


Real-world Surgical Outcomes of Primary Angle-closure Glaucoma

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Purpose: To evaluate surgical outcomes of the four common procedures utilized for primary angle-closure glaucoma (PACG).

Methods: A retrospective study of survival rate in surgical management of PACG was conducted in a referral eye center. One hundred and ninety-nine eyes from 173 PACG patients were collected for chart review. The procedures used were phacoemulsification (PE), combined PE with goniosynechialysis (PE-GSL), combined PE with trabeculectomy (PE-Trab), and trabeculectomy alone. Failure was defined as postoperative IOP >21 mmHg in patients who needed second surgical intervention or those who had IOP <5 mmHg with loss of light perception. Cumulative survival rates, risk of surgical failure, and complications were analyzed.

Results: PE, PE-GSL, PE-Trab, and trabeculectomy were performed in 84 eyes (42.2%), 76 eyes (38.2%), 21 eyes (10.6%), and 18 eyes (9%), respectively. Cumulative survival rates at 60 months were 13%, 55%, 42% and 43%, respectively. Cox regression analysis indicated that each mmHg IOP increased, the risk of surgical failure decreased by 13% (adjusted hazard ratio (HR) 0.87; 95%CI: 0.84–0.93, $p < 0.001$).

Conclusion: Real-world surgical outcomes of PACG showed that PE alone had a low survival rate of 13% in 60-month follow-up whereas PE-GSL achieved the highest rate of 55%. PE-GSL should be initially considered for management of PACG, since it can restore and sustain the physiologic aqueous pathway and preserve the conjunctiva for future filtering surgery if needed.

Keywords: primary angle-closure glaucoma, surgical outcome, combined procedure, phacoemulsification, trabeculectomy, goniosynechialysis, survival, Asian, complication

Introduction

Primary angle-closure glaucoma (PACG) is a leading cause of blindness in Asia, and a meta-analysis of global glaucoma has demonstrated that the prevalence of PACG is highest in Asians.¹ This is an anatomic disorder² which usually occurs in a relatively small eye with crowded anterior segment, leading to iridotrabecular contact and resulting in intraocular pressure (IOP) elevation.³ Relative pupillary block is a common mechanism of PACG, and its definitive treatment is laser peripheral iridotomy (LPI); however, mechanisms other than pupillary block may be involved in PACG. In the Liwan Eye Study, one-fifth of primary angle-closure suspects (PACS) still had residual angle closure after LPI⁴ while Yan et al reported that two-thirds of Chinese cases of PACG had appositional angle closure after laser treatment.⁵ Additional mechanisms, eg plateau iris,^{6,7} enlarged or anteriorly positioned lens, support the peripheral iris, leading to peripheral anterior synechia

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(PAS) formation, and persistent IOP elevation will develop unless PAS is managed in a timely manner. Argon laser peripheral iridoplasty (ALPI) is an alternative treatment for primary-angle closure (PAC)^{8,9} and has been found to achieve successful long-term outcomes for plateau iris syndrome.¹⁰ In addition, EAGLE study demonstrated that clear lens extraction had better outcome than LPI in treatment of PACG.¹¹

Surgical interventions can be applied to control the IOP of PACG when laser and medical treatment have failed. The results of phacoemulsification (PE) alone, combined PE with goniosynechialysis (PE-GSL), combined PE and trabeculectomy (PE-Trab), and trabeculectomy alone have been reported by various study groups, but the outcomes are somewhat difficult to compare because of the differences in definitions used in the reports. Herein, we review the charts of PACG patients who underwent the four procedures in our eye center and reported their outcomes, and it is representative of real-world practice for PACG patients who required surgical intervention.

Patients and Methods

This study was a retrospective chart review of PACG patients who underwent surgical intervention between August 2000 and December 2014. All investigations were carried out in accordance with the Declaration of Helsinki. The study protocol was approved by the Institutional Review Board of Rajavithi Hospital in May 2015, document No. 112/2558. Informed consent was waived and data was analyzed anonymously.

Inclusion criteria were patients who were ≥ 40 years old, phakic, and had no previous intraocular surgery. All patients were diagnosed as PAC and PACG. PAC was defined as those who had trabecular meshwork apposition or closed at least 180 degrees obtained with gonioscopy, with IOP > 21 mmHg or with PAS. And PACG defined as PAC with glaucomatous optic nerve and visual field damage. Acute angle-closure glaucoma (AACG) was defined as present when there were symptoms and signs of suddenly increased IOP, such as ocular pain, halo, corneal edema, and IOP ≥ 21 mmHg. Chronic angle-closure glaucoma (CACG) was defined as an asymptomatic form of PACG and was taken as present in patients who had onset of AACG > 6 months.

