Impact of Preoperative Factors on Intraocular Pressure Following Phacoemulsification in Acute Primary Angle-Closure Glaucoma

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ABSTRACT

Purpose: We aim to evaluate the follow-up outcomes of phacoemulsification inpatients who presented with acute primary angle-closure glaucoma (PACG) and to identify factors influencing the final intraocular pressure (IOP) levels in these patients.

Materials and Methods: Patients diagnosed with acute PACG with an initial IOP ≥ 40 mmHg and no secondary ocular conditions who underwent phacoemulsification were retrospectively reviewed. Surgical success was defined as IOP levels ranging between 5 and 22 mm Hg at the final postoperative visit, regardless of topical treatment.

Results: The study included 36 eyes of 32 patients with a mean age of 63±10 (37–91) years and a mean follow-up duration of 21.8±15.8 months. Postoperative IOP at the final visit was significantly lower compared to preoperative levels [14 (6–44) mm Hg vs. 44.5 (40–58) mm Hg, P<0.001]. Additionally, postoperative best-corrected visual acuity significantly improved compared to preoperative values [0.5 (0.1–3.0) LogMAR vs. 1.3 (0.2–2.7) LogMAR, P<0.001]. When comparing preoperative and postoperative IOP levels between genders, no significant differences were observed (P>0.05), and preoperative laser peripheral iridotomy (LPI) also did not affect either preoperative or postoperative IOP levels (P>0.05). Surgical complications occurred in 22.2% of cases, with a surgical success rate of 88.9%. Trabeculectomy was required in two eyes, transscleral diode laser cyclophotocoagulation in one, and blindness occurred in another.

Conclusion: Phacoemulsification surgery for treating acute PACG provides both rapid and effective IOP reduction and improved visual acuity. IOP levels and LPI do not appear to influence surgical success in acute cases.

Keywords: Acute, Intraocular pressure, Laser peripheral iridotomy, Phacoemulsification, Primary angle-closure glaucoma

INTRODUCTION

Glaucoma is the second most common cause of blindness around the world, with the number of affected individuals projected to reach 79.6 million by 2020.[1] Primary angle-closure glaucoma (PACG) is a significant subtype of glaucoma, with its prevalence increasing with age and being more common among women.[2] PACG is particularly widespread in certain populations and is a common ocular condition in Asia.[3] In a study, among Chinese individuals with glaucoma, PACG accounts for 44.4% of cases.[4]

Previous studies demonstrated that phacoemulsification combined with intraocular lens (IOL) implantation leads to a reduction in intraocular pressure (IOP) in both glaucoma and non-glaucoma patients.[5,6] However, the extent of IOP reduction varies based on the type of glaucoma and the duration of follow-up. Notably, patients with PACG experience a more significant decrease in IOP and a reduction in

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the need for antiglaucoma medications compared to those with primary open-angle glaucoma (POAG) following cataract surgery.[7]

Laser peripheral iridotomy (LPI) is the established management for PACG.[8] By employing a neodymium-doped yttrium aluminum garnet (Nd: YAG) laser, or an argon laser, a small hole is formed in the peripheral iris. This opening serves as a different route for aqueous humor to flow from the posterior chamber to the anterior chamber, reducing the pressure gradient. At the same time, it helps resolve pupillary block and promotes the maintenance of a widened iridocorneal angle.[9] While the initial treatment proves ineffective, filtering surgery is recommended; however, this procedure carries a high risk of shallow anterior chamber, hypotony, choroidal detachment, and malignant glaucoma.[10]

Additionally, phacoemulsification has proven effective in lowering IOP in angle-closure glaucoma (ACG) by deepening the angle through an increase in anterior chamber width. Villavicencio et al. found that combined treatment with phacoemulsification, viscogoniosynechialysis, and endocyclophotocoagulation was safe and effective in lowering IOP in chronic ACG.[11] Another study observed a 30% reduction in IOP in chronic ACG and a 71% reduction in acute ACG, accompanied by a substantial decrease in the use of glaucoma medications.[12]

