Comparing phacoemulsification and phacotrabeculectomy for managing primary angle-closure glaucoma with cataracts: a review

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INTRODUCTION

Cataracts and glaucoma, two eye illnesses that are frequently the leading causes of blindness worldwide, have received considerable attention in the field of ophthalmology in recent decades.¹,²,³ Cataracts and glaucoma are frequently observed together in ophthalmology investigations, posing a significant therapeutic problem for medical providers. Both diseases substantially impact patients’ quality of life and well-being. Thus, a greater knowledge of how to manage them is vital.¹,²,³

Cataracts, the world’s largest cause of blindness, can cause gradual vision impairment by covering the eye’s lens. Meanwhile, glaucoma, the second leading cause of global blindness, is a disorder characterized by increased intraocular pressure and optic nerve damage. With the prevalence of glaucoma growing with age, particularly in primary angle closure glaucoma, which is more common in Asian populations⁴, the issues of controlling glaucoma alongside cataracts are becoming increasingly complex. Despite the use of optimum medical therapy, there is still doubt surrounding the management of uncontrolled intraocular pressure in this scenario.

Aside from age, the size and position of the lens have an important influence on the development of cataracts and glaucoma.⁵,⁶ Therefore, selecting the optimal surgical method becomes critical in effectively addressing these disorders. However, cataract surgery can impact IOP control, and some glaucoma surgery treatments can hasten the development of cataracts. This emphasizes the significance of surgical technique selection in treating primary angle-closure glaucoma, which is frequently accompanied by cataracts. As a result, combination surgical methods such as phacotrabeculectomy have emerged. Nonetheless, the decision to use this surgical method is not simple, as long-term effectiveness, benefits and potential complications must be considered.⁷ This review will compare phacoemulsification and phacotrabeculectomy for managing primary angle-closure glaucoma with cataracts.

ANATOMY AND FUNCTION OF THE EYE

The eye, a remarkable organ of vision, has unique dimensions, being nearly spherical with a length ranging from 24 to 25 mm and a volume of approximately 6.5 cc. The eye anatomy is divided into three separate layers: the sclera and cornea on the outside, the middle layer, and the inner layer. The eyeball has three essential fluid-filled compartments: the anterior chamber between the cornea and iris, the posterior chamber between the iris, zonular fibers, and lens, and the vitreous chamber between the lens and retina. The first two compartments are filled with aqueous humor, whereas the third, the vitreous chamber, is filled with vitreous humor, which has a thicker consistency.⁸

Intraocular pressure (IOP) is a critical feature of eye function because it measures the force generated by the aqueous fluid inside the eye. Sudden rises in IOP can
have substantial consequences for the eye, potentially causing retinal damage and functioning as a risk factor for the development of glaucoma.9

As an important component of the eye's refractive medium, the crystalline lens is translucent, flexible, and biconvex-ellipsoid in shape. The capsule, cortex, fibers, epithelium, and nucleus are all parts of the lens. The lens epithelial layer, which is positioned just beneath the capsule in the anterior and equatorial parts of the lens, alters and continues to develop into lens fiber cells. The density and hardness of the lens cortical nucleus increase with the aging process.10 These alterations can affect the color of the nucleus and the volume of the anterior chamber, which has important consequences for ocular equilibrium.

ENS ANATOMY

The eye lens is an important refractive medium distinguished by its translucent, flexible structure and unusual biconvex shape. The anterior radius of curvature of the lens surface is roughly 10 mm, and the posterior radius of curvature is around 6 mm. The lens layers are the capsule, cortex, fibers, epithelium, and nucleus. The lens capsule is a translucent and elastic basal membrane that surrounds the lens and is made up of collagen type IV, collagen type I and collagen type III, laminin, fibronectin, and sulfated glycosaminoglycans. The lens epithelium, which forms a single-layered cuboidal structure, is positioned right under the capsule in the anterior part and the equator of the lens. Lens fibers originate in lens cells and have lengthy hexagonal patterns in cross-section. The lens changes with age, including a shift in color to yellow or brown, an increase in lens density, and changes in the volume of the anterior chamber. However, the volume of the posterior chamber changes little because the posterior pole of the lens does not shift backward.10