Patients underwent LPI and/or ALPI, and glaucoma medications were prescribed if the IOP was uncontrolled. Indications for surgical intervention included:

1. Uncontrolled IOP despite maximally tolerated medical therapy
2. PACG with visually significant cataract
3. Poor compliance with medical treatment.

Ocular biometry, including axial length and intraocular lens (IOL) power, was obtained with IOL Master 500 (Carl Zeiss Meditec, CA, USA). If IOL Master could not obtain measurements from dense cataract, A-scan ultrasound, OcuScan (Alcon Laboratories, Fort Worth, TX, USA) was employed.

Surgical Interventions

The four procedures used for PACG in our eye center were performed under topical or local anesthesia and are briefly described below.

1. PE alone: temporal clear cornea PE with posterior chamber IOL (PC IOL) insertion was performed.
2. Combined PE-GSL: PE-IOL was first made, after which GSL was performed with cyclo-spatula under direct visualized Swan-Jacob gonioscens, in all of the PAS area.
3. Combined PE-Trab: PE-IOL was first made, followed by superior fornix-based trabeculectomy with mitomycin C (0.4 mg/mL), with four-minute subconjunctival application.
4. Trabeculectomy alone: superior fornix-based trabeculectomy, with mitomycin C (0.4 mg/mL) four-minute application, was performed.

The choice of procedure for each patient was based on individual clinical settings, and decisions were made by a senior glaucoma specialist (BW). The procedure was performed by the instructor (BW) and a number of clinical fellows under his supervision. Intra-, early- and late-postoperative complications were recorded.

Postoperative medications included prednisolone acetate 1%, and antibiotic (tobramycin or levofloxacin) eye drops qid for four weeks after which the prednisolone acetate was tapered off gradually in the following four weeks. Postoperative data were collected for analysis at one month, three months, six months, 12 months, and then every six months until 60-month follow-up. Additional glaucoma medication and follow-up was made as needed.

Definition of Surgical Failure

Surgical failure was defined as present in patients with postoperative IOP >21 mmHg with medical treatment at least two visits, and needed second surgical intervention (SSI), eg revised trabeculectomy or glaucoma drainage device. Those who had IOP <5 mmHg with loss of light perception were also classified as failure. Needling bleb revision was not defined as SSI or surgical failure.¹²

Data Analyses

Data was recorded with SPSS 16.0 (SPSS Inc., Chicago IL, USA), and statistical analyses were performed to compare the outcomes of the four surgical procedures. Subgroup analysis of the results of AACG and CACG was also performed, and distributions of the data were tested using the Kolmogorov–Smirnov test. Time to failure was analyzed with Kaplan–Meier estimates, and comparison among the procedures was made first with log rank test and then with Cox regression analysis. We used Mann–Whitney *U*-test for nonparametric data analysis,

and Student's *t*-test and ANOVA were employed for continuous variables. Significance was set at $p < 0.05$.

Results

The records of 188 patients were retrieved from hospital data relating to surgical treatment of PACG. Fifteen patients were excluded because they were lost to follow-up during the first three months postoperatively, and 199 eyes were included from 173 patients of whom 123 (71.1%) were female, and 50 (28.9%) were male. Table 1 shows various demographic data, including age, sex, underlying disease, family history of glaucoma, diagnosis, type of surgery, preoperative best-corrected visual acuity, IOP, number of glaucoma medications, axial length and cup to disc ratio (C/D). Median age at the time of the operations was 67 years (IQR 58–71), median preoperative IOP was 19 mmHg (IQR 15–27), and median number of medications was three (IQR 2–4).

In Table 2, a total of 84 (42.2%) eyes underwent PE alone, 76 (38.2%) had PE-GSL, 21 (10.6%) received PE-Trab, and 18 (9%) had trabeculectomy. PE had the highest

Table 1 Patient Characteristic and Demographic Data (Number of Patients=173)

Number of Eyes (%)	199 (100)
Gender	
Male (%)	59 (29.6)
Female (%)	140 (70.4)
Age, median (interquartile range) years	67 (58–71)
Underlying disease	
Hypertension (%)	91 (45.7)
Diabetic mellitus (%)	38 (19.1)
Dyslipidemia (%)	38 (19.1)
Family history of glaucoma	5 (2.5)
Diagnosis	
AACG (%)	50 (25.1)
CACG (%)	149 (74.9)
Procedure	
PE (%)	84 (42.2)
PE-GSL (%)	76 (38.2)
PE-Trab (%)	21 (10.6)
Trab (%)	18 (9)
Preoperative IOP, median (interquartile range) mmHg	19 (15–27)
Number of medication, median (interquartile range)	3 (2–4)
Cup to disc ratio, median (interquartile range)	0.8 (0.5–0.9)
Axial length, median (interquartile range) mm	22.65 (21.95–23.15)