A study investigating factors that predict postoperative IOP following cataract operation found that, in PACG, the success rate was notably higher when the highest preoperative IOP was below 42 mmHg, fewer preoperative antiglaucoma medications were required, or the extent of peripheral anterior synechiae was less than 4 clock hours.[13]

However, another report showed that cataract surgery was effective for IOP control in PACG regardless of the preoperative IOP peak, number of antiglaucoma medications, and the area of peripheral anterior synechiae at 36 months after surgery.[14]

We aimed to evaluate the follow-up outcomes of phacoemulsification surgery in patients with acute PACG and the preoperative factors affecting the final IOP levels, including investigating whether the application of surgical LPI affected the final IOP.

METHODS

Patients

All participants provided written informed consent following the Declaration of Helsinki, and the study received ethical approval from our hospital's ethics committee (number: 2025/010.99/13.8). In this retrospective study, patients who presented to the glaucoma unit of Kartal Dr. Lutfi Kirdar City Hospital between January 2020 and September 2024, were diagnosed with acute PACG, and received systemic or topical medical treatment, were included. Patients with PACG who had an initial IOP ≥ 40 mmHg were retrospectively screened, and those who could not achieve IOP control with topical antiglaucoma drops and systemic medical treatment (oral acetazolamide and 300 cc of 20 % intravenous mannitol) and underwent phacoemulsification surgery within one week were included in the study. Patients were divided according to the application of LPI before phacoemulsification surgery.

The study included only patients without secondary ocular conditions that could lead to elevated intraocular pressure. Patients with no posterior synechiae on biomicroscopic examination were included in the study. Those with secondary angle closure were excluded. Exclusion criteria encompassed systemic diseases such as uncontrolled diabetes mellitus and untreated hypertension, cardiac, neurological, rheumatologically, or hematological diseases. Additionally, patients with any intraocular pathology, including ocular trauma, previous eye surgery, active or chronic uveitis, retinal diseases, or a history of optic neuritis, were excluded. Patients requiring core vitrectomy due to IOP elevation during phacoemulsification surgery were also excluded from the study.

A detailed ocular examination was performed to establish a differential diagnosis and rule out secondary glaucoma causes. Best-corrected visual acuity (BCVA), biomicroscopic evaluation, and IOP measurement using a Goldmann applanation tonometer were conducted. If visible, gonioscopic examinations were conducted using a four-mirror Posner-style gonio lens (G-4; Volk Optical, Mentor, Ohio, USA). In cases where the fundus was visible, dilated fundus examinations were performed to assess the optic nerve head cup-to-disc (c/d) ratio, and peripapillary retinal nerve fiber layer (RNFL) analysis was conducted using optical coherence tomography (Triton DRI, Topcon, Tokyo, Ja-

pan). For cases where the fundus could not be visualized, orbital ultrasonography was used to exclude secondary causes.

Patient's follow-up duration, and preoperative and postoperative number of glaucoma medications were determined based on the patients' last follow-up examination. Surgical success was defined as IOP levels ranging between 5 and 22 mm Hg at the final postoperative visit, regardless of topical treatment. The relationships between preoperative and postoperative IOP levels were examined. Additionally, the effect of patients' age, gender, preoperative IOP levels, and history of LPI on surgical success following phacoemulsification was investigated.

Laser peripheral iridotomy

Among patients presenting with acute PACG, LPI was performed before phacoemulsification in 16 eyes whose corneal edema had improved sufficiently to allow LPI, based on the surgeon's discretion. LPI was performed using 1–15 shots at 3.2–3.6 mJ, targeting the 10 o'clock or 2 o'clock positions, with an Nd: YAG laser (Visulas YAG III, Carl Zeiss, Meditec AG, Germany) at a wavelength of 1064 nm, under topical anesthesia and with the assistance of a contact iridotomy lens (Volk Iridectomy Lens, Volk Optical, Mentor, Ohio, USA). Topical dexamethasone 0.1% (Maxidex, Alcon, Puurs, Belgium) was initiated four times daily.

