Comparative Evaluation of Phacoemulsification with Goniosynechialysis and Phacoemulsification with Viscogonioplasty in Angle-Closure: A Randomized Clinical Trial

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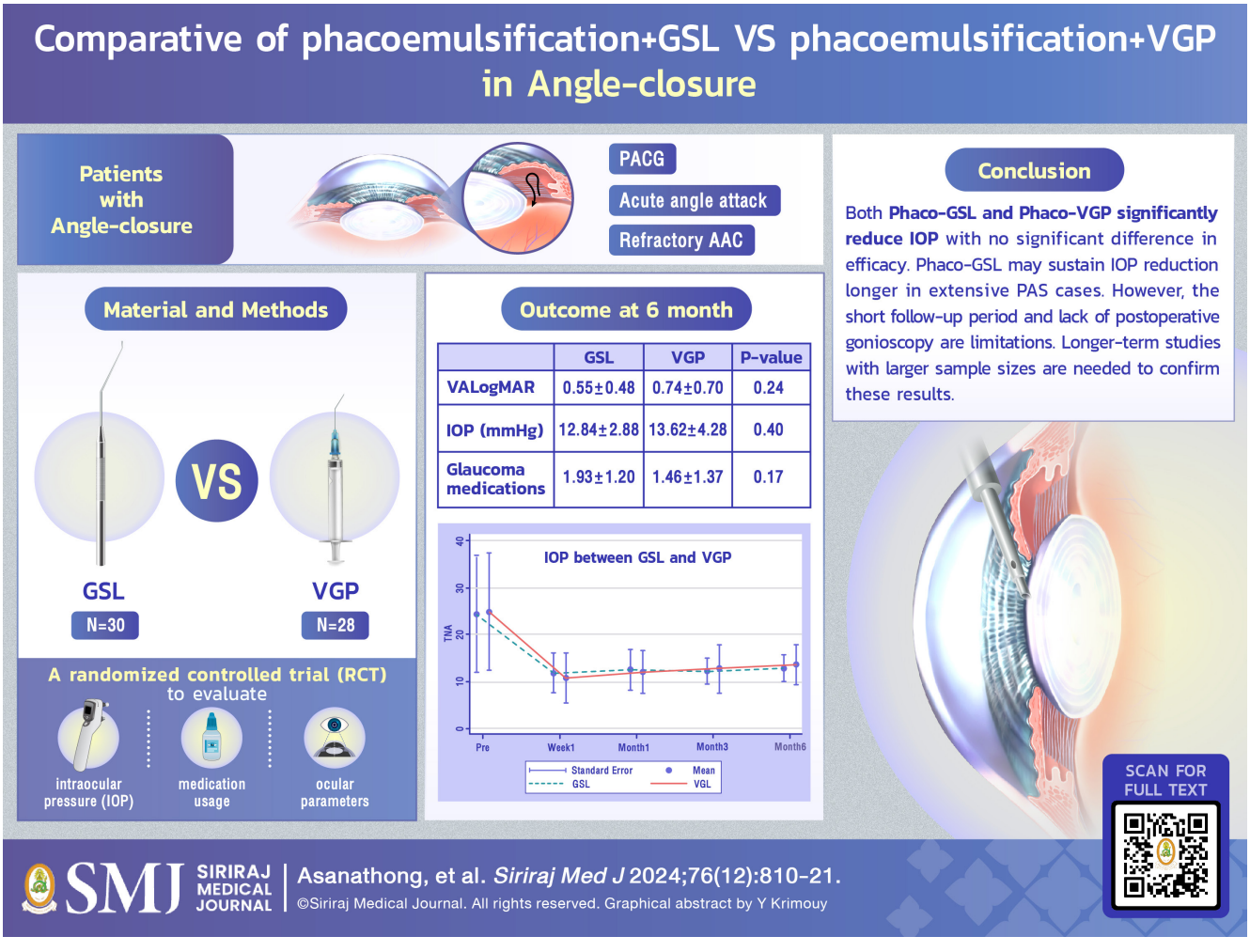

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ABSTRACT

Objective: To compare the effects of phacoemulsification with goniosynechialysis (GSL) versus viscogonioplasty (VGP) on intraocular pressure (IOP) reduction and medication use in angle-closure patients.

