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Clinical Outcome of Patients with Glaucoma undergoing Peripheral Iridectomy and Phacoemulsification: Long-Term Follow-Up Case Series Study

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Purpose. *Primary angle-closure glaucoma (PACG) is a leading cause of irreversible blindness globally, with elevated intraocular pressure (IOP) as a critical risk factor. Surgical interventions, such as phacoemulsification (PE) with intraocular lens (IOL) implantation and peripheral iridectomy (PI), have shown efficacy in IOP control and visual restoration. This study evaluates the long-term clinical outcomes of PE and IOL combined with PI in PACG management.*

Material and Method. *A retrospective case series was conducted involving 13 PACG patients (22 eyes) who underwent PE and IOL or PE and IOL with PI between 2018 and 2023. Data were collected from medical records, including pre- and postoperative IOP and best corrected visual acuity (BCVA). Follow-up assessments were performed on Day 1, Month 1, Month 3, Month 6, and annually up to Year 4.*

Result. *Both surgical approaches effectively reduced intraocular pressure (IOP) and improved best corrected visual acuity (BCVA). The addition of PI showed a more consistent early postoperative IOP reduction (100% of eyes decreased from baseline to day 1 and month 6) and maintained lower IOP in the majority of cases over long-term follow-up. BCVA improved in all eyes except those with baseline no light perception (LP-), with the PE + PI group demonstrating greater and more sustained visual improvement. However, some cases in the PE-only group experienced IOP elevation or vision decline during follow-up.*

Conclusions. *PE and IOL, particularly when combined with PI, provides superiority in early IOP control and sustained BCVA gain. However, irreversible optic nerve damage at baseline remains a limiting factor for visual recovery.*

Key words:

visual acuity, intraocular pressure, angle-closure glaucoma, phacoemulsification, intraocular lens implantation, iridectomy

Introduction

Glaucoma is a group of optic neuropathies and a leading cause of blindness worldwide, contributing to the second-highest number of blindness cases globally [1]. The global burden of glaucoma continues to rise, with current epidemiological data showing it affects 3.54% of individuals aged 40 to 80 years, and it is projected to impact over 100 million people by 2040 [2]. Primary open-angle glaucoma (POAG) is particularly common, affecting approximately 57.5 million people globally, with a higher prevalence observed among Asian populations [3, 4]. The two most common forms, POAG and primary angle-closure glaucoma (PACG), carry substantial risks to vision, with PACG associated with a higher rate of blindness compared to POAG [4, 5].

Both POAG and PACG are characterized by the progressive, irreversible loss of optic nerve axons and retinal ganglion cells (RGCs), leading to significant visual impairment [5]. Key risk factors for glaucoma include age, family history, race, thin central corneal thickness (CCT), elevated intraocular pressure (IOP), and other systemic factors, such as hypertension, myopia, corticosteroid use, and obstructive sleep apnea [2, 6, 7]. Elevated IOP is a primary risk factor associated with optic nerve fiber damage, visual field defects, and an increased cup-to-disc ratio, as well as resistance to outflow through the trabecular meshwork (8,9). In POAG, increased drainage resistance in the trabecular meshwork occurs while the anterior chamber angle remains open. In PACG, pupillary block is the primary mechanism, where abnormal contact between the iris and lens leads to resistance of aqueous flow and results in iris bowing, obstructing the trabecular meshwork [10, 11].

Various treatment approaches for glaucoma have emerged, including pharmacologic therapies, laser interventions, and surgical options. Among these, surgical interventions such as phacoemulsification (PE) and intraocular lens (IOL) implantation have shown promise in effectively lowering IOP, particularly in PACG patients with coexisting cataracts [1, 12, 13]. Additionally, peripheral iridectomy (PI) has been effective in alleviating pupillary block, restoring physiological aqueous flow, and balancing pressures in the anterior and posterior chambers with minimal damage to ocular tissues [14, 15]. A meta-analysis of PE suggests its efficacy in reducing IOP, while a

10-year follow-up study supports its safety and effectiveness in PACG with cataracts [16, 17]. Recent findings also indicate that PI offers a more favorable safety profile than compound trabeculectomy [18]. However, there remains a need for long-term clinical studies to better understand these outcomes.

This case series aims to evaluate the long-term outcomes of glaucoma patients who underwent PE and IOL as well as PE combined with IOL and PI, focusing on IOP reduction and visual acuity preservation. These insights may help enhance clinical management strategies for glaucoma and improve patient outcomes.

Methods

Study Design

A single-center, retrospective, uncontrolled, non-randomized, consecutive case series on patients was conducted between 2018 and 2023. The data were collected based on patient's medical records from Sarila Husada Hospital Sragen. Ethical approval was obtained from the Institutional Review Board of Universitas Muhammadiyah Surakarta No. 5409/C.1/KEPK-FKUMS/XII/2024, and all procedures adhered to the Declaration of Helsinki.