PRIMARY ANGLE-CLOSURE GLAUCOMA WITH CATARACT

Closure of the primary angle Glaucoma with cataract is a complex disorder with an unknown cause. One of the most common causes is pupil block, which is frequently related to the continual expansion of the eye lens. This is caused by increased aqueous humor flow resistance between the iris pupil and the anterior surface of the lens, which is connected with pupil dilation. Anterior peripheral iris movement can cause the anterior chamber angle to close (Figure 1).10

This condition starts with suspected primary angle closure (PACS), defined by iridotrabecular contact along 180 degrees without peripheral anterior synchiae (PAS), high intraocular pressure, or optic nerve injury. When intraocular pressure rises in PACS, this definition moves to primary angle closure (PAC). In PAC instances, alterations in intraocular pressure and the onset of glaucomatous optic nerve injury indicate the presence of primary angle-closure glaucoma. Increasing age, female gender, shallow anterior chamber depth, short axial length in hyperopic patients, small corneal diameter, steep and thick corneal curvature, and prominent anterior lens position are risk factors for developing primary angle-closure glaucoma with cataract.11

DIAGNOSTIC EVALUATION OF PRIMARY ANGLE-CLOSURE GLAUCOMA WITH CATARACT

Cataract Examination

The primary focus of cataract assessment is measuring the patient's visual impact, with lens opacity estimated based on everyday activities. Furthermore, other causes of vision impairment, such as retinal, optic nerve, and corneal illnesses, must be ruled out. Examining visual acuity, contrast sensitivity, and pupil size are all part of the evaluation process. B-scan ultrasonography is utilized as an extra evaluation technique when cataracts are dense and restrict the image of the posterior region.11

Senile cataracts are classified into four phases based on the level of opacity in the lens (incipient, immature, mature, and hypermature) and three types based on the location of the opacity (nuclear, posterior subcapsular, and cortical). Exams are performed using a slit lamp and the Lens Opacity Classification System (LOCS) III criteria or the Buratto method to determine the degree of cataracts. Nuclear opalescence (NO), nuclear color (NC), cortical cataract, and posterior subcapsular cataract are all included in the LOCS III categorization.12

Based on visual acuity, the Buratto classification divides lens hardness densities into five kinds. Grade I cataracts are the softest and have better visual acuity than 6/12. Grade II is a nucleus with minor hardness and visual acuity ranging from 6/12 to 6/30. Grade III is a nucleus with medium hardness and visual acuity ranging from 6/30 to 6/30. Grade IV is a hard nucleus with visual acuity ranging from 3/60 to 1/60. Buratto et al. (2019) define Grade V as an extremely hard nucleus with a visual acuity of 1/60 or worse.13

Primary Angle Closure Glaucoma Examination

Patients with primary angle closure glaucoma typically have elevated intraocular pressure. Slit lamp

Figure 1. Aqueous humor flow obstruction due to the closure of Schlemm's canal by the iris, pushed by the lens.10

Figure 2. Bullous keratopathy with irregular corneal surface and stromal edema.11
Anterior chamber angle (Figures 3 and 4). In glaucoma, the neuroretinal rim is critical for evaluating the extent of optic nerve damage. Other areas of evaluation include shunt vessels, disc bleeding, neovascularization, and disc drusen. Dense cataracts, on the other hand, can make disc evaluation difficult.14

**USE OF ANTERIOR SEGMENT OPTICAL COHERENCE TOMOGRAPHY (AS-OCT)**

Anterior Segment Optical Coherence Tomography (AS-OCT) can provide reliable information on the anterior chamber depth of the eye as well as factors such as the lens vault (LV), which can serve as a prognostic indicator in primary angle-closure glaucoma. Understanding the link between primary angle-closure glaucoma, anterior chamber depth, and lens thickness is also important for diagnosis.15 In both glaucoma and cataracts, standard visual field exams are used to determine the level of visual loss. Mean Deviation (MD) and Pattern Standard Deviation (PSD) are two parameters that can be used to assess the impact of cataracts on vision. Changes in the visual field after cataract extraction might be seen in patients with severe visual field loss. There are differences in MD and PSD parameters before and after cataract surgery. However, it should be noted that age-related cataracts can lead to false-positive responses in visual field testing, which can complicate the diagnosis of glaucoma.16