Phacoemulsification with posterior chamber intraocular lens implantation

Patients who underwent phacoemulsification surgery within one week of the acute attack were included in the study. Patients underwent phacoemulsification with posterior chamber IOL implantation under sub-Tenon's anesthesia by two surgeons (FISD, SS). A 2.8 mm blade (2.8 mm Knife Angled, Teknomek Medical, Tekirdag, Turkey) was used to create a clear corneal incision in the superior side, and the anterior chamber was filled with 3% sodium hyaluronate (Hyotek, Teknomek Medical, Tekirdag, Turkey). A continuous curvilinear capsulorhexis was performed, followed by nucleus hydrodissection. Phacoemulsification was conducted with a Stellaris system (Bausch & Lomb, Rochester, NY, USA) using the stop-and-chop technique to segment and remove the nucleus. Residual cortical material was aspirated using a bimanual approach, and the capsular bag was prepared with viscoelastic material. A foldable, mono-focal, hydrophobic surface, acrylic IOL (ALSIOL, Alsanza, Pfullingen, Germany) was inserted into the capsular bag. Afterward, the viscoelastic substance was thoroughly removed by irrigation and aspiration. Balanced saline solution was used to reform the anterior chamber, and the corneal incisions, including side ports, were hydrated and left unsutured. After the procedure, 1 mg/0.1 mL cefuroxime (Cefeye 50 mg, Deva, Istanbul, Turkey) was administered intracamerally as a prophylactic measure. No additional agents, such as miotics or anesthetics, were utilized during the surgery. Posterior capsule rupture occurred in a total of five patients. Three-piece IOL (Acrysof, MA60AC, Alcon, USA) was implanted in the sulcus of three of these patients, while the other two were left aphakic.

Postoperatively, patients were instructed to use topical 0.5 % moxifloxacin hydrochloride (Moxai, Abdi Ibrahim, Istanbul, Turkey) six times daily for two weeks. Additionally, they were prescribed topical dexamethasone 0.1 % (Maxidex, Alcon, Puurs, Belgium) to be applied six times daily for the first week, followed by a gradual taper over the next three weeks.

Statistical Analyses

All analyses were conducted using SPSS software version 24 (IBM Corp., Armonk, NY, USA). A P-value of less than 0.05 was considered statistically significant. The Shapiro-Wilk test was used to assess whether the data followed a normal distribution. The Wilcoxon signed-rank test was applied to compare preoperative and postoperative data. Categorical variables were analyzed using the Chi-square test. The comparison of data based on the presence of preoperative LPI application or gender was conducted using the non-parametric Mann–Whitney U test. Spearman's rank correlation test was used to perform the correlation analysis. A multivariate linear regression analysis was performed to identify independent predictors of postoperative IOP. The statistical significance of each regression coefficient was evaluated using the *t*-test, while overall model significance was assessed using the *F*-test.

RESULTS

Thirty-six eyes (17 right, 19 left) of 32 patients (21 females, 11 males) with a mean age of 63±10 (37–91) years were included in the study. The mean follow-up period was 21.8 ± 15.8 months. Besides, patient characteristics such

as c/d ratio [0.6 (0.3–0.9)], peripapillary RNFL thickness [73 (45-91) µm], and the presence of preoperative LPI (16 eyes) are detailed in Table 1.

At the final follow-up, postoperative IOP levels were markedly reduced compared to preoperative values [14 (6–44) mm Hg vs. 44.5 (40–58) mm Hg, $P<0.001$] (Figure). The mean IOP reduction was calculated as 32 ± 8.6 mmHg (68.2 % ± 12.0). Furthermore, postoperative BCVA showed a significant improvement over preoperative measurements [0.5 (0.1–3.0) LogMAR vs. 1.3 (0.2–2.7) LogMAR, $P<0.001$]. The number of antiglaucoma medications required postoperatively [0 (0–4)] also demonstrated a significant decline compared to preoperative [4 (1–4)] levels ($P<0.001$) (Table 2).

