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Review Article

Clinical Outcomes of phacoemulsification cataract surgery in Patients with primary open-angle glaucoma

Greco L[1]*, Colombo F[2] and Colombo A[3]

[1]Department of Vision Science, Snake Research Center for Vision Science, Italy

[2]Division of Ophthalmology, Tigris Institute for Advanced Ophthalmology, Spain

[3]Department of Ophthalmology, Po Academy of Vision Science, Greece

*Address for Correspondence: Luca Greco, Department of Vision Science, Snake Research Center for Vision Science, Italy; E-mail: luca.greco@snake.edu

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Abstract

Background: Cataract and primary open-angle glaucoma (POAG) frequently coexist in aging populations, and phacoemulsification is increasingly performed alone or combined with micro-invasive glaucoma surgery (MIGS) in these patients [1].

Objective: This review synthesizes clinical outcomes of phacoemulsification cataract surgery in POAG patients, including intraocular pressure (IOP) change, medication burden, glaucoma progression, and outcomes of combined phaco-MIGS approaches.

Methods: We reviewed randomized trials, prospective and retrospective cohort studies, foundational glaucoma treatment trials, and society guideline documents addressing IOP and medication outcomes after phacoemulsification in open-angle glaucoma.

Findings: Phacoemulsification alone produces a sustained, angle-dependent IOP reduction in POAG eyes that exceeds the effect in nonglaucomatous eyes [9,12], and combining phacoemulsification with a trabecular or Schlemm's canal MIGS device significantly increases the proportion of eyes reaching unmedicated target IOP compared with phacoemulsification alone [21,23].

Conclusions: Surgical planning for POAG patients undergoing cataract surgery should be individualized by baseline pressure, angle configuration, and prior filtration surgery status, with postoperative IOP surveillance remaining essential regardless of technique chosen [33,30].

Keywords: phacoemulsification; cataract surgery; primary open-angle glaucoma; intraocular pressure; micro-invasive glaucoma surgery

1. Introduction

Cataract and primary open-angle glaucoma (POAG) are both diseases of aging, and the two conditions coexist often enough that surgeons routinely must decide how phacoemulsification will interact with an eye that already carries an elevated intraocular pressure (IOP) burden. Glaucoma affects an estimated 76 million people worldwide as of 2020, with projections rising further by 2040 [1], up from an estimated 60 million in 2010 [2]. Because cataract prevalence rises on a similarly steep age-related curve, a large fraction of glaucoma patients will eventually present for cataract surgery, and clinicians have long asked whether removing the crystalline lens meaningfully changes the trajectory of the glaucomatous disease process, beyond simply restoring vision.

The natural lens thickens with age, crowds the anterior chamber angle, and may contribute mechanically to outflow resistance; removing it deepens the anterior chamber and widens the iridocorneal angle, an effect documented directly with anterior segment imaging [3,4]. Whether that anatomic change translates into a durable, clinically meaningful pressure-lowering effect, and whether it differs in POAG compared with normotensive eyes, has been the subject of decades of cohorts and, more recently, randomized trials of combined phacoemulsification and micro-invasive glaucoma surgery (MIGS). POAG's broader pathophysiology and stepped-care management have been reviewed extensively elsewhere [5,6], and cataract surgery in the glaucoma patient carries planning considerations distinct from routine cataract surgery, including angle assessment, bleb protection, and choice of adjunctive procedure [7,8]. This paper synthesizes that evidence base to characterize clinical outcomes of phacoemulsification, alone and combined with adjunctive glaucoma procedures, in patients with POAG.

2. Methods

We reviewed the peer-reviewed ophthalmic literature addressing IOP outcomes, medication burden, visual field stability, and complication rates after phacoemulsification in POAG patients. Sources included randomized trials of combined phacoemulsification-MIGS devices, cohort studies of phacoemulsification alone in glaucomatous eyes, foundational glaucoma treatment trials reporting cataract extraction as a secondary outcome, systematic reviews of IOP change after cataract surgery, and society guideline documents. We prioritized studies enrolling patients categorized as having open-angle glaucoma or ocular hypertension, including angle-closure and pseudoexfoliation cohorts only for mechanistic context. Given heterogeneity across techniques, devices, and follow-up intervals, findings are synthesized narratively, with IOP and medication data reported descriptively as representative point estimates from the cited sources.