**MANAGEMENT OF PRIMARY ANGLE-CLOSURE GLAUCOMA WITH CATARACT**

**Medical and Laser Therapy**

Glaucome therapy aims to reduce intraocular pressure while maintaining visual function with minimum side effects and high patient compliance.17 Primary angle-closure glaucoma is managed using intraocular pressure-lowering medicines, laser techniques such as peripheral laser iridotomy (LPI), and cataract surgery combined with glaucoma surgery as an alternate option.18 A 30-40% drop in intraocular pressure can arrest the progression of optic nerve degeneration. Trabeculectomy may be the best option if a patient demands very low intraocular pressure and does not have extensive cataracts. If the patient has extensive cataracts, the surgeon must examine the expected results, the required intraocular pressure level, and whether using phacoemulsification alone or in combination with trabeculectomy is more suitable.19

**Surgical Therapy**

Surgical procedures must be considered in treating primary angle-closure glaucoma with cataracts. Lens extraction via phacoemulsification or ECCE is an option, as are glaucoma operations such as trabeculectomy or goniolysis. Lens extraction with trabeculectomy, EPC, CPC, deep sclerotomy, viscosanostomy, canuloplasty, Express shunt, or glaucoma drainage device is another option.20 The topics of this talk will be phacoemulsification and phacotrabeculectomy.

**Lens Extraction with Phacoemulsification**

Phacoemulsification surgery is indicated for visually significant cataracts with regulated intraocular pressure, no difficulty with glaucoma drug use, and visual field impairment.20 A crowded anterior chamber angle is a risk factor, and early-stage phacoemulsification can assist in widening the angle and deepening the anterior chamber while avoiding more invasive methods such as trabeculectomy or phacotrabeculectomy.21,22 According to research, phacoemulsification can enhance anterior segment depth, expand the angle, and lower intraocular pressure in patients with primary angle-closure glaucoma.21,24 Patients with high preoperative intraocular pressure, more glaucoma medications, narrower iridotrabecular

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**Figures 3.** Spaeth gonioscopy classification of the anterior chamber angle, based on three variables: (A) Angle width, (B) Peripheral iris configuration, (C) Clear insertion of the iris root.14

**Figures 4.** Shaffer’s gonioscopy classification of the anterior chamber angle is based on the angle width (A) Wide open (20 to 45 degrees), (B) Moderately narrow (10 to 20 degrees), (C) Very narrow: possible closure, (D) Partially or completely closed.14
angles, and extensive peripheral anterior synechia (PAS) formation and glaucomatous optic neuropathy have greater intraocular pressure reduction after phacoemulsification. Enhanced endogenous prostaglandin production, enhanced uveoscleral outflow, and interleukin-1 generation by the trabecular meshwork are all possible pathways for intraocular pressure reduction after phacoemulsification. While phacoemulsification can be helpful, phacotrabeculectomy may improve intraocular pressure control but is associated with bigger problems.

Phacotrabeculectomy Combination Surgery
Combination surgery is advised in cases of visually significant cataracts, uncontrolled intraocular pressure with drugs, or widespread peripheral anterior synechiae in primary angle-closure glaucoma with cataracts. Within 1-2 years after surgery, phacotrabeculectomy reduces intraocular pressure by roughly 8 mm Hg, whereas cataract extraction alone only reduces intraocular pressure by an average of 2-4 mm Hg. This combined procedure lowers the likelihood of advanced glaucoma problems such as “wreepout.” Despite the increased risk of complications, phacotrabeculectomy delivers medical, economic, and societal benefits by addressing both concerns in a single procedure.