Preoperative and postoperative IOP showed no significant difference according to gender ($P>0.05$). Similarly, no significant difference was found in preoperative and final postoperative IOP according to LPI history ($P>0.05$). No correlation was found between the preoperative and final postoperative IOP levels, RNLF thickness, and c/d ratio ($P>0.05$). The surgical success rate, regardless of topical treatment, was 88.9%. No significant difference was found between the application of LPI, patients' gender, and surgical success ($P>0.05$). Similarly, no effect of the patient's age or preoperative IOP levels on surgical success was found ($P>0.05$). Additionally, in the multivariate linear regression analysis adjusting for age, gender, preoperative IOP, and the presence of prior LPI, only gender was significantly associated with postoperative IOP (B = 6.698, $P = 0.019$), with higher IOP values observed in males compared to females. Age ($P = 0.993$), preoperative IOP ($P = 0.138$), and the presence of prior LPI (P = 0.269), were not significantly associated with postoperative IOP. The model explained 25% of the variance in postoperative IOP ($R^2 = 0.250$, adjusted $R^2 = 0.153$), and the overall model approached but did not reach statistical significance ($F = 2.583$, $P = 0.056$).

Surgical complications occurred in 22.2% of cases. Posterior capsule rupture occurred in a total of five patients (13.9%). Three patients underwent sulcus IOL implantation, and two of them required trabeculectomy. In one patient, Descemet's membrane detachment was observed at the main corneal incision site, while another patient required penetrating keratoplasty due to postoperative pseudophakic bullous keratopathy. Additionally, blindness developed in one patient, and transscleral diode laser cyclophotocoagulation was performed six months after phacoemulsification to reduce IOP (Table 3).

Table 1 *Patients and Eyes Characteristics*

	32 patients, 36 eyes
Age *(years), [mean ± SD (min-max)]*	63±10 (37–91)
Eye (right/ left)	17/19
Laser peripheral iridotomy *(yes/no)*	16/20
Cup-to-disc ratio*	0.6 (0.3–0.9)
Global peripapillary RNFL thickness**(µm)*	73 (45-91)
Follow-up duration *(months), (mean ± SD)*	21.8 ± 15.8

Max maximum, *Min* minimum, *RNFL* Retinal nerve fiber analysis, *SD* standard deviation
*Median (minimum-maximum)

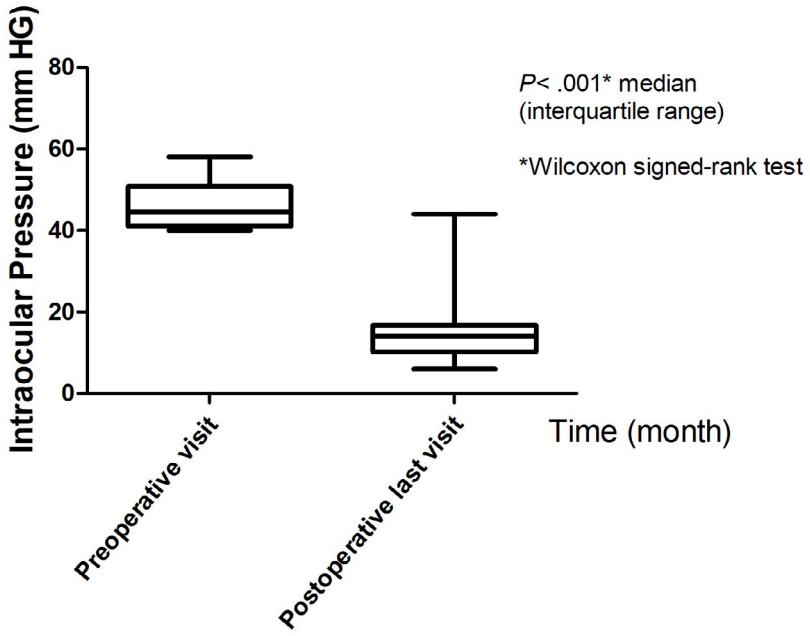

Figure 1: *Preoperative and Postoperative İntracular Pressure Changings After Phacoemulsification İn Acute Primary Angle Colosure Glaucoma*