Data collected included demographics, comorbidities, medication usage, pre- and post-operative IOP, and changes in visual acuity. Categorical variables were presented in tables. While continuous variables, such as IOP and Best Corrected Visual Acuity (BCVA), were represented as mean ± standard deviation (SD) in tables and graphs. IOP was measured preoperatively using a CT-80 Computerized Tonometer (Topcon®), with the normal range defined as 11-21 mmHg. Visual acuity was assessed using a Snellen chart by Nidek. Furthermore, various supportive examinations were also conducted to assess the necessity of surgery. Anterior segment examination was conducted using a Nidek slit lamp. For the purpose of accurate IOL power calculation, an immersion A-scan was employed to measure the eyeball axis length, corneal curvature, and anterior chamber depth.

Participant

Participants included 13 patients with a PACG necessitating surgery. Seven patients (13 eyes) underwent PE and IOL insertion surgery (later on referred to as patients 1-7A). All patients underwent surgery on both eyes, except for patient 5A, who underwent surgery only on the left eye. Six patients (9 eyes) underwent PE and IOL with PI surgery (later on referred to as patients 1-6B). Patient 1B underwent surgery only on the right eye, while patients 5B and 6B underwent surgery only on the left eye. The remaining patients underwent surgery on both eyes.

Inclusion criteria encompass patients with PACG who meet surgical indications, including acute attack with corneal edema, shallow anterior chamber depth (ACD), oval pupil with the size of >5 mm, and negative or delayed light reflex, intumescent or unevenly cloudy lens, and a difficult-to-assess fundus reflex. Patients with a history of ocular trauma, corneal abnormalities, or inadequate postoperative IOP control, as well as those requiring a second surgery, were excluded. All surgeries were conducted by the time inflammation (if any) has already resolved.

Outcome

The assessed primary outcomes were treatment efficacy, which in this study was described through IOP and BCVA. Follow-up evaluations on IOP and BCVA were performed at first visit (FV), Day of Surgery (DOS), Day 1 (D1), Month 1 (M1), Month 2 (M2), Month 3 (M3), Month 6 (M6), Month 9 (M9), Year 1 (Y1), Year 2 (Y2), Year 3 (Y3), and Year 4 (Y4) post surgery.

Surgical Procedure

All surgeries were conducted by a single ophthalmologist. Preoperative IOP-lowering medications were implemented in both surgical groups in order to reduce the IOP to less than 25 mmHg. Patients were given Acetazolamide (Glauseta®) 250 mg three times daily, Potassium Chloride tablets (KSR®) once daily, and Timolol Maleate 0.5% twice daily. Patients were also given postoperative care instructions including Tobramycin and Dexamethasone eyedrop (Bralifex®) six times daily on the affected eye, combined with oral Levofloxacin (LFX) 500mg three times daily for infection prevention, as well as oral Methylprednisolone (MP) 8mg twice daily for inflammation control. In several patients, addition of oral Cefixime 200mg twice daily, oral Acetazolamide, oral Potassium Chloride, and Prednisolone eyedrop (P-Pred®) maybe necessary. Regular follow-ups were also scheduled to monitor their IOP and visual function.

Phacoemulsification and Intraocular Lens

The procedure was performed using the femtosecond laser technology (LenSx®) Patients were positioned supine, and local anesthesia was administered with topical xylocaine and subconjunctival injections. A 2.75-mm clear corneal incision was created along with two paracenteses, allowing self-sealing without sutures. The anterior lens capsule was stained with trypan blue, rinsed with Ringer's lactate, and subsequently accessed by an ultrasonic phacoprobe. After hydro-dissection and hydro-delineation, the nucleus was rotated within the capsular bag to facilitate phacoemulsification using "divide and conquer," "stop and chop," and "direct chop" techniques. Following nucleus and cortical matter removal, a monofocal IOL (Neo Eye®) was implanted, and viscoelastic material was aspirated to prevent secondary glaucoma.

Peripheral Iridectomy

Under an operating microscope, the patient's eye was prepared with forceps, scissors, and a speculum. A segment of the peripheral iris was grasped with forceps and excised using Vannas scissors, creating an iridectomy opening. Post-procedure, carbachol and cefuroxime antibiotics were administered, followed by corneal hydration and antibiotic drops.