Table 2 Results Classified by Surgical Procedures

	Total (N=199)	PE (N=84)	PE-GSL (N=76)	PE-Trab (N=21)	Trab (N=18)	p-value ^b
Age, ^a years	67 (58–71)	70 (65–73.5)	66 (58–73.5)	65 (57–71)	54 (49–58)	<0.001
Preoperative IOP, ^a mmHg	19 (15–27)	16 (14–20)	24.5 (17.5–34)	22 (18–31)	26.5 (18–30)	<0.001
Preoperative PAS ^a , (degree)	270 (0–360)	0 (0–135)	360 (270–360)	360 (120–360)	270 (45–330)	<0.001
Postoperative IOP at 6 months, ^a mmHg	14 (12–16)	14 (12–16)	13 (12–16)	14.5 (12.5–18.5)	12.5 (10–20)	0.540
Postoperative IOP at 12 months, ^a mmHg	14 (12–17.5)	14 (12–17.5)	13 (12–16)	17 (12.5–18)	14.5 (12–18)	0.298
Postoperative IOP at 24 months, ^a mmHg	14 (12–16)	14 (12–17.5)	14 (12.5–16)	15 (14–15.5)	14 (13.5–16)	0.898
Postoperative IOP at 36 months, ^a mmHg	14 (11–16)	15 (12–17)	12 (10.5–14)	16 (14–18)	12 (10–15)	0.024
Postoperative IOP at 48 months, ^a mmHg	14 (12–17)	16 (12–17)	12 (10–15)	15 (13–16)	12 (11–13)	0.120
Postoperative IOP at 60 months, ^a mmHg	14 (12–16)	15 (13–17)	12 (11.5–14)	18 (16–20)	12 (10–14)	0.015
Percent of IOP reduction at 60 months ^a	54 (44–65.5)	58 (44–63)	54 (48.5–67.5)	44 (41.5–55.5)	61 (60–62)	0.645
Preoperative number of medications ^a	3 (2–4)	2 (1–3)	3 (2.5–4)	4 (3–4)	3 (2–4)	<0.001
Postoperative number of medications ^a	1 (0–1)	1 (0.5–2)	0 (0–1)	1 (0–2)	0 (0–1.5)	0.105

Notes: ^aMedian (interquartile range). ^bKruskal–Wallis test. Postoperative number of medication is at six months. Follow-up period is time to failure in months.

median patient age, and trabeculectomy had the lowest (70, 66, 65, and 54 years respectively, $p < 0.001$). Median IOP reduction was 54% (IQR 44–65.5), and the final number of medications decreased to one (IQR 0–1). Median IOP reduction in was highest in Trab and lowest in PE-Trab.

Median pre- and postoperative IOP (mmHg) classified by surgical procedures are shown in Figure 1, presenting that IOP significantly decreased from six months onwards.

Median survival of all procedures was 24 months while cumulative survival of overall procedures at the 60-month follow-up was 0.26, Figure 2.

Median survival time of PE alone, PE-GSL, PE-Trab, and trabeculectomy were 6, 60, 12, and 48 months respectively, and cumulative survival rates at 60 months were 13%, 55%, 42% and 43% respectively, Figure 3.

Cox regression analysis indicated that higher preoperative IOP was a protective factor of the surgical outcome. When we adjusted the regression model with covariates of age, sex, diabetes mellitus, numbers of medication, and axial length, the adjusted HR was 0.87; 95%CI: 0.84–0.93, $p < 0.001$. In plain words, each mmHg of IOP increased, the chance of failure decreased by 13%. Preoperative PAS was not related to surgical failure of these procedures (Table 3).

Subgroups of AACG (50 eyes) and CACG (149 eyes) were analyzed. We performed PE-GSL in 70% of AACG and PE in 49% of CACG, Table 4. Mean IOP reductions in the groups were 51.5% (SD 18.25) and 55.06% (SD 13.92) respectively at the 60-month follow-up (Table 5).

Figure 4 demonstrated Kaplan–Meier plots of surgical failure between acute and chronic angle-closure glaucoma, with nonsignificant difference ($p = 0.538$, log rank test).

Complications and Second Surgical Intervention

Perioperative complications, up to the three-month follow-up, were shown in Table 6. Most cases were self-limited or manageable. None of these patients experienced loss of vision to no light perception from hypotony. Vision-threatening events such as suprachoroidal hemorrhage or endophthalmitis was not found in this chart review from early to late follow-up. Two patients, one in PE-GSL and one in PE-Trab, developed epiretinal membrane in this study.