Table 2 *Preoperative and Postoperative Eye Characteristics after Phacoemulsification in Patients with Acute Primary Angle-Closure Glaucoma*†

	Preoperative	**Postoperative**	***P****
BCVA *(LogMAR)*	1.3 (0.2–2.7) (2.5)	0.5 (0.1–3.0) (2.9)	**<,001**
IOP *(mmHg)*	44.5 (40–58) (18)	14 (6–44) (38)	**<,001**
Number of antiglaucoma medications	4 (1-4) (3)	0 (0–4) (4)	**<,001**

BCVA Best corrected visual acuity, *IOP* intraocular pressure
* Wilcoxon signed ranks test
† Median (minimum-maximum) (interquartile ranges)

Table 3 *Surgical Complications During and After Phacoemulsification in Patients with Acute Primary Angle-Closure Glaucoma*

	Number of eyes (%)*
Posterior Capsule Rupture	5 (13.9%)
Sulcus IOL Implantation	3
Aphakia	2
Pseudophakic Bullous Keratopathy	1
IOL capture and Descemet's Membrane Detachment	1
Blindness	1

IOL intraocular lens
* A total of 8 eyes (22.2%)

DISCUSSION

In cases of acute PACG, postoperative IOP following phacoemulsification surgery was found to be lower compared to preoperative values. Preoperative IOP, age, gender, and prior LPI application were not found to have a significant effect on surgical success. No correlation was detected between preoperative and postoperative IOP. Additionally, although the regression model did not reach overall statistical significance, gender remained a significant predictor after adjusting for other covariates.

The pathogenesis of PACG may involve four distinct mechanisms: the pupillary block, abnormalities in the ciliary body (plateau iris), lens-related factors, and posterior segment anomalies such as aqueous misdirection.[15] The management of PACG typically starts with efforts to reopen the drainage angle, primarily through LPI.[16] Besides, numerous studies have shown that LPI alone may not be sufficient to achieve adequate IOP reduction, and disease progression can occur.[17,18] Consequently, medical or surgical interventions may be necessary. Studies have shown that phacoemulsification for lens extraction effectively lowers IOP in patients with PACG who have poorly controlled IOP.[7,19,20] Phacoemulsification can deepen the anterior chamber, resolve pupillary block, and address lens-related factors.[21,18] Therefore, phacoemulsification surgery may lower IOP and halt glaucoma progression[22,23] unless there is significant synechial angle closure or extensive trabecular damage.

In addition, efforts have been made to define practical gonioscopic examination methods for differentiating lens-related conditions. In the PACGA study found that in eyes where the ciliary body processes were visible on gonioscopy, the anterior chamber depth and axial length were shorter, while lens thickness, lens vault, and the lens–axial length factor were statistically greater. It was suggested that the gonioscopic visualization of ciliary processes may indicate that anterior segment crowding, particularly the lens factor, could be the underlying mechanism contributing to primary angle closure (PAC).[24] Another study showed that higher preoperative IOP was associated with a greater IOP reduction in both the phacoemulsification and LPI groups, regardless of whether the ciliary body process was visible on gonioscopic examination in eyes with PACG.[25]

Although the primary treatment for angle closure involves LPI combined with glaucoma medications in cases of elevated IOP, LPI only resolves the pupillary block mechanism and does not significantly influence other factors, such as a crowded anterior chamber.[26,27] A study also mentioned that early lens extraction may result in better outcomes for IOP control compared to initial LPI.[9] In a previous study investigating the effect of early phacoemulsification in acute primary angle closure, a total of 47 eyes (24 eyes in Group A and 23 eyes in Group B) underwent surgery. Our study includes a total of 36 eyes that underwent phacoemulsification. Although our sample size was smaller, our findings appear comparable and remain relevant despite the smaller cohort size.[28]