Case series

Of the 13 patients who underwent PE and IOL implantation surgery, 6 were female and 1 was male. The patients

Tabel 1. Patient's Characteristics

No	Sex	Age	Sign and Symptoms	Diagnosis	Comorbidity	Treatment (Post-Operative)
Patients underwent PE-IOL						
1A	M	65	Tired and blurred eyes both eyes	Acute Glaucoma OU	HT	Bralifex™ 6x1, LFX 3x1, MP 2x8mg, Glauseta 2x1, KSR 1x1, Cefixime 2x1
2A	F	86	Blurred vision in both eyes since one month ago	Acute Glaucoma OU	HT	Brafilex 6x1, LFX 3x1, MP 8 mg 2x1
3A	F	62	Blurred vision in both eyes since one week ago followed by swelling since the last three days, itchy and gritty in both eyes	Acute Glaucoma OU, Immature Cataract OU	-	Brafilex 6x1, LFX 3x1, MP 8 mg 2x1, Glauseta 3x1 , KSR 1x1, Ranitidin, Transamin
4A	F	69	Blurred vision both eyes since one week ago	Acute Glaucoma OU and Senile Cataract	HT	Brafilex 6x1, LFX 3x, MP 8 mg 2x1, Cendo P.-Pred™ 6x1
5A	F	61	Tired and blurred left eye	Acute Glaucoma OS	-	Cendo P-Pred 6x1, LFX 3x1, Glauseta 3x1, KSR 1x1, MP 8 mg 2x1
6A	F	50	Blurred vision both eyes	Acute Glaucoma OU, Senile Cataract OU	HT	Brafilex 6x1, LFX 3x1, MP 8 mg 2x1, Cenco P-Pred 6x1, Glauseta 3x250 mg, KSR 1x1,
7A	F	74	Tired eyes and blurred vision both eyss	Acute Glaucoma OU, Senile Cataract OU	HT, HHD	Bralifex 6x1, LFX 3x1, Cendo P-Pred 3x1
Patients Underwent PE IOL + Iridectomy						
1B	F	67	Sudden blurred vision, teary, redness on the right eye, and throbbing headache.	Acute Glaucoma OD	HT	Brafilex 6x1, LFX 3x1, MP 8 mg
2B	M	65	Blurred vision in both eyes	Acute Glaucoma OU	HT	Brafilex 6x1, LFX 3x1, MP 8 mg 2x1
3B	M	68	Blurred vision in both eyes	Acute Glaucoma OU	HT	Brafilex 6x1, LFX 3x1, MP 8 mg 2x1, Glauseta, KSR
4B	F	65	Sudden blurred vision both eyes and pain in the eyes	Acute Glaucoma OU	HT	Brafilex 6x1, LFX 3x, MP 8 mg 2x1, Cendo P- Pred 6x1
5B	F	70	Decreased vision since few months ago, pain in the eye and dizziness	Acute Glaucoma OS	-	Brafilex 6x1, LFX 3x, MP 8 mg 2x1, Cendo P- Pred 6x1
6B	F	65	Blurred vision in both eyes	Acute Glaucoma OS, Phacomorphic Glaukoma OD	HT	Brafilex 6x1, LFX 3x, MP 8 mg 2x1, Cendo P- Pred 6x1

Note : OU, both eyes; OS, left eye; OD, right-eye; HT, Hypertension; LFX, Levofloxacine; MP, Methylprednisone; HHD, Hypertensive Heart Disease

were 66.71 years old on average, with the youngest being 50 years old and the oldest being 86 years old. All patients showed up with the chief complaint of blurred vision. Meanwhile, five out of seven individuals had a history of hypertension (HT), a common comorbidity in PACG. Patient's characteristics as in demographics, comorbidities, and medication usage were all summarized in Table 1.

Intraocular Pressure

A decreasing trend in IOP was observed between FV and Y4 across four groups, as illustrated in Figure 1. However, throughout postoperative follow-ups, the dynamics of mean IOP in each group did not always decrease in a linear manner. But note that the following values are still within the normal range. As seen in Table 2, the PE and IOL (right eye) group showed an increase in mean IOP from 13.75 ± 5.31 mmHg (DOS) to 13.84 ± 3.32 (D1), 14.83 ± 5.07 (M1), 15.67 ± 4.46 (M6), and 16.00 ± 4.73 (Y1). As for the PE and IOL (left eye) group, mean IOP reduced from 21.86 ± 8.59 (DOS) to 17.57 ± 8.90 (D1), 13.86 ± 3.93 (M1), subsequently increased to 15.57 ± 6.35 (M6), and 15.86 ± 3.32 (Y1). Similarly, the PE and IOL-with PI (right eye) group showed a mean IOP reduction from 25.25 ± 3.30 (DOS) to 19.25 ± 4.20 (D1), 14.00 ± 2.16 (M1), 12.75 ± 2.21 (M6), and subsequently an in-