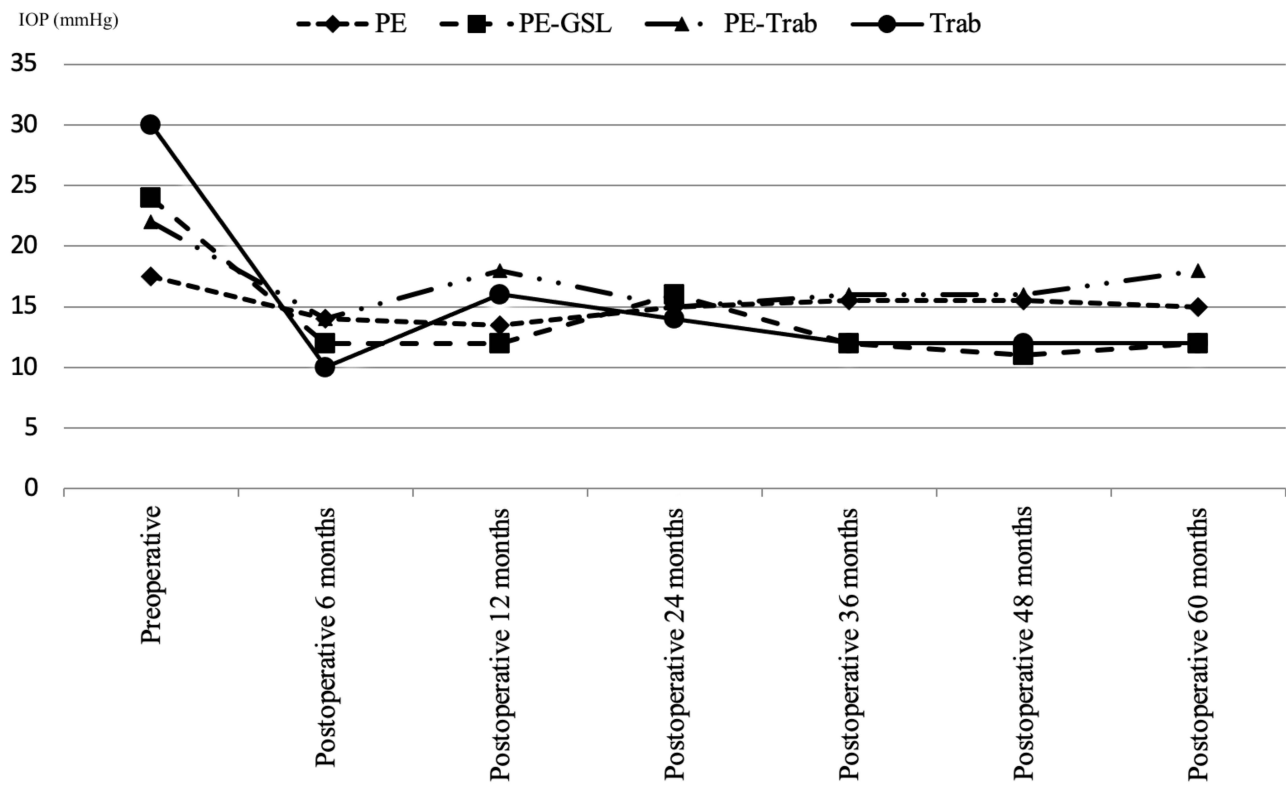


Figure 1 Median pre- and post-operative IOP (mmHg) classified by surgical procedures. IOP significantly decreased from six months onwards.

