technique. First introduced by Barkan in 1947, goniotomy involves incising the trabecular meshwork to facilitate aqueous humor drainage through Schlemm's canal and collector channels (Barkan, 1947). Although initially developed for congenital glaucoma, advances in surgical instrumentation have expanded its application to adult glaucoma management.

Contemporary studies have demonstrated favorable outcomes for GT in various glaucoma subtypes. In primary open-angle glaucoma, 120°, 240°, and 360° goniotomy procedures have all shown effectiveness in reducing IOP and medication burden, either alone or in combination with phacoemulsification (Y. Zhang et al., 2023). Another study explains that regardless of the stage of the disease, incisional GT and PEI dramatically lower intraocular pressure and the need for glaucoma medication in patients with PACG. Furthermore, (Gupta et al., 2021) reported that combining incisional GT with PEI significantly reduced IOP and glaucoma medication requirements in patients with PACG regardless of disease severity. These findings suggest that GT may provide additional functional improvement beyond the anatomical restoration achieved through PEI and GSL alone.

The rationale for combining PEI, GSL or VGSL, and GT is based on their complementary mechanisms of action. Phacoemulsification addresses lens-related crowding and deepens the anterior chamber, GSL or VGSL reopens synechially closed angles, and GT directly improves trabecular outflow by reducing resistance within the conventional drainage pathway. Together, these procedures target multiple pathological mechanisms responsible for elevated IOP in PACG. Consequently, the combined surgical approach has the potential to achieve greater IOP reduction, decrease dependence on glaucoma medications, and reduce the need for more invasive filtering procedures.

Despite the growing number of studies evaluating these combined procedures, the available evidence remains scattered and heterogeneous. Differences in study design, patient characteristics, surgical techniques, follow-up duration, and reported outcomes have complicated interpretation of the literature. Furthermore, the relative contribution of each component procedure to overall treatment success remains unclear. A comprehensive synthesis of the existing evidence is therefore needed to better understand the effectiveness and safety of combining PEI with GSL or VGSL and GT in patients with PACG. Therefore, this mini systematic review aims to evaluate and synthesize the current evidence regarding the effectiveness and safety of phacoemulsification combined with goniosynechialysis or visco-goniosynechialysis and goniotomy in the management of primary angle-closure glaucoma. By summarizing the available clinical outcomes, this review seeks to support evidence-based decision-making and identify future directions for research in the surgical management of PACG.

## **METHOD**

This mini systematic review was conducted to evaluate the effectiveness and safety of phacoemulsification (PEI) combined with goniosynechialysis (GSL) or visco-goniosynechialysis (VGSL) and goniotomy (GT) in the management of primary angle-closure glaucoma (PACG). The review was conducted and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A systematic literature search was performed in PubMed, ProQuest, and Google Scholar from database inception to March 2025. The search strategy incorporated both Medical Subject Headings (MeSH) and free-text terms related to primary angle-closure glaucoma (PACG) and surgical interventions. The following search string was applied: ("primary angle-closure glaucoma" OR "angle-closure glaucoma" OR PACG) AND phacoemulsification AND goniotomy AND ("goniosynechialysis" OR "visco-goniosynechialysis"). Reference lists of all eligible studies and relevant review articles were also manually screened to identify additional studies. Duplicate records were removed prior to title, abstract, and full-text screening.

The inclusion criteria of an article to be included in this review were (1) an empirical study design in any form of designs, either qualitative, quantitative, or mixed methods, (2) related to the effect of PEI alongside GSL or VGSL and GT on the treatment of PACG. Articles were excluded according to the criteria: (1) unrelated topic, (2) insufficient data, (3) studies in the form of reviews,

abstracts, presentation in a conference, or protocol. All of the publications were evaluated by two researchers. Following the elimination of duplicates, one of the authors went over the article titles and abstracts. Next, using the inclusion and exclusion criteria, the first author assessed the full-text papers' applicability. This was followed by manual searches of previously published meta-analyses, employing review articles and bibliographies to find further relevant research. In accordance with the goals and parameters of the systematic review, the information gleaned from the literature was displayed descriptively in a table. Each reviewer who took part in the previous step carried out this process independently, and a third reviewer was brought in to help come to an agreement on the discrepancies found. Numerical and thematic results were presented in a narrative, theme manner, as indicated by the results, which summarized the responses to the research questions in the chosen articles.