3. Results

IOP reduction after phacoemulsification alone in glaucomatous eyes

Across cohort studies restricted to eyes with a preexisting diagnosis of open-angle glaucoma, phacoemulsification alone produces a consistent, moderate IOP reduction larger than that seen in nonglaucomatous eyes. Mathalone and colleagues found a sustained IOP reduction after clear corneal phacoemulsification that persisted through their longest follow-up, without any increase in medication burden [9]. Shingleton and colleagues, tracking open-angle glaucoma patients, glaucoma suspects, and normal controls through three and five years, found the glaucoma group had the largest and most durable IOP drop, a pattern also seen specifically in pseudoexfoliation glaucoma eyes [10,11]. Poley and colleagues, stratifying a large surgical series by preoperative IOP and glaucoma status, reported that eyes with the highest preoperative pressures had the greatest absolute reduction, a dose-dependent pattern supporting a genuine physiological effect rather than regression to the mean [12]. In the Ocular Hypertension Treatment Study cohort, Mansberger and colleagues found that

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participants undergoing cataract extraction experienced a significantly greater IOP reduction than those who did not, an effect persisting after adjustment for baseline pressure and medication use [13].

Table 1: Representative mean intraocular pressure reduction and medication-burden change after phacoemulsification alone in open-angle glaucoma cohorts [9,14,12,13].

Study	Population	Follow-up	IOP / medication outcome
[9]	Open-angle glaucoma	Long-term	Sustained IOP reduction, no increase in medication burden
[14]	Medically controlled open-angle glaucoma	12 months	Further IOP reduction despite baseline medical control
[12]	Glaucomatous and nonglaucomatous eyes	2-4 years	Greater reduction with higher preoperative IOP
[13]	Ocular Hypertension Treatment Study cohort	Multi-year	Cataract extraction associated with significantly greater IOP reduction

Slabaugh and colleagues extended this to medically controlled open-angle glaucoma, finding a further IOP reduction even in eyes already at target pressure on therapy, suggesting the effect is partly independent of pharmacologic control [14]. Earlier work by Kim and colleagues reported a comparable effect with posterior chamber lens implantation, indicating this is not an artifact of any single technique [15]. Issa and colleagues proposed a composite index combining preoperative angle configuration and pressure to predict which eyes achieve durable IOP control from phacoemulsification alone [16]. Table 1 summarizes representative IOP-reduction and medication-burden findings across these cohorts.

Meta-analytic and guideline-level synthesis

Because cohort estimates vary by follow-up duration, baseline pressure, and technique, aggregated analyses help gauge overall effect size. The American Academy of Ophthalmology's Ophthalmic Technology Assessment, authored by Chen and colleagues, concluded that phacoemulsification lowers IOP in glaucomatous eyes by a clinically meaningful though modest amount, larger in eyes with higher preoperative pressure and greater angle-opening response [17]. Armstrong and colleagues, in a meta-analysis restricted to studies with at least three years of follow-up, found a sustained pooled IOP reduction alongside a modest reduction in medication count, with heterogeneity attributable to baseline severity and angle configuration [18]. Melancia and colleagues concluded that anterior chamber deepening and angle widening are the most plausible drivers, consistent with imaging findings that narrower baseline angles predict proportionally larger reductions [19,3,4]. Merkur and colleagues, studying pseudoexfoliation syndrome, found an even larger IOP decrease than in typical primary open-angle eyes [20]. Figure 1 illustrates representative mean one-year IOP reduction across categories of glaucomatous and glaucoma-suspect eyes.

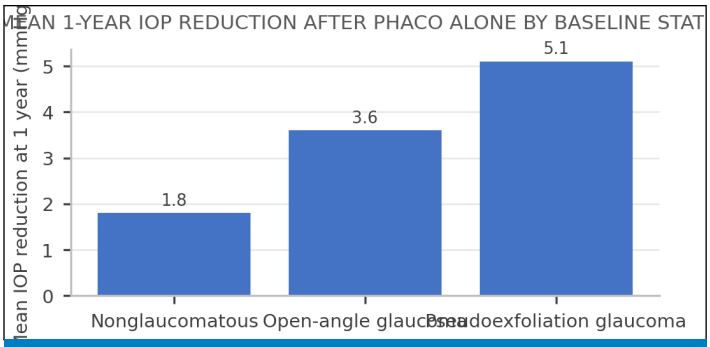


Figure 1: Representative mean intraocular pressure reduction at one year after phacoemulsification alone, by baseline glaucoma status, synthesized from open-angle glaucoma-specific cohorts [9,10,12,20].