As part of the preparation for phacoemulsification surgery, we aimed to perform a patent LPI on sixteen eyes with acute PACG, in which corneal edema had partially subsided, allowing the procedure to be carried out. No significant effect of LPI on the postoperative IOP outcomes of phacoemulsification surgery was observed. Additionally, a study observed certain changes in the anterior chamber angles of patients who underwent LPI.[29] However, due to the retrospective nature of our study, the pre-phacoemulsification status in the groups with and without LPI could not be assessed. A study demonstrated that phacoemulsification surgery led to a 20.7% reduction in IOP at five years in patients with PACG and was superior to phacotrabeculectomy in terms of postoperative complications during the same follow-up period.[30] Additionally, a review indicated that in patients with chronic PACG and clear crystalline lenses, lens extraction had an advantage over LPI after three years of follow-up.[31] A meta-analysis revealed that while both lens extraction and LPI effectively manage PACG, their impact on IOP reduction did not differ significantly.[32]

In the EAGLE study, it was demonstrated that higher preoperative IOP levels in eyes with ACG were associated with better IOP control outcomes following early lens extraction compared to LPI after initial medical management.[33] Similarly, in our study, phacoemulsification effectively reduced

IOP (68.2 ± 12.0 %) in eyes with a preoperative IOP of 44.5 (40–58) mm Hg, consistent with the literature.[12] A randomized controlled trial also demonstrated that patients with PACG or PAC are ten times more likely to achieve and maintain good IOP control without requiring medications when treated with clear lens extraction compared to LPI.[34] Likewise, there was a significant reduction in the number of antiglaucoma medications in the postoperative period compared to preoperative values in our study (P<0.001). Additionally, preoperative BCVA showed a significant improvement in the postoperative period, consistent with the literature.[25] Although a previous study found the posterior capsule rupture rate to be 1.83%,[35] our study reported a higher rate of 13.9% in eyes with acute PACG compared to the literature. This situation may be due to glaucoma being a risk factor for posterior capsule rupture.[36,37] Furthermore, according to the risk model reported in a previous study, when the risk for posterior capsule rupture in our report was estimated—given that most patients were glaucoma patients over the age of 60, many with zonular weakness and poor fundus visualization—the calculated odds ratio for this high-risk profile was approximately 12.13, which is comparable to our findings, corresponding to a predicted probability of posterior capsule rupture or vitreous loss of around 10%.[37]The current study has certain limitations, including its retrospective design and small sample size. The small sample size and the resulting lack of statistical power in subgroup comparisons involving LPI represent significant limitations of the study. Since the study is retrospective, preoperative gonioscopic angle status data were not available; furthermore, it is presumed that gonioscopic angle assessment was likely not possible due to corneal edema. However, in postoperative gonioscopic examinations, no peripheral anterior synechiae were observed in the angle, leading to the presumption that appositional closure was the primary mechanism involved. Additionally, due to the lack of data on important angle parameters, such as the presence of preoperative peripheral anterior synechiae, as well as biometric measurements like anterior chamber depth, axial length, lens-related parameters, cataract grades, and ultrasound energies used in phacoemulsification surgery, the findings cannot be extended to all eyes with PACG. Since the study included patients with acute PACG, visual field testing could not be performed during the glaucoma crisis. Moreover, data on visual field or optic nerve progression, including changes in RNFL thickness and c/d ratio before and after surgery, were not collected in this study, which represents another limitation. Due to the limited number of participants, glaucoma grading could not be applied, and comparisons with other glaucoma surgeries or control groups could not be made. Preoperative IOP, age, gender, and prior LPI application were not found to have a significant effect on surgical success in this study. However, given the limited sample size and statistical power, these findings should be interpreted with caution, and further studies with larger cohorts are warranted to confirm these results. In conclusion, phacoemulsification was found to be effective in reducing IOP in cases of acute PACG, regardless of the presence or absence of a history of LPI. This effectiveness is likely attributed to the multifaceted benefits of phacoemulsification in managing PACG.