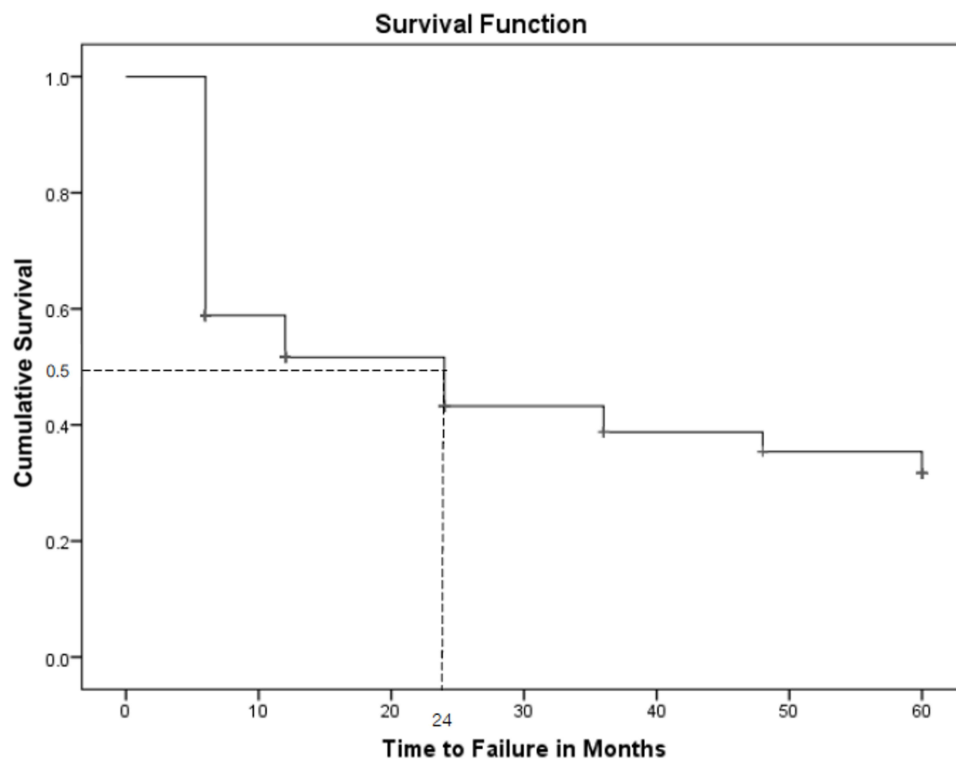


Figure 2 Kaplan-Meier estimates of surgical failure across the four procedures.

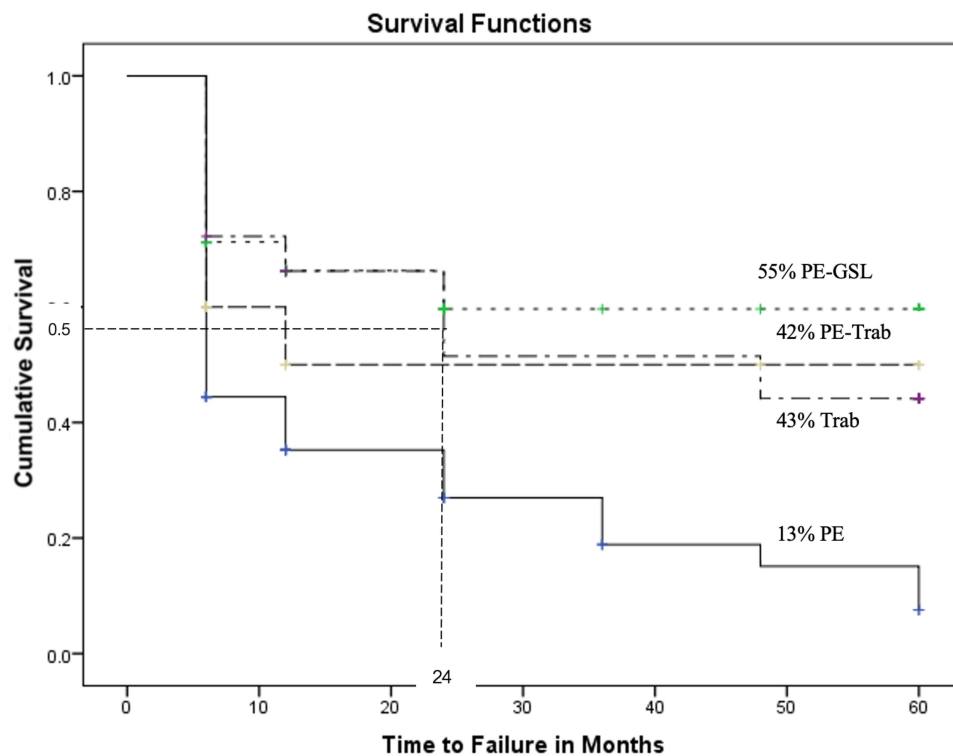


Figure 3 Median survival time of PE alone, PE-GSL, PE-Trab, and trabeculectomy were 6, 60, 12, and 48 months respectively, and cumulative survival rates at 60 months were 13%, 55%, 42% and 43% respectively.

The 14 eyes of 14 patients for whom the first procedure failed were managed as follows: six eyes after failed PE alone underwent trabeculectomy; two eyes after failed PE-GSL received trabeculectomy; two eyes that underwent unsuccessful

combined PE-Trab underwent revised trabeculectomy; one eye of failed PE-Trab underwent Ahmed glaucoma valve; and patients who had failed trabeculectomy underwent PE (one eye), PE-GSL (one eye), and PE-Trab (one eye).

Table 3 Factors Related to Failure Time by Cox Regression

Factors		Adjusted HR ^a	95%CI	p-value
Preoperative IOP		0.87	0.84–0.93	<0.001
PAS		1	0.99–1.01	0.834
Numbers of medication		1.10	0.87–1.39	0.421
Axial length		1.01	0.73–1.40	0.938
Age		1.01	0.98–1.05	0.480
Sex	Male	1	–	–
	Female	1.17	0.66–2.07	0.588
Diabetes	No	1	–	–
	Yes	1.36	0.77–2.41	0.294
Procedure	PE	1	–	–
	PE-GSL	0.83	0.43–1.59	0.575
	PE-Trab	0.81	0.27–2.47	0.712
	Trab	1.63	0.34–7.72	0.541

Notes: ^aAdjusted with age, sex, diabetes mellitus, numbers of medication, preoperative IOP, and axial length.