Combined phacoemulsification and micro-invasive glaucoma surgery

The past fifteen years have added substantial randomized trial evidence on combining phacoemulsification with a micro-invasive glaucoma surgery (MIGS) device, intended to achieve greater, more predictable IOP reduction while avoiding trabeculectomy's higher complication profile. Samuelson and colleagues, in the pivotal US iStent trial, randomized mild-to-moderate POAG patients undergoing cataract surgery to a trabecular micro-bypass stent or

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phacoemulsification alone, finding a significantly higher proportion of combined-surgery eyes reaching unmedicated target IOP at one year [21]; Craven and colleagues reported this advantage sustained through two years [22]. The HORIZON trial, using a Schlemm's canal microstent, similarly demonstrated a significantly greater proportion of stented eyes achieving 20% or more unmedicated IOP reduction versus phacoemulsification alone [23]. The COMPASS trial evaluated a supraciliary microstent and likewise found superior IOP and medication reduction at two years, though this device class was later withdrawn from several markets over longer-term endothelial safety signals [24]. Fea and colleagues, comparing a second-generation trabecular bypass device against topical therapy, found comparable IOP control with less dependence on chronic medication [25]. Table 2 compares the design and headline outcomes of these trials.

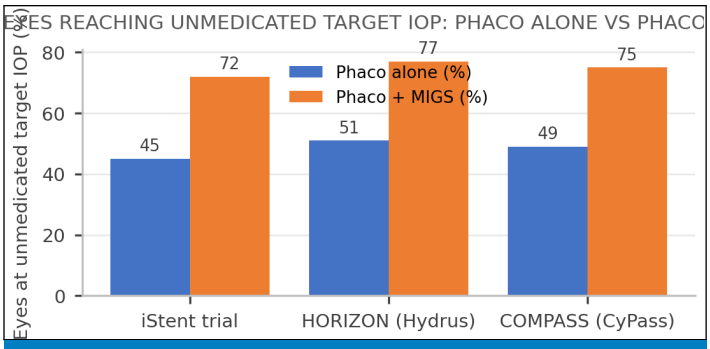


Figure 2: Proportion of eyes reaching unmedicated target intraocular pressure at one to two years, phacoemulsification alone versus combined phacoemulsification with a micro-invasive glaucoma surgery device, across three pivotal randomized trials [21,22,23].

Comparisons with trabeculectomy and filtration-based approaches

For patients whose disease is more advanced or unlikely to reach target with phacoemulsification or MIGS alone, filtration surgery remains a relevant comparator. Friedman and colleagues' evidence-based review concluded that combined phacotrabeculectomy achieves lower IOP than phacoemulsification alone but at the cost of a substantially higher complication rate, framing the choice as an individualized tradeoff [26]. Husain and colleagues showed that cataract surgery in an eye with a pre-existing functioning trabeculectomy carries a meaningful risk of subsequent bleb failure, with a significant proportion of eyes requiring resumed medication or further surgery [27]. The Tube Versus Trabeculectomy Study, reported by Gedde and colleagues, included eyes with prior cataract surgery and found comparable long-term IOP control between tube shunts and trabeculectomy at five years, a durability benchmark against which phaco-MIGS outcomes are increasingly compared [28]. Tham and colleagues, in angle-closure glaucoma, found phacoemulsification alone achieved IOP control comparable to trabeculectomy in selected eyes, reinforcing that lens removal's mechanism is angle-configuration dependent [29].

Table 2: Design and headline outcomes of pivotal combined phacoemulsification-MIGS trials compared with filtration-based benchmarks [21,23,24,28].

Trial	Comparison	Duration	Headline finding
[21]	Trabecular micro-bypass stent + phaco vs phaco alone	12 months	Higher proportion reaching unmedicated target IOP with stent
[23]	Schlemm's canal microstent + phaco vs phaco alone	12 months	Greater proportion with 20% or more unmedicated IOP reduction
[24]	Supraciliary microstent + phaco vs phaco alone	24 months	Superior IOP/medication reduction; later safety withdrawal
[28]	Tube shunt vs trabeculectomy	5 years	Comparable long-term IOP control between filtration approaches

Glaucoma progression, visual field stability, and long-term registry data

Beyond IOP as an intermediate outcome, several major glaucoma treatment trials have reported on cataract extraction and its downstream relationship to disease progression. The Early Manifest Glaucoma Trial demonstrated that IOP reduction of any origin reduces the risk of visual field progression, establishing the pressure-progression relationship underlying the