Materials and Methods: This randomized controlled trial at Sisaket Hospital, Thailand, from November 2021 to May 2024, enrolled patients with angle-closure and cataracts. Group 1 underwent phacoemulsification with GSL, and Group 2 with VGP. Visual acuity, IOP, and medication use were assessed before surgery, then at 1 week, 1 month, 3 months, and 6 months post-surgery.

Results: 58 eyes were included: 30 in Group 1 and 28 in Group 2. The average age was 67.16±9.65 years in Group 1 and 67.78±7.38 years in Group 2 (P=0.79). Baseline IOP was 24.31±12.34 mmHg in Group 1 and 24.92±12.50 mmHg in Group 2 (P=0.85). After 6 months, IOP decreased to 12.84±2.88 mmHg in Group 1 and 13.62±4.28 mmHg in Group 2 (P=0.40). Glaucoma medications decreased from 3.47±0.94 to 1.93±1.20 in Group 1 and from 3.54±0.58 to 1.46±1.37 in Group 2 (P=0.17). Hazard ratio: 4.29 (P=0.066, 95% CI: 0.91–20.18).

Conclusion: Both Phaco-GSL and Phaco-VGP significantly reduce IOP, with no significant difference in efficacy. Phaco-GSL may sustain IOP reduction longer in extensive PAS cases. However, the short follow-up period and lack of postoperative gonioscopy are limitations. Longer-term studies with larger sample sizes are needed to confirm these results.

Keywords: Phacoemulsification; goniosynechialysis; viscogonioplasty; angle-closure; primary angle-closure glaucoma
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INTRODUCTION

Angle-closure is a disorder characterized by the presence of iridotrabecular contact (ITC), which can be either appositional or synechia.[1] This contact leads to the blockage of the aqueous drainage system of the anterior chamber, increasing intraocular pressure (IOP). ITC plays a significant role in the progression of various ocular diseases. Primary angle-closure glaucoma (PACG) is a condition where ITC causes a progressive increase in IOP, extensive peripheral anterior synechiae (PAS), and optic nerve damage. Acute angle closure (AAC) is a condition marked by the sudden onset of increased IOP, causing severe eye pain in patients. Several mechanisms are responsible for angle closure, including pupillary block, plateau iris, and lens-related factors.[2-5] These mechanisms contribute to ITC and lead to blockage of the aqueous drainage system. Secondary angle-closure glaucoma may involve other mechanisms, which are not included in this study.[6] The prevalence of angle closure increases with age.[7,8] The increasing thickness of the lens with age[9] may cause the presence of ITC and the extensive formation of synechiae. Cataract extraction can deepen the anterior chamber and open the iridotrabecular angle,[10-12] reducing IOP after phacoemulsification.[13-15] However, in some cases, the iridotrabecular angle does not widen, and the IOP does not decrease after cataract surgery, possibly due to the persistence of PAS. By breaking PAS and separating the iris from the trabecular meshwork, the anterior chamber drainage system may function more effectively, resulting in a decrease in IOP.[16-28]

Goniosynechialysis (GSL) is a glaucoma procedure that breaks PAS and ITC under direct visualization with a gonio lens. This procedure involves separating the iris from the angle using a spatula[21] to restore trabecular function and decrease IOP.[2,16-22] GSL is usually combined with cataract surgery, referred to as Phaco-GSL. Viscogonioplasty (VGP) is a similar procedure to GSL, but instead of using a spatula, VGP employs heavy viscoelastic[23-26] to separate the iris from the angle. Similar effects on decreasing IOP have been observed with VGP.[23-26] Many studies have compared the effects of Phaco-GSL with phacoemulsification alone and Phaco-VGP with phacoemulsification alone. However, few studies directly compare Phaco-GSL with Phaco-VGP.