## **RESULT**

The online database search yielded a total of 57 records. After removing 8 duplicate records, 49 articles remained for title and abstract screening. Following this screening process, 44 articles were excluded because they did not meet the eligibility criteria. Five full-text articles were assessed for eligibility, and all five studies met the inclusion criteria and were included in the final systematic review. The study selection process is presented in Figure 1. The earliest study assessing intraocular pressure (IOP) reduction following combined surgical interventions for PACG and cataract was published in 2019, while the latest was published in 2024. Among the five included studies, two employed retrospective case series designs, one was a prospective randomized clinical trial, and two were multicentre observational studies. The studies were conducted across various international ophthalmologic centers and involved a total of 534 eyes from 475 patients diagnosed with PACG and cataract.

The combination of PEI, GSL, and GT—often utilizing the Kahook Dual Blade—was the most commonly evaluated surgical approach. Follow-up durations ranged from one week to 24 months. Across studies, the primary outcome was the extent of IOP reduction, often accompanied by secondary outcomes such as medication burden reduction and safety outcomes, including post-operative complications. Most studies reported significant and sustained reductions in IOP. For example, Dorairaj & Tam (2019) found that 85.7% of eyes achieved complete freedom from glaucoma medications six months after surgery. In a subsequent long-term follow-up study, Dorairaj et al. (2021) confirmed these findings, reporting that 100% of eyes experienced a  $\geq 20\%$  IOP reduction and 69.0% were medication-free at 24 months. Lin et al. (2024) extended this evidence through a multicentre observational study and highlighted the role of peripheral anterior synechiae (PAS) extent in treatment efficacy.

The only randomized clinical trial, conducted by Shokoohi-Rad et al. (2021), demonstrated that combining phacoemulsification with VGSL yielded superior IOP reduction, with significant differences observed at three and six months postoperatively. Song et al. (2022) similarly documented a 48% mean IOP reduction in patients with advanced PACG and a substantial 85% reduction in medication burden over a 12-month period. While complications such as hyphema, transient IOP spikes, and corneal edema were noted, these were generally mild and self-limiting. Overall, these studies consistently support the efficacy and safety of combined PEI, GSL, and GT procedures in managing PACG with coexisting cataract. However, further research may be needed to assess long-term complications, functional visual outcomes, and cost-effectiveness, particularly in low-resource settings.