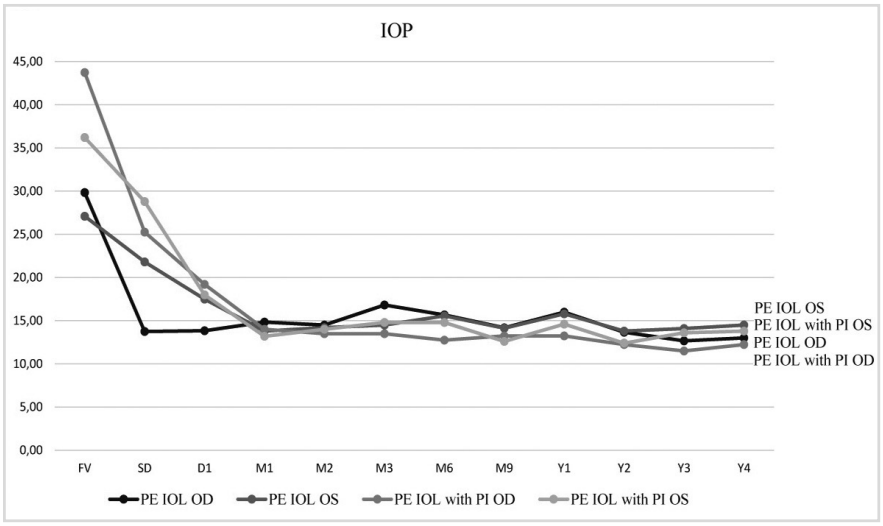

Figure 1. Dynamics of Intraocular Pressure Between Groups Over Long Period of Follow Ups

Note: Trend of IOP are presented in mmHg. PE, Phacoemulsification; IOL, intraocular lens; PI, peripheral iridectomy; OD, right eye; OS, left eye; FV, first visit; DOS, day of surgery; D1, day 1; M1, month 1; M2, month 2; M3, month 3; M6, month 6; M9, month 9; Y1, year 1; Y2, year 2; Y3, year 3; Y4, year 4.

crease to 13.25 ± 1.50 (Y1). The PE and IOL with PI (left eye) group showed a decrease in mean IOP from 28.80 ± 12.73 (DOS) to 18.00 ± 4.00 (D1), 13.20 ± 3.35 (M1), 14.80 ± 3.11 (M6), and 14.60 ± 2.51 (Y1).

Varying percentage of patients experiencing a decreased IOP from DOS to D1 and M6, as well as throughout long-term follow-up (Y1–Y4) were assessed between each group. During a period of DOS to D1, IOP reduction was seen in 4 of 6 eyes (66.7%) of the PE and IOL (right eye) group, 6 of 7 eyes (85.7%) of the PE and IOL (left eye) group, all 4 eyes (100%) of the PE and IOL with PI (right eye) group, and all 5 eyes (100%) of the PE and IOL with PI (left eye) group. As for comparison between DOS and M6, 5 of 6 eyes (83.3%) of the PE and IOL (right eye) group, 5 of 7 eyes (71.4%) of the PE and IOL (left eye) group, all 4 eyes (100%) of the PE and IOL with PI (right eye) group, and all 5 eyes (100%) of the PE and IOL with PI (left eye) group had IOP values in M6 remain lower or equal to their DOS level. Meanwhile, long-term trends from Y1 to Y4 revealed general stability or further IOP decline 5 of 6 eyes (83.3%) of the PE and IOL (right eye) group, 6 of 7 eyes (85.7%) of the PE and IOL (left eye) group, 3 of 4 eyes (75%) of the PE and IOL with PI (right eye) group, and 2 of 5 eyes (40%) of the PE and IOL with PI (left eye) group.

This indicates that in PE and IOL group there were still patients who experienced an increase in IOP from DOS to D1. There were also those whose IOP values in M6 remained higher than DOS, and there were those whose IOP increased during the long-term follow-up (Y1-Y4). But in contrast to the PE and IOL with PI group, all patients experienced a decrease in IOP from DOS to D1, and displayed lower IOP values in M6 than DOS. But there were still some whose IOP increased during the long-term follow-up (Y1-Y4).

Best Corrected Visual Acuity

A rising trend was observed in BCVA between FV and Y4 among the four groups, as illustrated in Figure 2. Further details of the values were described in Table 2. The PE and IOL (right eye) group, showed a rise in BCVA from