Phaco-GSL and Phaco-VGP are widely utilized globally, particularly in Southeast Asia and China, where the prevalence of PACG is significantly higher in the Asian population[8] compared to other regions. This higher prevalence is due to anatomical predispositions,[27] such as shallower anterior chambers, thicker lens size, and narrower angles commonly seen in Asian eyes. In these regions, PACG represents a substantial public health concern, accounting for a significant portion of glaucoma-related blindness. As a result, surgical approaches like Phaco-GSL and Phaco-VGP are increasingly favored

as effective treatment options to address both cataracts and angle closure in a single procedure.

This randomized clinical trial compares the effects of combined phacoemulsification and GSL versus combined phacoemulsification and VGP on IOP, anterior segment parameters, and complications in angle closure.

MATERIALS AND METHODS

This prospective randomized clinical trial was conducted at Sisaket Hospital in Sisaket, Thailand. The study protocol adhered to the tenets of the Declaration of Helsinki and was approved by the Sisaket Hospital Research Ethical Committee REC No 094/2564, COA No.031. The trial was registered with the Thai Clinical Trials Registry (TCTR20240805005). Patients visiting the Ophthalmology Department, Glaucoma clinic, Sisaket Hospital, Thailand, from November 2021 to May 2024 were enrolled in the study.

The inclusion criteria were as follows: 1) patients with angle closure defined by the presence of ITC of at least 180 degrees, which can be either appositional or synechial; 2) patients with visually significant cataract with visual acuity (VA) worse than 20/50. The exclusion criteria were: 1) presence or history of any cause of secondary glaucoma, including traumatic glaucoma, uveitic glaucoma, neovascular glaucoma, phacomorphic glaucoma, and pseudo-exfoliation glaucoma; 2) history of previous intraocular surgery.

Examinations included VA assessment using the Snellen chart, IOP measurement with the ICare ic200 (Icare Finland Oy, Helsinki, Finland), slit lamp and fundus examination, and gonioscopy. A single glaucoma specialist performed all examinations and evaluations. Baseline clinical characteristics and demographic data were collected, including the history of anti-glaucoma medication use before the operation. Anterior segment optical coherence tomography (AS-OCT) (Cirrus 5000; anterior segment premier module; Carl Zeiss Meditec) collected the anterior segment parameters. Examination was done pre-operation and 1 week, 1 month, 3 months, and 6 months after surgery.

Gonioscopy was performed using a four-mirror gonio lens (Model G-4, Volk Optical). A narrow beam of the slit lamp was used to examine all quadrants in the primary position. Indentation of the gonio lens against the cornea was conducted to investigate the iridotrabecular angle. The angle was graded based on the presence of an ITC of at least 180 degrees.

AS-OCT was performed under dim lighting by a single technician. Scans were centered on the pupil and obtained along the horizontal axis using the anterior segment premier module protocol. The image of the best quality was selected for analysis. A single glaucoma specialist performed measurements. Anterior segment parameters were obtained, including central corneal thickness (CCT) and anterior chamber depth (ACD), defined as the distance from the endothelium to the anterior surface of the crystalline lens or the pupillary plane in pseudophakic eyes. Lens vault (LV) was defined as the perpendicular distance between the anterior lens surface and the horizontal line connecting the two scleral spurs. Angle parameters measured included the angle opening distance (AOD), trabecular-iris space area (TISA) at 500 μm and 750 μm from the scleral spur, and scleral spur angle (SSA) in the nasal and temporal quadrants. The means of the nasal and temporal AOD, TISA, and SSA were used. If the image of the angle parameters in the nasal or temporal quadrant was unclear, the data were excluded from the analysis. AS-OCT was done pre-operative and three months after the operation.