Phacoemulsification Surgical Technique
Preoperative
Because of factors such as small anterior chambers, big lenses, poor mydriasis, posterior synechiae, and the danger of suprachoroidal hemorrhage, cataract surgery in primary angle-closure glaucoma eyes presents problems for phaco surgeons. Except in extreme circumstances such as very hard cataracts or significant zonular weakening, where extracapsular cataract extraction may be required, phacoemulsification with foldable intraocular lenses is advised. Lens stability, mydriasis, angle closure, and cup-disc ratio should all be evaluated prior to surgery. Because phacoemulsification alone may not be effective in eyes with closed angles, significant peripheral anterior synechia, and high intraocular pressure, combined phacotrabeculectomy surgery is indicated. Before surgery, the endothelial cell count should be checked, especially in eyes with a history of acute angle-closure attacks.

Except for pilocarpine and prostaglandin analogs, antiglaucoma drugs are taken until the day of surgery. Pilocarpine should be stopped at least two weeks before surgery. Preoperative intraocular pressure reduction therapies such as mannitol or acetazolamide may be used since high intraocular pressure before surgery increases the risk of intraoperative choroidal hemorrhage. Combination surgery may be required in cases of extremely high intraocular pressure.

Intraoperative
Topical anesthesia is recommended, although peribulbar anesthesia may be considered for lengthy surgeries. In eyes with small pupils due to posterior synechiae, synechiolysis should be performed first. Intracameral viscoelastic and adrenaline can help dilate the pupil if necessary. Ensure that the patient has no contraindications to the use of adrenaline. During phacoemulsification, attention must be paid to the aspiration rate or vacuum power to protect the iris and corneal endothelial tissues. Use low-viscosity phthalimide dispersive viscosurgical devices (OVD) or cohesive and dispersive viscoadaptive devices to protect the corneal endothelium. Avoid excessive hydro dissection and be cautious about pressure on the edge of the posterior wound. Avoiding posterior capsule rupture and vitreous loss is crucial as they can affect long-term intraocular pressure control. Ensure complete removal of viscoelastic material at the end of the surgery to avoid postoperative intraocular pressure spikes.

Postoperative
Corneal clarity, intraocular pressure, and anterior chamber reactions should be assessed on the first day postoperatively. Subsequently, patients should be reevaluated within 1-2 weeks and then as clinically needed. All preoperative antiglaucoma medications should be continued and titrated based on intraocular pressure. Pilocarpine and prostaglandin analogs increase the risk of pseudophakic cystoid macular edema. Prophylactic treatment with topical non-steroidal anti-inflammatory drugs and steroids may be considered in the immediate postoperative period. Topical steroid medication and antibiotics should be administered 6-8 times a day for 2 weeks and tapered gradually over 4-6 weeks in parallel with a decrease in anterior chamber reaction.

Complications
Phacoemulsification with intraocular lens implantation can decrease endothelial cell count by about 5%, potentially causing irreversible corneal damage. This risk is higher in primary angle-closure glaucoma due to a shallow anterior chamber, large hard cataract, and increased postoperative intraocular pressure within the first 24 hours. To avoid endothelial cell damage, it is essential to maintain intraocular pressure after surgery and exercise caution during surgery in eyes with an axial length below 22.6 mm.

Combined Phacotrabeculectomy Surgical Technique
Preoperative
Preoperative evaluation involves assessing cataracts, optic nerve status, and glaucoma treatment tolerance. Indications for combined surgery vary depending on the surgeon's experience. Antibiotics and non-steroidal anti-inflammatory eye drops are recommended 3 days before surgery. Discontinuation of miotics should be done one week before surgery, and prostaglandin analogs can also be discontinued to prevent postoperative macular edema. Discontinuation of antiagulation should be considered in high-risk eyes.