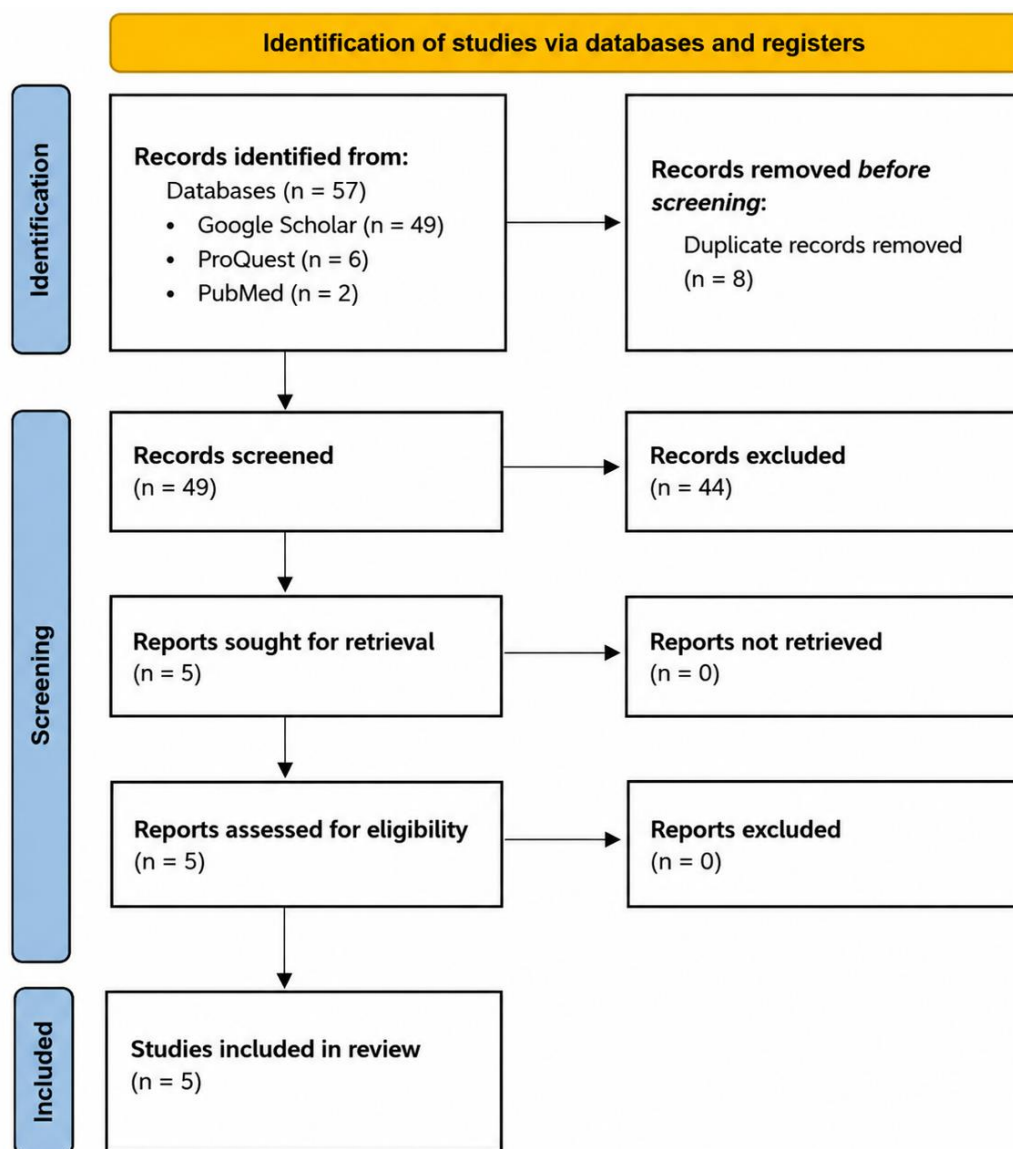


Figure 1. PRISMA Flow Diagram

Table 2.  
Characteristics of the included studies

| Study ID              | Journal             | Aims of Study                                                                                                                                                                                    | Study Design                             | Population                                    | Sample Size            | Follow Up Duration |                                                                 |
|-----------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|-----------------------------------------------|------------------------|--------------------|-----------------------------------------------------------------|
| Dorairaj & Tam (2019) | Journal of Glaucoma | To characterize reductions in IOP and the need for IOP-lowering medications following PEI combined with Kahook Dual Blade-assisted GSL and excisional GT in eyes with angle-closure glaucoma and | Retrospective interventional case series | Patient's angle-closure glaucoma and cataract | 42 eyes of 24 subjects | 6 months           | Significant and sustained IOP re freedom from glaucoma drugs (p |

| Study ID                   | Journal                               | Aims of Study                                                                                                                                                           | Study Design                          | Population                                                                                                    | Sample Size              | Follow Up Duration                |                                                                                                                 |
|----------------------------|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|---------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------------------|-----------------------------------------------------------------------------------------------------------------|
| cataract                   |                                       |                                                                                                                                                                         |                                       |                                                                                                               |                          |                                   |                                                                                                                 |
| Dorairaj et al. (2021)     | Asia-Pacific Journal of Ophthalmology | To describe changes in IOP and IOP medications after PEI with Kahook Dual Blade-assisted GSL and excisional GT in eyes with angle-closure glaucoma and cataract         | Retrospective case series             | Patient's angle-closure glaucoma and cataract                                                                 | 42 eyes of 24 subjects   | 24 months                         | 95.2% (40/42 eyes) achieved IO reduction; 85.7% (36/42 eyes) medication-free                                    |
| Lin et al. (2024)          | Journal of Glaucoma                   | To evaluate the impact of the extent of peripheral anterior synechiae (PAS) on the effectiveness and safety of combined PEI, GSL, and GT in eyes with PACG and cataract | Multicentre observational study       | Patients diagnosed with PACG and cataract who underwent combined PEI and 120 degrees GSL plus GT (PEI+GSL+GT) | 304 eyes of 283 patients | -                                 | Significant reduction in IOP (P < 0.001)                                                                        |
| Shokoohi-Rad et al. (2021) | European Journal of Ophthalmology     | To evaluate the effects of GT on patients with PACG who underwent phacoemulsification and VGSL                                                                          | Prospective randomized clinical trial | Patients with PACG                                                                                            | 63 eyes of 61 patients   | 1 week; 1, 3, and 6 months        | Greater mean IOP reduction; Th months; Anterior segment optical differences post-intervention. AL VGSL + group. |
| Song et al. (2022)         | Asia-Pacific Journal of Ophthalmology | To evaluate the IOP-lowering effect of the combination of PEI with intraocular lens implantation, GSL, and GT in eyes of advanced PACG with cataract.                   | Multicentre observational study       | Patients with advanced PACG who received combined PEI+GSL+GT                                                  | 83 eyes of 83 patients   | 1, 7 days, 1, 3, 6, and 12 months | Mean IOP reduction (48% reduction); Complications like hyphaemia, I                                             |