Randomization of subjects and sample size

The sample size was calculated using the method for randomized controlled trials involving continuous data as outlined by Bernard R. The calculation was based on the following parameters: the mean in the treatment group was 9 (from Moghimi et al.[23]) with a standard deviation (SD) of 4, while the mean in the control group was 12 (from Tekhasaenee et al.[2]) with an SD of 4. With an alpha level of 0.05, a beta level of 0.2, and a ratio of 1, the required sample size was determined to be 28 patients in each group. Accounting for an anticipated 20% dropout rate, the final sample size was adjusted to 34 patients in each group. Patients were randomized into two groups using block randomization to receive either phacoemulsification with GSL (Phaco-GSL) or phacoemulsification with VGP (Phaco-VGP).

Surgical technique

A single glaucoma specialist surgeon performed all surgeries. Both procedures were conducted under local anesthesia with a retrobulbar block. The periocular skin was prepared with a povidone-iodine solution, and a 10% povidone-iodine solution was used to irrigate the conjunctival sac. The area was draped using a Steri-Drape, and an eye speculum was applied. Phacoemulsification was performed with two side-port incisions and a 27 mm temporal clear corneal incision. The Phaco-chop technique was used, and an intraocular lens was implanted in the bag. Cohesive viscoelastic (Visiol, TRB CHEMEDICA, Geneva, Switzerland) was utilized during the procedure. A phacoemulsification machine (Centurion; Alcon

Laboratories Inc., Fort Worth, TX) was used in all cases. Postoperatively, topical antibiotics and steroids were prescribed to all patients, with the steroids tapered off over four weeks.

In the Phaco-GSL group, after inserting the intraocular lens (IOL), viscoelastic was filled in the anterior chamber and the angle area. A 27G cannula of viscoelastic was inserted through the main port. Under direct gonioscopic visualization using the Mori upright surgical gonio lens (Ocular Instruments, Inc., Bellevue, WA, USA), the PAS was gently released through the main port, accessing approximately 270 degrees of the angle.

In the Phaco-VGP group, viscoelastic was filled in the anterior chamber like the Phaco-GSL group after IOL implantation. Under direct gonioscopic visualization, a 27G viscoelastic cannula was inserted through the main port to the angle. Viscoelastic was then injected to fill the angle until the separation of the PAS was observed, covering approximately 270 degrees in the superior, nasal, and inferior quadrants, similar to the Phaco-GSL group. No surgical instruments were used to break the PAS physically.

Statistical analysis

Statistical analysis was performed using STATA software (StataCorp LP, College Station, TX, USA). Continuous variables are presented as mean ± standard deviation, while categorical variables are presented as frequency and percentage. Paired t-tests were used to compare IOP, ocular parameters, and the average number of types of glaucoma medications before and after surgery. Kaplan-Meier survival curves were used to compare the success rates between Phaco-GSL and Phaco-VGP over the follow-up period, with a target IOP of 21 mmHg. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 68 eyes were recruited for the study. After excluding patients lost to follow-up, we evaluated 58 eyes. However, there was missing data for certain ocular parameters, including LV, AOD500, AOD750, TISA500, TISA750, and SSA, due to poor image clarity. This affected 3 cases in the Phaco-GSL group and 4 cases in the Phaco-VGP group. There were 30 in Group 1 (Phaco-GSL group) and 28 in Group 2 (Phaco-VGP group). The mean age of patients was 67.16±9.65 years in Group 1 and 67.78±7.38 years in Group 2 (P = 0.79). The mean baseline IOP was 24.31±12.34 mmHg in Group 1 and 24.92±12.50 in Group 2 (P = 0.85). The mean of cup-disc ratio was 0.71±0.22 in Group 1 and 0.77±0.21 in Group 2 (P=0.28). The average number of glaucoma medications was 3.47±0.94 in Group 1 and 3.54±0.58 in Group 2 (P = 0.74). The details of demographic data and ocular parameters are summarized in Table 1.

When considering the division of patients based on diagnosis, they can be divided into three groups as follows: 1) PACG, 2) Post-acute angle closure attack group (Post AAC), and 3) Refractory angle closure attack group (Refractory AAC).