Table 4 Surgical Procedures Between Acute and Chronic PACG

	PE	PE-GSL	PE-Trab	Trab	Total
AACG (%)	11 (22)	35 (70)	3 (6)	1 (2)	50 (100)
CACG (%)	73 (49)	41 (27.5)	18 (12.1)	17 (11.4)	149 (100)

Table 5 Surgical Outcomes Between Acute and Chronic Angle-closure Glaucoma

	AACG (N=50)	CACG (N=149)	p-value
Age, ^a years	63.5 (57–68)	67 (58–72)	0.008 ^b
Sex, Female (%)	40 (80)	100 (67.1)	0.084 ^c
Axial length, ^a mm	22.21 (21.63–22.65)	22.78 (22.26–23.27)	<0.001 ^b
Preoperative IOP, ^a mmHg	24 (16–38)	18 (15–25)	0.014 ^b
Postoperative IOP, ^a mmHg	12 (11–15)	14 (11–17)	0.125 ^b
Percent of IOP reduction (mean ±SD)	51.50±18.25	55.06±13.92	0.573 ^d
Preoperative number of medications ^a	3 (2–4)	3 (2–4)	0.075 ^b
Postoperative number of medications ^a	0 (0–1)	1 (0–2)	0.271 ^b

Notes: ^aMedian (interquartile range). ^bMann–Whitney U-test. ^cChi-squared test. ^dIndependent t-test.

Discussion

In the present study, the 60-month survival rate of PE-GSL was the highest (55%), followed by trabeculectomy alone (43%), PE-Trab (42%), and PE alone (13%). Subgroup analysis of the survival rates between AACG and CACG showed no significant difference. Of interest, our report demonstrated that the higher preoperative IOP was related

to the higher success rate of the procedures. There might be a few explanations for this finding. First, the surgeon might consider a surgical technique which could be more aggressive IOP lowering, for instance, extensive GSL, or made a larger internal ostium of trabeculectomy. Second, postoperative care might be more intensive. And third, the surgeon might consider early surgery in AACG which had

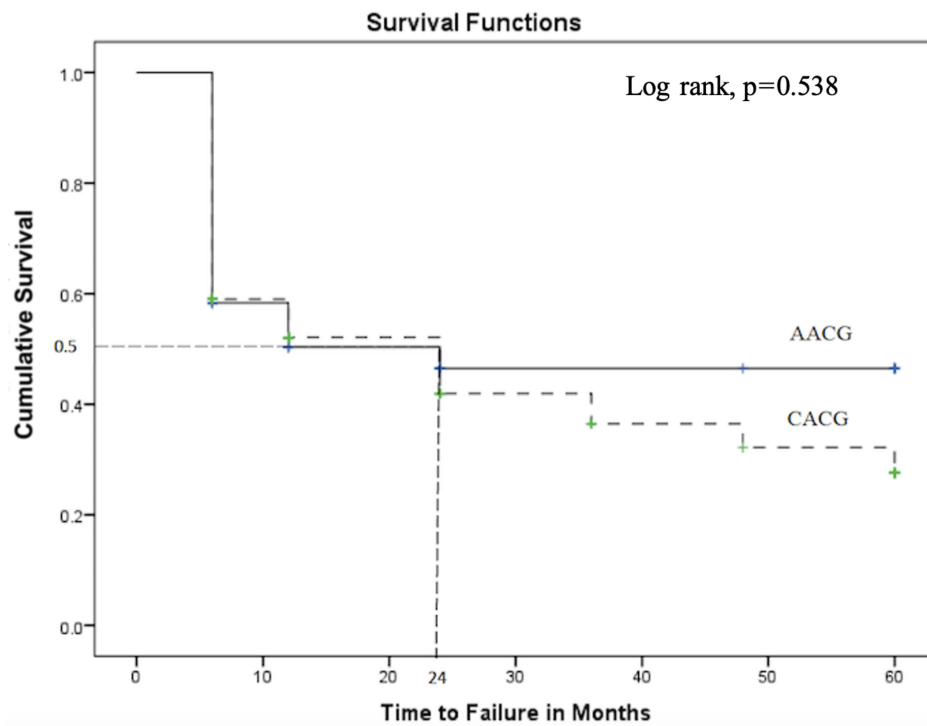
**Figure 4** Kaplan–Meier plots of surgical failure between acute and chronic angle-closure glaucoma, with nonsignificant difference.