REFERENCES

1. Quigley HA, Broman AT. The number of people with glaucoma worldwide in 2010 and 2020. Br J Ophthalmol. 2006;90(3):262-7.
2. Zhang N, Wang J, Chen B, et al. Prevalence of Primary Angle Closure Glaucoma in the Last 20 Years: A Meta-Analysis and Systematic Review. Front Med (Lausanne). 2020;7:624179.
3. Aung T, Friedman DS, Chew PT, et al. Long-term outcomes in asians after acute primary angle closure. Ophthalmology. 2004;111(8):1464-9.
4. Liu Y, Yao B, Chen X, et al. Glaucoma in rural China (the Rural Epidemiology for Glaucoma in China (REG-China)): a national cross-sectional study. Br J Ophthalmol. 2023;107(10):1458-66.
5. Mathalone N, Hyams M, Neiman S, et al. Long-term intraocular pressure control after clear corneal phacoemulsification in glaucoma patients. J Cataract Refract Surg. 2005;31(3):479-83.
6. Shingleton BJ, Gamell LS, O'Donoghue MW, et al. Long-term changes in intraocular pressure after clear corneal phacoemulsification: normal patients versus glaucoma suspect and glaucoma patients. J Cataract Refract Surg. 1999;25(7):885-90.
7. Hayashi K, Hayashi H, Nakao F, et al. Effect of cataract surgery on intraocular pressure control in glaucoma patients. J Cataract Refract Surg. 2001;27(11):1779-86.

8. Prum BE, Jr., Herndon LW, Jr., Moroi SE, et al. Primary Angle Closure Preferred Practice Pattern((R)) Guidelines. Ophthalmology. 2016;123(1):P1-P40.
9. Ong AY, McCann P, Perera SA, et al. Lens extraction versus laser peripheral iridotomy for acute primary angle closure. Cochrane Database Syst Rev. 2023;3(3):CD015116.
10. Gedde SJ, Schiffman JC, Feuer WJ, et al. Treatment outcomes in the Tube Versus Trabeculectomy (TVT) study after five years of follow-up. Am J Ophthalmol. 2012;153(5):789-803 e2.
11. Izquierdo Villavicencio JC, Agudelo Arbelaez N, Lastra BR, et al. Primary Outcomes of Patients with Chronic Angle-Closure Glaucoma Treated with Combined Phacoemulsification, Viscogoniosynechialysis, and Endocyclophotocoagulation. J Ophthalmol. 2019;2019:6378489.
12. Chen PP, Lin SC, Junk AK, et al. The Effect of Phacoemulsification on Intraocular Pressure in Glaucoma Patients: A Report by the American Academy of Ophthalmology. Ophthalmology. 2015;122(7):1294-307.
13. Lee YH, Yun YM, Kim SH, et al. Factors that influence intraocular pressure after cataract surgery in primary glaucoma. Can J Ophthalmol. 2009;44(6):705-10.
14. Kim WJ, Kim JM, Kim KN, et al. Effect of Preoperative Factor on Intraocular Pressure after Phacoemulsification in Primary Open-angle Glaucoma and Primary Angle-closure Glaucoma. Korean J Ophthalmol. 2019;33(4):303-14.
15. European Glaucoma Society Terminology and Guidelines for Glaucoma, 5th Edition. Br J Ophthalmol. 2021;105(Suppl 1):1-169.
16. Tham CC, Kwong YY, Baig N, et al. Phacoemulsification versus trabeculectomy in medically uncontrolled chronic angle-closure glaucoma without cataract. Ophthalmology. 2013;120(1):62-7.
17. Ang LP, Aung T, Chew PT. Acute primary angle closure in an Asian population: long-term outcome of the fellow eye after prophylactic laser peripheral iridotomy. Ophthalmology. 2000;107(11):2092-6.
18. Nonaka A, Kondo T, Kikuchi M, et al. Cataract surgery for residual angle closure after peripheral laser iridotomy. Ophthalmology. 2005;112(6):974-9.
19. Jacobi PC, Dietlein TS, Luke C, et al. Primary phacoemulsification and intraocular lens implantation for acute angle-closure glaucoma. Ophthalmology. 2002;109(9):1597-603.
20. Kubota T, Toguri I, Onizuka N, et al. Phacoemulsification and intraocular lens implantation for angle closure glaucoma after the relief of pupillary block. Ophthalmologica. 2003;217(5):325-8.