In the PACG group, there were 20 eyes in Group 1 and 17 in Group 2. The mean age of patients was 54.25±15.78 years in Group 1 and 68.88±6.34 years in Group 2 (P = 0.63). The mean baseline IOP was 19.77±7.46 mmHg in Group 1 and 22.39±9.80 mmHg in Group 2 (P = 0.36). The mean cup-disc ratio was 0.73±0.20 in Group 1 and 0.82±0.16 in Group 2 (P = 0.13). The average number of glaucoma medications was 3.20±1.01 in Group 1 and 3.35±0.61 in Group 2 (P = 0.59).

In the Post AAC group, there were 4 eyes in Group 1 and 6 in Group 2. The mean age of patients was 70.00±7.30 years in Group 1 and 69.17±5.91 years in Group 2 (P = 0.06). The mean baseline IOP was 17.25±6.65 mmHg in Group 1 and 18.20±8.44 mmHg in Group 2 (P = 0.86). The mean cup-disc ratio was 0.58±0.32 in Group 1 and 0.72±0.33 in Group 2 (P = 0.51). The average number of glaucoma medications was 4.00±0 in Group 1 and 3.67±0.52 in Group 2 (P = 0.24).

In the Refractory AAC group, there were 6 eyes in Group 1 and 5 in Group 2. The mean age of patients was 66.33±4.76 years in Group 1 and 62.40±10.88 years in Group 2 (P = 0.44). The mean baseline IOP was 44.17±7.03 mmHg in Group 1 and 41.60±11.76 mmHg in Group 2 (P = 0.66). The mean cup-disc ratio was 0.73±0.20 in Group 1 and 0.66±0.23 in Group 2 (P = 0.58). The average number of glaucoma medications was 4.00±0 in Group 1 and 4.00±0 in Group 2 (P = 1.00).

There is a significant decrease in IOP after surgery, with an 11.47±2.34 mmHg reduction in the Phaco-GSL group at 6 months compared to preoperative (P<0.001) and an 11.29±2.50 mmHg reduction in the Phaco-VGP group at 6 months compared to preoperative (P<0.001). In both groups, a significant decrease in IOP from baseline was observed, but no significant difference between the two groups was found. The reduction in IOP at 6 months was 12.84±2.88 mmHg in group 1 and 13.62±4.28 mmHg in group 2 (P=0.40). When considering the diagnosis, there was a more significant decrease in IOP in Refractory AAC compared to other PACG and Post AAC in both the Phaco-GSL and Phaco-VGP groups. However, when comparing the two groups, they were equally effective: in PACG, Group 1 had a reduction

TABLE 1. Demographic data and Ocular parameters.

	GSL	VGP	P-value
Number of eyes	30	28	
Age	67.16±9.65	67.78±7.38	0.79
Sex			0.55
Male	8	10	
Female	22	18	
Cup-Disc ratio	0.71±0.22	0.77±0.21	0.28
VA LogMAR	0.98±0.50	1.39±0.57	0.005
IOP (mmHg)	24.31±12.34	24.92±12.50	0.85
Types of glaucoma medications	3.47±0.94	3.54±0.58	0.74
Diagnosis			0.67
PACG	20	17	
Post AAC	4	6	
Refractory AAC	6	5	
CCT (μm)	523.53±39.65	520.15±42.89	0.76
ACD (mm)	1.96±0.36	1.88±0.43	0.45
LV (μm)	775.57±280.06	801.19±211.66	0.70
AOD500 (mm)	0.155±0.9	0.165±0.11	0.73
AOD750 (mm)	0.249±0.11	0.265±0.17	0.69
TISA500 (mm^2)	0.060±0.40	0.070±0.74	0.56
TISA750 (mm^2)	0.141±0.17	0.111±0.74	0.43
SSA (degree)	16.85±8.80	17.13±11.04	0.92
PACG			
Number of eyes	20	17	
Age	70.00±7.30	68.88±6.34	0.63
Cup-Disc ratio	0.73±0.20	0.82±0.16	0.13
VA LogMAR	0.90±0.33	1.40±0.52	0.001
IOP (mmHg)	19.77±7.46	22.39±9.80	0.36
Types of glaucoma medications	3.20±1.01	3.35±0.61	0.59
CCT (μm)	518.15±38.20	511.31±29.04	0.56
ACD (mm)	2.09±0.37	2.03±0.48	0.65
LV (μm)	747.35±271.00	771.69±246.51	0.78
AOD500 (mm)	0.188±0.09	0.198±0.11	0.78
AOD750 (mm)	0.274±0.10	0.316±0.17	0.39
TISA500 (mm^2)	0.074±0.04	0.089±0.04	0.54
TISA750 (mm^2)	0.177±0.21	0.133±0.07	0.46
SSA (degree)	20.19±8.28	20.29±10.81	0.98