Table 6 Perioperative Complications of the Procedures for PACG

	PE (N=84) N (%)	PE-GSL (N=76) N (%)	PE-Trab (N=21) N (%)	Trab (N=18) N (%)
Shallow AC	–	–	5 (23.8)	3 (16.7)
AC bleeding	1 (1.2)	8 (10.4)	2 (9.5)	2 (11.1)
Fibrinoid AC reaction	–	2 (2.6)	1 (4.8)	–
Inflammation >3 months	3 (3.6)	2 (2.6)	1 (4.8)	1 (5.6)
Wound leak	–	–	4 (19)	1 (5.6)
Hypotony maculopathy	–	–	1 (4.8)	1 (5.6)
Choroidal detachment	–	1 (1.3)	1 (4.8)	2 (11.1)
Encapsulated bleb	–	–	4 (19)	2 (11.1)
Needling revision	–	–	5 (23.8)	1 (5.6)

a higher IOP, this could prevent subsequent trabecular damage from PAS formation.

Surgical management for PACG is evolving and still being debated,¹³ and although comparative studies between two procedures have been reported by various authors (Table 7), real-world practice is sparsely reported.

PACG appears to involve multiple factors, including pupillary block, plateau iris, lens and posterior to lens mechanisms.³ Proper surgical management for individual patients may save the eye from glaucoma's blinding process.

For decades, trabeculectomy has been the standard procedure for most cases of glaucoma; however, its success rate is rather low, particularly in AACG. It has been reported to have a success rate of 56% in medical uncontrolled AACG;⁸ however, PE has shown good outcomes for AACG.²⁰ It is common to find coexisting glaucoma and cataracts in elderly patients. The lens component of PACG is caused by thick lens and/or anteriorly positioned lens, and choice of clinical treatment for patients who have both conditions is based on the general principles of glaucoma and cataract surgery. If glaucoma (IOP elevation) is more prominent, trabeculectomy should be used, whereas in the opposite case, cataract surgery should be performed. If both glaucoma and cataract are prominent, combined

glaucoma and cataract surgery is the preferred choice. Combined operations for PACG include PE-Trab and PE-GSL.

Goniosynechialysis involves stripping off the adhesion of the peripheral iris from the trabecular surface to restore the physiologic aqueous passage;²¹ this can reduce IOP in PACG if the function of the trabecular meshwork has not been damaged from long duration of PAS. We did not perform GSL alone because we were aware that the lens component would push the PAS back later. We always combine PE and GSL in our practice, as combined PE-GSL has demonstrated a 90% success rate for PACG post-acute attack in Asian patients.²² Favorable outcomes of PE-GSL have also been reported by some research groups;^{23–25} however, a randomized controlled study by Husain et al reported that PE-GSL did not have any additional IOP-lowering effect compared to PE alone,¹⁹ and meta-analysis in seven randomized controlled trials also showed that PE-GSL was not superior to PE alone in terms of IOP reduction.²⁶ Our data confirmed this, showing that median final IOP and percent IOP reduction were not significantly different between PE-GSL and PE alone.

Regarding combined PE-Trab in PACG, some randomized controlled trials have reported that combined PE-Trab demonstrated better IOP control than PE alone¹⁴

Table 7 Comparative Studies of Surgical Procedures for PACG

Authors	Year	Surgical Interventions		Number of Patients	Follow-up (Months)	Results
Tham et al ¹⁴	2009	PE	PE-Trab	27 vs 24	24	PE-Trab lowered IOP better than PE
Tsai et al ¹²	2009	Trab	PE-Trab	24 vs 75	36	NS
Wang et al ¹⁵	2012	Trab	PE-Trab	14 vs 17	10	NS
Tham et al ¹⁶	2013	PE	Trab	26 vs 24	24	NS
Zhao et al ¹⁷	2013	PE-GSL	PE-Trab	33 vs 32	12	NS
Song et al ¹⁸	2016	Trab	PE-Trab	29 vs 15	12	NS
Husain et al ¹⁹	2019	PE	PE-GSL	40 vs 38	12	NS

Abbreviation: NS, not significantly different.

while Zhang et al reported similar success rates with PE, trabeculectomy, and PE-Trab.²⁷

Combined PE and glaucoma procedures, GSL or trabeculectomy, could yield some advantages in PACG. In addition to the lens removal effect in PACG,³ GSL can restore physiologic aqueous humor drainage, and trabeculectomy can bypass trabecular resistance.^{22,28} Zhao et al reported comparable effects of PE-GSL and PE-Trab in 65 Chinese eyes.¹⁷ They found that both procedures significantly lowered IOP from preoperative up to 12-month follow-up, and that PE-GSL was able to open the PAS (>270 degrees) in all 18 eyes, so they concluded that PE-GSL could be applied as primary surgery for PACG with coexisting cataract. In addition, the conjunctiva is preserved in PE-GSL, so that trabeculectomy could be performed if uncontrolled-IOP occurred subsequently.