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rationale for a phacoemulsification-related benefit [30,31]. The Collaborative Initial Glaucoma Treatment Study, analyzed by Musch and colleagues, found cataract extraction was associated with a transient improvement in visual field indices attributable partly to reduced media opacity and partly to the accompanying IOP reduction, complicating interpretation of perioperative field trends [32]. The Advanced Glaucoma Intervention Study established that eyes with consistently low, well-controlled IOP had substantially less field deterioration than eyes with fluctuating or elevated pressure, a benchmark against which the more modest gains from phacoemulsification alone must be judged [33]. Kass and colleagues' Ocular Hypertension Treatment Study established that pharmacologic IOP reduction delays or prevents conversion to POAG, and the same cohort later provided the data Mansberger and colleagues used to isolate cataract extraction's additional IOP effect [34,13]. Coleman and Lum, summarizing registry experience, noted real-world outcomes broadly mirror trial-derived estimates, though with wider variation in technique and medication adjustment [35]. Brubaker's classic discussion of the delayed functional consequences of glaucomatous damage underscores why long observation intervals are required before any IOP-lowering intervention can be judged to have altered disease trajectory [36].

4. Discussion

The weight of the evidence supports a real, if modest, IOP-lowering effect of phacoemulsification in POAG eyes, larger than in nonglaucomatous eyes, larger with higher baseline pressure or narrower angles, and durable to five years in several cohorts [9,10,12]. The anatomic mechanism, anterior chamber deepening and trabecular meshwork unloading after removing the aging, thickening lens, is supported by direct imaging and explains why the effect scales with baseline angle narrowness rather than occurring uniformly [3,4,19]. Patients with wide angles and well-controlled baseline pressure should not be counseled to expect a large benefit from cataract surgery alone, whereas those with narrower angles, elevated baseline pressure, or pseudoexfoliation are more plausible candidates for meaningful medication reduction [20,16].

The evidence has moved fastest in combined phacoemulsification-MIGS surgery, where randomized trials of trabecular bypass stents and Schlemm's canal microstents have consistently shown superior IOP and medication-burden outcomes versus phacoemulsification alone in mild-to-moderate POAG [21,22,23]. These trials offer a lower-risk adjunct for patients who previously faced a choice between a smaller benefit from phacoemulsification alone or the higher complication burden of phacotrabeculectomy [26]. The supraciliary microstent experience is a useful caution: strong efficacy data from COMPASS were followed by longer-term safety concerns leading to withdrawal, a reminder that two-year efficacy signals do not by themselves establish long-term risk-benefit [24].

For patients with an existing functioning trabeculectomy, the evidence argues for caution around subsequent cataract surgery, since many eyes experience bleb dysfunction and rebound IOP elevation that can erode the original benefit [27]. Together with AGIS and EMGT data showing that even modest sustained IOP elevation accelerates field loss, this supports close postoperative surveillance rather than assuming cataract removal is uniformly pressure-neutral [33,30,27]. The transient field improvement in CIGTS is a reminder that clinicians should be cautious attributing postoperative field changes purely to IOP, since reduced media opacity confounds early perimetry [32].

Limitations qualify this synthesis: the literature is heterogeneous in technique, severity definitions, and follow-up duration, and randomized MIGS trials are largely restricted to mild-to-moderate disease. Registry data offer broader generalizability but less certainty about confounding [35]. Given the growing global burden of

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glaucoma and rising cataract surgical volume in aging populations, continued long-term follow-up and head-to-head device comparisons will be needed to refine which POAG patients benefit most from each strategy [1,2].

5. Conclusion

Phacoemulsification cataract surgery produces a real, angle-configuration-dependent reduction in intraocular pressure in patients with primary open-angle glaucoma that exceeds the effect seen in nonglaucomatous eyes, and this benefit is substantially amplified when phacoemulsification is combined with a micro-invasive glaucoma surgery device, as multiple randomized trials over the past decade have now demonstrated [21,23,22]. The clinical implication is that surgical planning for POAG patients presenting for cataract surgery should be individualized around baseline pressure, angle configuration, disease severity, and prior filtration surgery status, rather than treated as a uniform decision, and that postoperative IOP surveillance remains essential regardless of which surgical strategy is chosen, since the pressure-progression relationship established by the major glaucoma treatment trials continues to govern long-term visual field outcomes after any of these procedures [33,30].

6. Conflicts of Interest

The authors declare no conflicts of interest relevant to this manuscript.

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