TABLE 1. Demographic data and Ocular parameters. (Continue)

	GSL	VGP	P-value
Post AAC			
Number of eyes	4	6	
Age	54.25±15.78	69.17±5.91	0.06
Cup-Disc ratio	0.58±0.32	0.72±0.33	0.51
VA LogMAR	0.70±0.22	12.27±0.64	0.13
IOP (mmHg)	17.25±6.65	18.20±8.44	0.86
Types of glaucoma medications	4.00±0	3.67±0.52	0.24
CCT (μm)	504.25±19.96	536.4±82.70	0.48
ACD (mm)	1.72±0.08	1.67±0.28	0.74
LV (μm)	1005.75±294.65	892.8±116.02	0.45
AOD500 (mm)	0.110±0.06	0.108±0.10	0.96
AOD750 (mm)	0.230±0.12	0.206±0.13	0.78
TISA500 (mm^2)	0.039±0.02	0.041±0.38	0.91
TISA750 (mm^2)	0.085±0.04	0.081±0.07	0.91
SSA (degree)	12.63±6.57	11.6±10.41	0.87
Refractory AAC			
Number of eyes	6	5	
Age	66.33±4.76	62.40±10.88	0.44
Cup-Disc ratio	0.73±0.20	0.66±0.23	0.58
VA LogMAR	1.46±0.80	1.49±0.79	0.95
IOP (mmHg)0	44.17±7.03	41.60±11.76	0.66
Types of glaucoma medications	4.00±0.63	4.00±0.00	1.00
CCT (μm)	554.33±42.20	532.20±25.90	0.34
ACD (mm)	1.70±0.12	1.64±0.09	0.41
LV (μm)	716.17±271.68	804.00±157.10	0.54
AOD500 (mm)	0.072±0.38	0.130±0.12	0.31
AOD750 (mm)	0.173±0.95	0.178±0.17	0.95
TISA500 (mm^2)	0.026±0.11	0.045±0.04	0.36
TISA750 (mm^2)	0.057±0.02	0.077±0.08	0.60
SSA (degree)	8.2±4.10	13.8±11.18	0.32

of 12.83±3.30 mmHg, and Group 2 had a decrease of 14.54±4.93 mmHg (P=0.22); in Post AAC, Group 1 had a decline of 11.65±1.70 mmHg and Group 2 had a reduction of 12.41±3.14 mmHg (P=0.67); and in Refractory AAC, Group 1 had a decrease of 13.67±1.75 mmHg and Group 2 had a decline of 12.00±2.23 mmHg (P=0.20), as shown in Table 2 and Fig 1.

At 6 months postoperatively, we found that 100% (30/30) of eyes in Group 1 had an IOP of less than 21 mmHg, with a 47.18% reduction in IOP, and 100% (28/28) of eyes in Group 2 had an IOP of less than 21 mmHg, with a 45.35% reduction in IOP, both with the use of glaucoma medications.