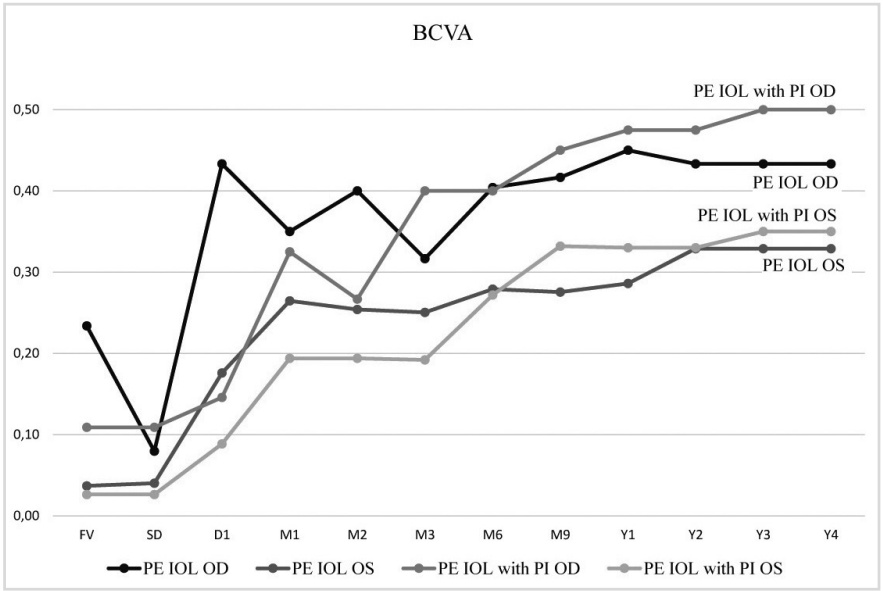

Figure 2. Dynamics of Best Corrected Visual Acuity Between Groups Over Long Period of Follow Ups

Note: Trend of visual acuity are presented without units of measurement. PE, Phacoemulsification; IOL, intraocular lens; PI, peripheral iridotomy; OD, right eye; OS, left eye; FV, first visit; DOS, day of surgery; D1, day 1; M1, month 1; M2, month 2; M3, month 3; M6, month 6; M9, month 9; Y1, year 1; Y2, year 2; Y3, year 3; Y4, year 4.

Table 2. Changes in Intraocular Pressure Between Groups Over Long Period of Follow Ups

Characte-ristics	Pre		Post									
	FV	DOS	D1	M1	M2	M3	M6	M9	Y1	Y2	Y3	Y4
Patients underwent PE and IOL (Right eye)												
Patient 1A	34	25	21	23	24	29	24	13	16	11	11	11
Patient 2A	40	25	15	9	9	13	13	9	9	9	9	9
Patient 3A	17	16	18	11	11	12	13	14	13	13	13	13
Patient 4A	45	13	12	15	15	16	17	17	17	17	17	17
Patient 6A	31	22	20	13	13	14	15	17	23	14	14	14
Patient 7A	12	15	18	18	15	17	12	15	18	18	12	14
All Patient	29.83± 12.92	13.75± 05.31	13.84± 03.32	14.83± 05.07	14.50± 05.07	16.83± 06.24	15.67± 04.46	14.17± 02.99	16.00± 04.73	13.67± 03.46	12.67± 02.73	13.00± 02.73
Patients underwent PE and IOL (Left eye)												
Patient 1A	30	21	16	21	21	21	29	16	20	9	9	9
Patient 2A	25	20	17	13	9	11	12	12	12	12	12	12
Patient 3A	30	22	17	9	17	17	13	15	17	17	17	17
Patient 4A	45	38	37	13	12	10	11	11	11	11	11	11
Patient 5A	35	19	12	12	14	14	12	11	16	16	16	16
Patient 6A	18	24	13	17	15	13	18	20	17	19	20	19
Patient 7A	11	9	11	12	12	16	14	14	18	13	14	18
All Patient	27.71± 11.13	21.86± 08.59	17.57± 08.90	13.86± 03.93	14.29± 03.93	14.57± 03.90	15.57± 06.35	14.14± 03.23	15.86± 03.23	13.86± 03.58	14.14± 03.80	14.57± 03.80
Patients underwent PE and IOL with PI (Right eye)`												
Patient 1B	59	29	21	11	17	13	12	15	12	11	11	11
Patient 2B	35	25	21	14	16	10	12	11	14	15	12	15
Patient 3B	25	21	13	15	9	13	16	14	12	11	12	12
Patient 4B	56	26	22	16	12	18	11	13	15	12	11	11
All Patient	43.75± 16.43	25.25± 03.30	19.25± 04.20	14.00± 02.16	13.50± 03.70	13.50± 03.31	12.75± 02.21	13.25± 01.70	13.25± 01.50	12.25± 01.90	11.50± 00. 56	12.25± 01.90
Patients underwent PE and IOL with PI (Left eye)												
Patient 2B	25	23	17	12	10	11	12	12	11	12	13	12
Patient 3B	28	21	21	13	15	19	18	10	13	12	14	14
Patient 4B	43	28	23	11	13	14	11	12	16	10	11	11
Patient 5B	28	21	16	19	17	15	17	18	16	14	19	21
Patient 6B	57	51	13	11	15	15	16	11	17	14	11	11
All Patient	36.20± 13.59	28.80± 12.73	18.00± 04.00	13.20± 03.35	14.00± 02.64	14.80± 02.86	14.80± 03.11	12.60± 03.13	14.60± 02.51	12.40± 01.63	13.60± 03.29	13.80± 04.20