Comparison of those results reveals limitations and may cause confusion. Firstly, they were conducted in various centers using diverse surgical techniques; for instance, Zhao et al performed GSL with a viscoelastic substance¹⁷ while we did so with a cyclo spatula; MMC dosage in trabeculectomy and combined PE-Trab was also different. In combined PE-Trab, Zhao et al did not apply MMC,¹⁷ whereas we used it as an adjunct in all cases. The definitions of success/failure were also different, and there is as yet no definite indication for these four procedures in PACG management.

In real-world clinical practice, the surgical decision to use PACG is based on many factors, such as preoperative IOP, number of medications, cataract status, lens thickening, anterior lens position, PAS, stage of glaucoma, and acute/chronic conditions. For example, we tend to perform PE alone in older patients who have quite well-controlled IOP, and we use trabeculectomy alone in younger patients with uncontrolled IOP. Median age of patients undergoing PE alone was 70 years, while that of trabeculectomy alone was 54 years, and median preoperative IOPs were 16 and 26.5 mmHg respectively. In between those two groups, we chose combined PE-GSL or PE-Trab. Median ages of PE-GSL and PE-Trab patients were 66 vs 65 years, and preoperative IOPs were 24.5 and 22 mmHg respectively. Combined PE-GSL was favored by our group for patients who had history of AACG (70%) while combined PE-Trab was considered for those who might have a lower degree of PAS.

In the present study, PE alone had the lowest five-year survival at 13%. Although it can eliminate pupillary block, deepen ACD, and widen the peripheral angle,^{29–31} PE alone may not eliminate preexisting PAS, and residual

PAS after PE could block aqueous outflow, resulting in IOP elevation. In addition, Sihota et al reported a histologic study of the trabecular meshwork of PACG, showing noninflammatory degeneration in AACG, and endothelial cell loss in CACG.³² Hamanaka et al reported Schlemm's canal occlusion with endothelial cell damage and fusion of the trabecular beam.³³ Both trabecular and Schlemm's canal changes lead to IOP elevation after PE alone. In the EAGLE study, in contrast, clear lens extraction performed favorably in lowering IOP compared with laser iridotomy in three years of follow-up.¹¹ The investigators employed PE in new cases of PAC and PACG with IOP >30 mmHg without cataract. We speculated that the aqueous drainage pathway might have been less changed in the EAGLE study than in ours. Early surgery might prevent PAS formation which can cause failure in the long-term follow-up period; however, there was markedly missing PAS data in the EAGLE study (247 from 419 patients). The chronic PACG in our patients might have had more damage to trabecular outflow than in the early glaucoma of the EAGLE study.

Strengths and Limitations

This study had both strengths and limitations. Its strengths include the fact that it used practice-based data, and the outcome measurements were analyzed within the same definitions and statistical methods. Long-term follow-up data is useful for validation of the outcomes of this chronic disease. Its limitations related to a retrospective manner of the study and included the fact that some data were missing. To date, there is no specific indication in various procedures for PACG yet. We made decisions arbitrarily and it could be one of the sources of bias. The numbers of patients in the groups and their follow-up periods were different, and the sample sizes were relatively small and varied among the groups. We had 26 patients who were operated on both sides, whereas 147 patients were operated on one side only. This could create a confounding factor, for the eyes would not be independent. This could therefore constitute a statistical bias.

In fact, trabeculectomy alone was uncommonly employed (9%) because our patients were relatively old with cataractous formation, so cataract removal and combined procedures appeared to be a better choice for the status of these patients. Even though trabeculectomy proportion was less than 10%, we did not exclude trabeculectomy from analysis in order to show a real-life practice for PACG.

In this study we excluded patients who had complications such as ruptured PC and zonular dialysis, and this could have resulted in overestimation of the failure rates. Lens thickness could not be obtained with IOL Master 500, so that we could not clarify the effect of lens thickness in PACG surgery outcomes. Future research is needed to specify indication of these procedures for the specific type of PACG.

Conclusions

Real-world surgical outcomes of PACG showed that PE alone had a low survival rate of 13% in a 60-month follow-up whereas PE-GSL achieved the highest rate of 55%. PE-GSL should be initially considered for surgical management of PACG, since it can restore and sustain the physiologic aqueous drainage in a long-term follow-up period.

Precis

Real-world data showed that stand-alone phaco was not as effective as combined phaco-goniosynechialysis in management of PACG, which showed a five-year survival rate of 13% vs 55% respectively.

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Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

Disclosure

The authors reported no conflicts of interest in this work and have no conflict of interest to declare regarding any devices mentioned in the study.

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