## DISCUSSION

This review evaluated the effectiveness and safety of combining phacoemulsification (PEI), goniosynechialysis (GSL) or visco-goniosynechialysis (VGSL), and goniotomy (GT) in the management of primary angle-closure glaucoma (PACG). Overall, the included studies consistently demonstrated clinically meaningful reductions in intraocular pressure (IOP), decreased dependence

on glaucoma medications, and favorable safety outcomes. These findings suggest that the combined surgical approach may provide both anatomical and functional benefits by addressing multiple mechanisms responsible for angle closure and impaired aqueous humor drainage in PACG.

The observed reduction in IOP is biologically plausible given the complementary mechanisms of the three procedures. Phacoemulsification addresses one of the principal anatomical contributors to angle closure by removing the crystalline lens, which is often enlarged and positioned anteriorly in patients with PACG. Lens extraction deepens the anterior chamber, widens the iridocorneal angle, reduces pupillary block, and facilitates aqueous humor circulation. Previous studies have consistently demonstrated that phacoemulsification alone can produce significant IOP reduction and angle widening in eyes with PACG (Singh et al., 2024) (Ghadamzadeh et al., 2022). However, despite successful lens extraction, residual peripheral anterior synechiae (PAS) may continue to obstruct the trabecular meshwork and limit aqueous outflow. Therefore, additional angle-based interventions may be necessary to achieve optimal pressure control.

The role of GSL and VGSL is particularly important in this context. These procedures mechanically separate PAS from the angle structures, thereby restoring access to previously obstructed portions of the trabecular meshwork. Reopening the drainage angle may enhance conventional aqueous outflow and improve the effectiveness of phacoemulsification. The randomized clinical trial included in this review demonstrated significantly greater IOP reduction in patients treated with PEI combined with VGSL compared with phacoemulsification alone, particularly at three and six months postoperatively. Furthermore, anterior segment optical coherence tomography findings confirmed improvements in angle anatomy following surgery. These findings support the hypothesis that anatomical restoration of the drainage angle contributes substantially to postoperative IOP reduction.

Interestingly, previous evidence regarding the additional value of GSL has been inconsistent Husain et al. (2019). reported no significant difference between phacoemulsification alone and phacoemulsification combined with GSL. Several factors may explain these discrepancies. First, the extent and chronicity of PAS differ among patient populations and may influence the degree of benefit obtained from synechialysis. Eyes with extensive or long-standing synechial closure may experience irreversible trabecular damage despite successful angle reopening. Second, differences in surgical techniques, surgeon experience, and postoperative management may contribute to variation in outcomes. Finally, differences in follow-up duration may affect the observed magnitude of treatment benefit. Therefore, patient selection remains an important consideration when determining the potential value of adjunctive GSL or VGSL.

In addition to anatomical restoration, the incorporation of GT may provide further functional enhancement of aqueous outflow. Goniotomy directly targets the trabecular meshwork by creating an incision that facilitates aqueous humor passage into Schlemm's canal and the distal collector channels. This mechanism differs from that of GSL, which primarily restores access to existing drainage structures. Consequently, GT may complement both phacoemulsification and GSL by reducing outflow resistance at the level of the trabecular meshwork. The favorable outcomes reported across the included studies suggest that the combined approach addresses multiple pathological components of PACG simultaneously, including lens-induced crowding, synechial angle closure, and trabecular outflow resistance. Such a multimodal strategy may explain the substantial and sustained reductions in IOP observed during follow-up periods extending up to 24 months.