Note: Data are presented in mmHg, with “All Patient” row display mean ± standard deviation. FV, first visit; DOS, day of surgery; D1, day 1; M1, month 1; M2, month 2; M3, month 3; M6, month 6; M9, month 9; Y1, year 1; Y2, year 2; Y3, year 3; Y4, year 4;

0.08± 0.08 (DOS) to 0.43± 0.24 (D1), slightly dropped to 0.35± 0.16 (M1), improved back to 0.40± 0.25 (M6), and 0.45± 0.20 (Y1). As for the PE and IOL (left eye) group, BCVA increased from 0.04± 0.04 (DOS) to 0.18± 0.17 (D1), 0.26 ± 0.22 (M1), 0.28± 0.19 (M6), and 0.29± 0.19 (Y1). Similarly, the PE and IOL with PI (right eye) group showed an elevated BCVA from 0.11± 0.19 (DOS) to 0.15± 0.13 (D1), 0.33± 0.28 (M1), 0.40± 0.27 (M6), and 0.48± 0.32 (Y1). The PE and IOL with PI (left eye) group also showed BCVA improvement from 0.03± 0.06 (DOS) to 0.09± 0.72 (D1), 0.19 ± 0.19 (M1), 0.27± 0.26 (M6), and 0.33± 0.28 (Y1).

An improved BCVA from DOS to D1 and M6, as well as throughout long-term follow-up (Y1–Y4), was seen in various percentage within each group. When evaluating individual responses from DOS to D1, BCVA improvement was seen in all 6 eyes (100%) of the PE and IOL (right eye) group, 5 of 7 eyes (71.4%) of the PE and IOL (left eye) group, 2 of 4 eyes (50%) of the PE and IOL with PI (right eye) group, and 4 of 5 eyes (80%) of the PE and IOL with

Table 3. Changes in Best Corrected Visual Acuity Between Groups Over Long Period of Follow Ups

Characte-ristics	Pre		Post									
	FV	DOS	D1	M1	M2	M3	M6	M9	Y1	Y2	Y3	Y4
Patients underwent PE and IOL (Right eye)												
Patient 1A	2/10	1/8	3/10	2/10	2/10	2/10	1/8	3/10	4/10	3/10	3/10	3/10
Patient 2A	2/10	1/300	2/10	3/10	5/10	2/10	4/10	4/10	4/10	4/10	4/10	4/10
Patient 3A	2/10	2/10	5/10	5/10	6/10	5/10	5/10	5/10	5/10	5/10	5/10	5/10
Patient 4A	2/10	2/60	8/10	6/10	6/10	6/10	6/10	6/10	6/10	6/10	6/10	6/10
Patient 6A	6/10	1/10	6/10	3/10	3/10	3/10	7/10	6/10	7/10	7/10	7/10	7/10
Patient 7A	1/300	1/60	2/10	2/10	2/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10
All Patient	0.2± 0.20	0.08± 0.08	0.43± 0.24	0.35± 0.16	0.40± 0.19	0.32± 0.19	0.40± 0.25	0.42± 0.20	0.45± 0.20	0.43± 0.22	0.43± 0.22	0.43± 0.22
Patients underwent PE and IOL (Left eye)												
Patient 1A	5/100	5/100	1/8	3/10	3/10	3/10	3/10	3/10	3/10	6/10	6/10	6/10
Patient 2A	1/8	1/8	2/10	2/10	1/8	2/10	3/10	3/10	3/10	3/10	3/10	3/10
Patient 3A	LP +	1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300	1/300
Patient 4A	1/60	1/60	3/10	5/10	5/10	5/10	5/10	5/10	5/10	5/10	5/10	5/10
Patient 5A	1/60	1/300	1/300	3/60	3/60	3/60	3/60	1/8	3/10	3/10	3/10	3/10
Patient 6A	2/60	2/60	5/10	6/10	6/10	5/10	5/10	5/10	5/10	5/10	5/10	5/10
Patient 7A	1/60	3/60	1/10	2/10	2/10	2/10	3/10	2/10	1/10	1/10	1/10	1/10
All Patient	0.04± 0.04	0.04± 0.04	0.18± 0.17	0.26 ± 0.22	0.25± 0.23	0.25± 0.20	0.28± 0.19	0.28± 0.18	0.29± 0.19	0.33± 0.22	0.33± 0.22	0.33± 0.22
Patients underwent PE and IOL with PI (Right eye)												
Patient 1B	2/60	2/60	3/10	5/10	5/30	5/10	5/10	5/10	6/10	6/10	6/10	6/10
Patient 2B	LP -	LP -	LP-	LP -	LP -	LP -	LP -	LP -	LP -	LP -	LP -	LP -
Patient 3B	4/10	4/10	2/10	2/10	3/10	5/10	5/10	6/10	6/10	6/10	7/10	7/10
Patient 4B	1/300	1/300	5/60	6/10	6/10	6/10	6/10	7/10	7/10	7/10	7/10	7/10
All Patient	0.11± 0.19	0.11± 0.19	0.15± 0.13	0.33± 0.28	0.27± 0.25	0.40± 0.27	0.40± 0.27	0.45± 0.31	0.48± 0.32	0.48± 0.32	0.50± 0.33	0.50± 0.33
Patients underwent PE and IOL with PI (Left eye)												
Patient 2B	1/300	1/300	5/60	5/10	5/10	5/10	6/10	6/10	5/10	5/10	6/10	6/10
Patient 3B	1/8	1/8	2/10	2/10	2/10	2/10	2/10	5/10	5/10	5/10	5/10	5/10
Patient 4B	1/300	1/300	6/60	2/10	2/10	2/10	5/10	5/10	6/10	6/10	6/10	6/10
Patient 5B	LP +	LP +	6/100	7/100	7/100	6/100	6/100	6/100	5/100	5/100	5/100	5/100
Patient 6B	LP-	LP-	LP-	LP -	LP -	LP -	LP -	LP -	LP -	LP -	LP -	LP -
All Patient	0.03± 0.06	0.03± 0.06	0.09± 0.72	0.19 ± 0.19	0.19± 0.19	0.19± 0.19	0.27± 0.26	0.33± 0.28	0.33± 0.28	0.33± 0.28	0.35± 0.30	0.35± 0.30