Intraoperative
Kim, W. S. and Kim, K. H., 2022, describe the steps of phacotrabeculectomy. They begin with a fornix-based incision and peritomy of the conjunctival limbus, leaving a 0.5 mm limbal conjunctiva. Tenonectomy is performed if the patient is at high risk of bleb failure. The
surgery can be performed in two ways: single-site or two-site, for cataract and glaucoma surgery. The advantages of two-site phacotrabeculectomy include superotemporal scar tissue requiring superonasal filtration, the presence of very thin conjunctiva increasing the risk of additional manipulation-induced defects, lower surgery-induced astigmatism, and reduced postoperative scarring on the scleral flap.20

Sclerotome knives are used to create a triangular incision (3 × 3 mm) meeting at the posterior end, followed by creating a half-thickness scleral flap. Mitomycin C is applied to the sclera and beneath the scleral flap before entering the anterior chamber. Care should be taken to protect the conjunctival incision from Mitomycin C. At all stages, the conjunctival bleb should be preserved from damage. The next steps involve pupil enlargement, followed by capsulorhexis and hydro dissection. Nucleus removal is recommended using the vertical chop technique if the pupil is small. Subsequently, a 3-piece acrylic intraocular lens (IOL) with PMMA haptics is implanted. Acetylcholine (Miochol) is used to induce miosis. Part of the trabecular meshwork is removed with a Crozafon punch, followed by peripheral iridectomy. The viscous elastic material is removed, and the trabeculectomy flap is sutured with 10-0 monofilament Nylon sutures. The conjunctiva is sutured at the limbus with 10-0 Vicryl sutures. The posterior chamber is deepened with BSS injection, and the wound is inspected for leakage.33

**Complications**

Phacotrabeculectomy has several complications, including astigmatism, hyphema, subconjunctival hemorrhage in the filtering bleb, choroid detachment, wound leakage, choroidal effusion, hypotonic maculopathy, increased intraocular pressure due to retained viscoelastic, obstructed sclerotomy, and malignant glaucoma-induced elevated intraocular pressure. Blebitis can also occur due to poor hygiene and is characterized by a thin-walled, avascular bleb with leakage.33 Nevertheless, the number of postoperative complications appears to be lower in phacotrabeculectomy compared to trabeculectomy with or without phacoemulsification (22.8% vs. 25.9%). The incidence of postoperative endophthalmitis is also low for both methods, around 0.4% for phacotrabeculectomy and 0.3% for trabeculectomy. Therefore, surgical complication factors should be considered in selecting the appropriate surgical method.

**Postoperative**

Early postoperative IOP spikes are common, necessitating close monitoring. Strict control of postoperative inflammation is key to maintaining bleb function. 1% Prednisolone phosphate is administered every hour while the patient is awake, then tapered over 2 months. Topical antibiotics and cycloplegics may be administered. Cataract surgery more than 12 months after glaucoma filtering surgery may result in bleb failure. All failed blebs can be treated with digital massage, subconjunctival FU-5 injection, and needling procedures. Patients should be made aware of the possibility of bleb failure, its symptoms, and consequences, and should be informed about this before surgery.20

Many complications associated with phacoemulsification are particularly emphasized in combined surgeries. They may be related to increased inflammation, surgical manipulation, wound integrity, and lens protein associated with the cataract surgery portion.32 Glaucoma filtering bleb failure is more common than filtering surgery alone. Potent steroid medications are crucial postoperatively.20

**CONCLUSION**

The prevalence of cataracts and glaucoma continuing to increase as the population ages, an emphasis on effective and sustainable management strategies will significantly impact society’s overall eye health. Phacotrabeculectomy has several complications. Nevertheless, the number of postoperative complications appears to be lower in phacotrabeculectomy compared to trabeculectomy with or without phacoemulsification (22.8% vs. 25.9%). Phacoemulsification with intraocular lens implantation can decrease endothelial cell count by about 5%, potentially causing irreversible corneal damage. This risk is higher in primary angle-closure glaucoma due to a shallow anterior chamber, large hard cataract, and increased postoperative intraocular pressure within the first 24 hours. Therefore, surgical complication factors should be considered in selecting the appropriate surgical method.

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**CONFLICT OF INTEREST**

The authors declare have no conflict of interest.

**AUTHOR CONTRIBUTIONS**

All authors contributed the same amount of work to this study.

**ETHICAL CLEARANCE**

None.

**REFERENCES**


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