Another clinically relevant finding of this review is the marked reduction in glaucoma medication requirements following surgery. Several studies reported substantial reductions in medication burden, with medication-free rates ranging from approximately 69% to 86% during follow-up.

Reducing medication dependence has important implications beyond IOP control. Long-term use of topical glaucoma medications may be associated with ocular surface disease, treatment-related adverse effects, reduced quality of life, and poor adherence. Medication non-compliance remains a major challenge in glaucoma management, particularly among elderly patients who often require multiple medications for various chronic conditions. Therefore, achieving satisfactory IOP control while minimizing medication use represents an important therapeutic advantage of the combined surgical approach.

The safety profile observed across the included studies was generally favorable. Reported complications included transient hyphema, temporary IOP spikes, and mild corneal edema, all of which were self-limiting and manageable with standard postoperative care. No study reported a high incidence of severe vision-threatening complications. This finding is particularly important because traditional filtering surgeries, while effective in lowering IOP, are associated with risks such as hypotony, bleb leakage, infection, and long-term bleb-related complications. The relatively mild complication profile observed with combined PEI, GSL/VGSL, and GT supports the growing interest in angle-based surgical procedures as less invasive alternatives for selected PACG patients.

The findings of this review are particularly relevant when considered alongside conventional surgical strategies for PACG. Historically, trabeculectomy has been regarded as the gold-standard surgical intervention for patients requiring substantial IOP reduction. While trabeculectomy is highly effective in lowering IOP, it is also associated with a relatively high incidence of postoperative complications, including hypotony, bleb leakage, bleb-related infection, cataract progression, and the need for intensive postoperative monitoring. In contrast, combined PEI, GSL/VGSL, and GT aim to restore physiological aqueous humor outflow pathways while avoiding the creation of a filtering bleb. This distinction may explain the favorable safety profile observed across the included studies.

Another important consideration is that trabeculectomy primarily addresses the consequence of angle closure, namely elevated IOP, whereas combined angle-based procedures target the underlying anatomical mechanisms responsible for disease development. Lens extraction reduces anterior segment crowding, goniosynechialysis reopens closed angle structures, and goniotomy enhances trabecular outflow. Consequently, this combined strategy may be viewed as a more pathophysiologically directed approach compared with conventional filtering surgery. Although direct comparative studies remain limited, the available evidence suggests that combined PEI, GSL/VGSL, and GT may offer an attractive alternative for selected PACG patients, particularly those with coexisting cataract and moderate disease severity.

The emergence of minimally invasive glaucoma surgery (MIGS) has further shifted the paradigm of glaucoma management toward procedures that provide meaningful IOP reduction while minimizing tissue disruption and postoperative morbidity. The incorporation of GT into combined cataract surgery reflects this evolving treatment philosophy. As healthcare systems increasingly prioritize patient safety, quality of life, and cost-effectiveness, angle-based procedures may become progressively more important in the management of PACG.

The extent of peripheral anterior synechiae appears to be an important determinant of surgical success. Peripheral anterior synechiae represent permanent adhesions between the peripheral iris and angle structures and are often indicative of chronic or advanced angle closure. Prolonged synechial closure may lead to irreversible dysfunction of the trabecular meshwork, limiting the ability of surgical interventions to fully restore aqueous outflow.

The multicentre observational study by Lin et al. (2024) highlighted the potential influence of PAS extent on treatment outcomes. Patients with less extensive synechial involvement generally

demonstrated more favorable postoperative outcomes, suggesting that earlier intervention may preserve trabecular function and improve surgical efficacy. These findings are biologically plausible because prolonged contact between the iris and trabecular meshwork can induce structural alterations that persist even after anatomical reopening of the angle.

The relationship between PAS severity and surgical success has important clinical implications. First, it supports the concept of earlier identification and treatment of PACG before extensive synechial closure develops. Second, it suggests that preoperative assessment of angle anatomy should play a central role in surgical planning. Modern imaging modalities, including gonioscopy and anterior segment optical coherence tomography, may help identify patients most likely to benefit from combined angle-based procedures. Future studies should investigate whether specific PAS thresholds can be used to guide patient selection and optimize outcomes.