Note: Data of visual acuity are presented without units of measurement, with “All Patient” row display mean ± standard deviation. FV, first visit; DOS, day of surgery; D1, day 1; M1, month 1; M2, month 2; M3, month 3; M6, month 6; M9, month 9; Y1, year 1; Y2, year 2; Y3, year 3; Y4, year 4;LP-, no light perception; LP+ positive light perception

PI (left eye) group. As for the DOS to M6 comparison, all 6 eyes (100%) in the PE and IOL (right eye) group, 6 of 7 eyes (85.7%) in the PE and IOL (left eye) group, 3 of 4 eyes (75%) in the PE and IOL with PI (right eye) group, and 4 of 5 eyes (80%) in the PE and IOL with PI (left eye) group displayed higher (or at least equal) M6 BCVA value compared to DOS. Patients who did not experience BCVA improvement from DOS to M6 were patient 3A (left eye) from the PE and IOL group, with a vision of 1/300 since the first visit, as well as patient 2B (right eye) and 6B (left eye) from the PE and IOL with PI group, with a vision of 0 from the first visit. Meanwhile, in the long-term follow-up (Y1-Y4), the PE and IOL group showed that there were 2 patients with vision other than no light perception (LP-) who experienced stagnancy in low BCVA (patient 3A, left eye) or even a decreased BCVA (patient 1A, right eye).

It is noteworthy that in patients with an initial vision of LP-, the final vision Y4 remains the same despite surgical intervention, suggesting advanced or irreversible glauco-

matous optic neuropathy at baseline. However, in the PE and IOL group, there is still stagnancy or even decreased BCVA in patients with an initial vision other than LP-. Meanwhile, in the PE and IOL with PI group, all patients with initial vision other than LP- experienced an improved BCVA.

Discussion

This long-term case series investigated the outcomes of PE and IOL with or without PI in patients with acute glaucoma. The demographic profile of our respondents, primarily elderly female patients with significant prevalence of systemic hypertension, aligns with established epidemiological data on PACG [19[. Our findings demonstrate that both surgical approaches contributed to IOP reduction and BCVA improvement, though with variability in outcomes depending on baseline severity, comorbid conditions, and extent of optic nerve damage. This significant reduction is likely caused by early preoperative medical intervention combining topical and systemic medications, such as carbonic anhydrase inhibitors (Acetazolamide) and beta blocker (Timolol Maleate 0.5%). These results emphasise the necessity of rapid intraocular pressure reduction therapy before surgical intervention in acute glaucoma patients [20, 21].