21. Dada T, Rathi A, Angmo D, et al. Clinical outcomes of clear lens extraction in eyes with primary angle closure. J Cataract Refract Surg. 2015;41(7):1470-7.
22. Spaeth GL. The clinical outcomes of cataract extraction by phacoemulsification in eyes with primary angle-closure glaucoma (PACG) and co-existing cataract: a prospective case series. J Glaucoma. 2006;15(4):346; author reply
23. Dias-Santos A, Ferreira J, Abegao Pinto L, et al. Phacoemulsification versus peripheral iridotomy in the management of chronic primary angle closure: long-term follow-up. Int Ophthalmol. 2015;35(2):173-8.
24. Tekcan H, Mangan MS, Celik G, et al. Lens factor as an underlying mechanism in primary angle closure with gonioscopically-visualized ciliary body processes. Jpn J Ophthalmol. 2023;67(6):678-84.
25. Un Y, Imamoglu S, Tekcan H, et al. Factors defining the intraocular pressure-lowering effect of phacoemulsification and laser peripheral iridotomy in patients with primary angle closure : Factors defining IOP lowering effect of PE and LPI in PAC. Lasers Med Sci. 2023;38(1):100.
26. Pose-Bazarra S, Azuara-Blanco A. Role of lens extraction and laser peripheral iridotomy in treatment of glaucoma. Curr Opin Ophthalmol. 2018;29(1):96-9.
27. Xu BY, Friedman DS, Foster PJ, et al. Anatomic Changes and Predictors of Angle Widening after Laser Peripheral Iridotomy: The Zhongshan Angle Closure Prevention Trial. Ophthalmology. 2021;128(8):1161-8.
28. Lin YH, Wu CH, Huang SM, et al. Early versus Delayed Phacoemulsification and Intraocular Lens Implantation for Acute Primary Angle-Closure. J Ophthalmol. 2020;2020:8319570.
29. Lim LS, Aung T, Husain R, et al. Acute primary angle closure: configuration of the drainage angle in the first year after laser peripheral iridotomy. Ophthalmology. 2004;111(8):1470-4.
30. Hansapinyo L, Choy BNK, Lai JSM, et al. Phacoemulsification Versus Phacotrabeculectomy in Primary Angle-closure Glaucoma With Cataract: Long-Term Clinical Outcomes. J Glaucoma. 2020;29(1):15-23.
31. Ong AY, Ng SM, Vedula SS, et al. Lens extraction for chronic angle-closure glaucoma. Cochrane Database Syst Rev. 2021;3(3):CD005555.
32. Sharif RK, Aljahdali FF, Aljabri HM, et al. Phacoemulsification versus Laser Peripheral Iridotomy for Treating Primary Angle Closure Glaucoma: A Systematic Review and Meta-Analysis. Clin Ophthalmol. 2024;18:1023-32.

33. Azuara-Blanco A, Burr J, Ramsay C, et al. Effectiveness of early lens extraction for the treatment of primary angle-closure glaucoma (EAGLE): a randomised controlled trial. Lancet. 2016;388(10052):1389-97.

34. Mitchell WG, Azuara-Blanco A, Foster PJ, et al. Predictors of long-term intraocular pressure control after lens extraction in primary angle closure glaucoma: results from the EAGLE trial. Br J Ophthalmol. 2023;107(8):1072-8.

35. Ti SE, Yang YN, Lang SS, et al. A 5-year audit of cataract surgery outcomes after posterior capsule rupture and risk factors affecting visual acuity. Am J Ophthalmol. 2014;157(1):180-5 e1.

36. Zetterberg M, Kugelberg M, Nilsson I, et al. A Composite Risk Score for Capsule Complications Based on Data from the Swedish National Cataract Register: Relation to Surgery Volumes. Ophthalmology. 2021;128(3):364-71.

37. Narendran N, Jaycock P, Johnston RL, et al. The Cataract National Dataset electronic multicentre audit of 55,567 operations: risk stratification for posterior capsule rupture and vitreous loss. Eye (Lond). 2009;23(1):31-7.