The growing body of evidence supporting combined PEI, GSL/VGSL, and GT reflects broader changes in glaucoma surgery. Contemporary glaucoma management increasingly emphasizes restoration of physiological outflow pathways rather than the creation of alternative drainage routes. This shift has been driven by advances in surgical technology, improved understanding of aqueous humor dynamics, and increasing recognition of the limitations associated with traditional filtering procedures.

For PACG, this evolution is particularly important because the disease is fundamentally characterized by anatomical abnormalities of the anterior segment. Procedures that directly address these anatomical mechanisms may offer advantages over interventions that focus exclusively on pressure reduction. The combination of PEI, GSL/VGSL, and GT represents a comprehensive strategy that simultaneously addresses lens-related crowding, synechial angle closure, and trabecular outflow resistance.

Furthermore, the reduction in medication burden observed across studies may have important implications for healthcare systems. Long-term glaucoma treatment imposes substantial economic costs on both patients and healthcare providers. Surgical approaches capable of reducing dependence on chronic pharmacological therapy may improve treatment adherence, reduce healthcare expenditures, and enhance patient quality of life. Although formal economic analyses were not available among the included studies, future investigations should explore the cost-effectiveness of combined angle-based surgery compared with conventional treatment pathways.

As surgical techniques and instrumentation continue to evolve, the role of combined PEI, GSL/VGSL, and GT is likely to expand. Additional evidence from large-scale randomized controlled trials and long-term observational studies will be required to determine the durability of treatment effects, identify optimal patient populations, and establish the position of these procedures within future glaucoma treatment algorithms.

From a clinical perspective, the findings of this review suggest that combined PEI, GSL/VGSL, and GT may be particularly beneficial for patients with PACG and coexisting cataract, especially those with significant PAS and persistent angle compromise. By simultaneously addressing cataract-related anatomical crowding and aqueous outflow obstruction, the procedure may reduce the need for future glaucoma interventions and improve long-term disease control. The reduction in medication burden may also be particularly valuable in resource-limited settings where access to long-term pharmacological therapy may be challenging. Nevertheless, the current evidence remains insufficient to recommend this approach as a universal first-line treatment for all PACG patients. Individual patient characteristics, extent of angle closure, severity of glaucomatous damage, and surgeon expertise should continue to guide treatment decisions.

This review has several strengths. It provides a focused synthesis of contemporary evidence regarding a rapidly evolving surgical strategy for PACG and summarizes outcomes related to both efficacy and safety. Furthermore, the review integrates evidence from different study designs, thereby providing a broader overview of current clinical practice. However, several limitations should be acknowledged. First, only five studies met the inclusion criteria, resulting in a relatively limited evidence base. Second, substantial heterogeneity existed among studies regarding patient characteristics, surgical techniques, extent of goniosynechialysis, goniotomy approaches, outcome definitions, and duration of follow-up. Third, most included studies were observational, increasing susceptibility to selection bias, confounding, and other methodological limitations. Fourth, a formal risk-of-bias assessment was not performed because of the limited scope of this mini systematic review; therefore, the quality of the included evidence should be interpreted cautiously. Fifth, potential overlap in patient populations between some studies may have influenced the overall interpretation of findings. Finally, quantitative meta-analysis was not feasible because of substantial methodological and clinical heterogeneity.

Future research should focus on well-designed randomized controlled trials with larger sample sizes and longer follow-up periods. Standardized reporting of IOP outcomes, medication use, visual function, quality-of-life measures, and complications would facilitate more robust comparisons across studies. Additionally, future investigations should determine which patient subgroups derive the greatest benefit from combined PEI, GSL/VGSL, and GT and evaluate the long-term durability and cost-effectiveness of these procedures. Such evidence will be essential for establishing the precise role of combined angle-based surgery in the management of PACG.

## CONCLUSION

Current evidence indicates that the combination of phacoemulsification, goniosynechialysis or visco-goniosynechialysis, and goniotomy effectively reduces intraocular pressure and glaucoma medication requirements in patients with primary angle-closure glaucoma and coexisting cataract while maintaining an acceptable safety profile. The available literature supports the potential role of this combined surgical

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