Surgical approach selection may be influenced by the severity of initial elevated IOP. Patients who underwent PE and IOL with PI exhibited higher baseline in intraocular pressure and more severe clinical symptoms. This combined surgery was more often used for IOP levels above 35 mmHg or optic nerve involvement, while those with moderately increased IOP and limited structural nerve damage were treated with lens extraction alone [22]. Phacoemulsification and IOL implantation act in reducing IOP due to the fact that lens removal deepens ACD and expands the iridocorneal angle, increasing aqueous outflow. This mechanism is important in angle-closure glaucoma, where lens-induced pupillary block and angle crowding raise IOP [23]. The addition of PI showed enhanced efficacy in IOP management, as all patients in the PE and IOL with PI case showed significant postoperative IOP decreases. PI increases aqueous humour drainage by establishing an alternate pathway from the posterior to the anterior chamber, thus relieving any remaining pupillary obstruction and preventing additional pressure accumulation. This integrated surgical approach demonstrated significant benefits in instances of phacomorphic or synechial angle-closure, as shown by the subgroup analysis [23, 24]

The enhancement in BCVA resulting from both types of surgical techniques can be explained by different approaches. BCVA improvement following PE and IOL was mostly attributed to cataract extraction, which restored visibility and reduced lens-induced narrowing of the ACD. While PI does not directly affect the visual axis, its importance in regulating IOP may indirectly contribute in preserving visual function by preventing more optic nerve damage in susceptible eye [22, 25]. However, two patients with LP- did not recover any visual function postoperatively, signifying irreversible optic nerve damage. Optic neuropathy resulting from prolonged increased intraocular pressure leads to RGCs death and irreversible vision field loss. Previous findings have established that when visual function attains the LP− threshold, surgical intervention rarely results in functional recovery [26, 27].

Despite the overall excellence in reducing IOP and improving BCVA, this study showed that PE and IOL group remained insufficient in some cases. Patient 6A (right eye) had an IOP increase postoperatively, possibly due to steroid-induced ocular hypertension or persistent angle crowding [28, 29]. Patient 3A (left eye) had impaired vision despite normalized IOP, likely due to extensive preoperative optic nerve injury. Patient 1A (right eye) had a postoperative BCVA decrease, suggesting increasing glaucomatous neuropathy or other visual axis problems. These data showed that irreversible structural damage or delayed presentation reduced PE and IOL effectiveness [26]. Similarly, the PE and IOL combined with PI group successfully reduced IOP in the majority of cases. However, its impact on visual recovery was minimal among patients with advanced systemic or ocular comorbidities. Patients 2B (right eye) and 6B (left eye) had a vision of LP- and demonstrated no postoperative visual improvement, indicating irreversible optic nerve injury. Patient 5B (left eye), despite an initial LP+ status, attained only a slight increase in BCVA, which can be attributed to persistent ischemia or macular involvement. These instances emphasize that in advanced glaucomatous neuropathy, surgical procedures may maintain intraocular pressure but cannot restore previous visual impairment [26, 27].

This study has limitations, including its small sample size and retrospective design, which may limit the generalizability of our findings to broader populations with PACG. Additionally, the study's focus on a single center further narrows the applicability of the results across diverse healthcare settings. Moreover, potential confounding factors, including individual variations in anatomical responses to surgery, were not entirely controlled, possibly affecting the consistency of observed outcomes. In order to enhance the generalizability and reliability of surgical outcome assessments in PACG, future studies should involve a prospective, multicenter design, larger, more diverse populations, and better control of anatomical and physiological confounders.

In conclusion, this long-term case series demonstrates that PE and IOL implantation with or without PI lowers IOP and improves BCVA in PACG patients. However, PE and IOL implantation, especially when combined with PI, showed greater efficacy in lowering IOP during the early postoperative phase. However, it showed similar efficacy with PE and IOL in long-term IOP maintenance. In addition, PE and IOL with PI showed superiority in both enhancing BCVA during the immediate postoperative phase and sustaining favorable BCVA over the long term. However, it must be underscored that despite surgical interven-

tion, patients with an initial vision of LP- did not attain visual improvement due to irreversible neuropathy.

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Abbreviation. *POAG – Primary open-angle glaucoma; PACG – Primary angle-closure glaucoma; RCGs – Retinal ganglion cells; CCT – Central corneal thickness; IOP – Intraocular pressure; PE – Phacoemulsification; IOL – Intraocular lens; PI – Peripheral iridectomy; BCVA – Best corrected visual acuity; SD – Standart deviation; ACD – Anterior chamber depth; FV – First visit; DOS – Day Of Surgery; D1 – Day 1; M1 – Month 1; M2 – Month 2; M3 – Month 3; M6 – Month 6; M9 – Month 9; Y1 – Year 1; Y2 – Year 2; Y3 – Year 3; Y4 – Year 4; LFX – Levofloxacin; MP – Metilprednyson; HT – Hipertension; HHD – Hypertensive heart disease; OU – Both eyes; OS – Left eye; OD – Right eye; LP – No light perception; LP+ – Positive light perception.*