At the 6 months of follow-up, there was a significant decrease in the number of glaucoma medications, with a reduction of 1.54±0.28 in Group 1 (P<0.001) and 2.08±0.28 in Group 2 (P<0.001). In both groups, a significant decrease in glaucoma medication was observed, but no significant difference was found between the two groups. When comparing the two groups based on diagnosis, they were equally effective in decreasing the types of glaucoma medication: in PACG, Group 1 had a reduction of 1.95±1.28 and Group 2 had a decrease of 1.76±1.39 (P=0.68); in Post AAC, Group 1 had a reduction of 1.50±1.00 and Group 2 had a decline of 1.00±1.26 (P=0.53); and in Refractory AAC, Group 1 had a decrease of 2.17±1.17 and Group 2 had a reduction of 1.00±1.41 (P=0.17).

Significant widening of ocular parameters (ACD, LV, AOD500, AOD750, TISA500, TISA750, SSA) was

TABLE 2. Ocular parameters after surgery.

Overall (Angle closure)	GSL	VGP	P-value
VA LogMAR	0.55±0.48	0.74±0.70	0.24
IOP (mmHg)	12.84±2.88	13.62±4.28	0.40
Types of glaucoma medications	1.93±1.20	1.46±1.37	0.17
ACD (mm)	3.27±0.30	3.21±0.27	0.41
LV (μm)	-477.73±157.05	-474.80±188.87	0.95
AOD500 (mm)	0.307±0.09	0.280±0.10	0.32
AOD750 (mm)	0.483±0.13	0.470±0.17	0.76
TISA500 (mm^2)	0.109±0.04	0.126±0.16	0.59
TISA750 (mm^2)	0.208±0.05	0.190±0.07	0.34
SSA (degree)	30.81±7.13	28.30±9.02	0.27
PACG			
VA LogMAR	0.41±0.23	0.63±0.66	0.16
IOP (mmHg)	12.83±3.30	14.54±4.93	0.22
Types of glaucoma medications	1.95±1.28	1.76±1.39	0.68
ACD (mm)	3.27±0.28	3.19±0.29	0.45
LV (μm)	-432.80±127.76	-420.07±172.32	0.80
AOD500 (mm)	0.319±0.09	0.320±0.09	0.98
AOD750 (mm)	0.455±0.12	0.520±0.13	0.16
TISA500 (mm^2)	0.115±0.04	0.164±0.20	0.31
TISA750 (mm^2)	0.206±0.05	0.217±0.07	0.64
SSA (degree)	31.91±6.80	31.86±7.37	0.98

TABLE 2. Ocular parameters after surgery. (Continue)

Overall (Angle closure)	GSL	VGP	P-value
Post AAC			
VA LogMAR	0.56±0.40	1.08±0.99	0.35
IOP (mmHg)	11.65±1.70	12.41±3.14	0.67
Types of glaucoma medications	1.50±1.00	1.00±1.26	0.53
ACD (mm)	3.44±0.25	3.26±0.23	0.29
LV (μm)	-547.50±246.90	-521.20±183.60	0.86
AOD500 (mm)	0.233±0.05	0.213±0.08	0.66
AOD750 (mm)	0.520±0.13	0.352±0.16	0.12
TISA500 (mm^2)	0.080±0.02	0.070±0.02	0.52
TISA750 (mm^2)	0.205±0.05	0.144±0.05	0.12
SSA (degree)	24.88±4.62	22.70±7.73	0.64
Refractory AAC			
VA LogMAR	1.03±0.86	0.68±0.31	0.41
IOP (mmHg)0	13.67±1.75	12.00±2.23	0.20
Types of glaucoma medications	2.17±1.17	1.00±1.41	0.17
ACD (mm)	3.19±0.42	3.20±0.28	0.93
LV (μm)	-581.00±140.35	-592.60±212.40	0.91
AOD500 (mm)	0.322±0.11	0.234±0.12	0.27
AOD750 (mm)	0.552±0.13	0.449±0.25	0.43
TISA500 (mm^2)	0.11±0.04	0.08±0.04	0.20
TISA750 (mm^2)	0.214±0.06	0.165±0.08	0.30
SSA (degree)	31.6±8.76	23.9±11.13	0.26

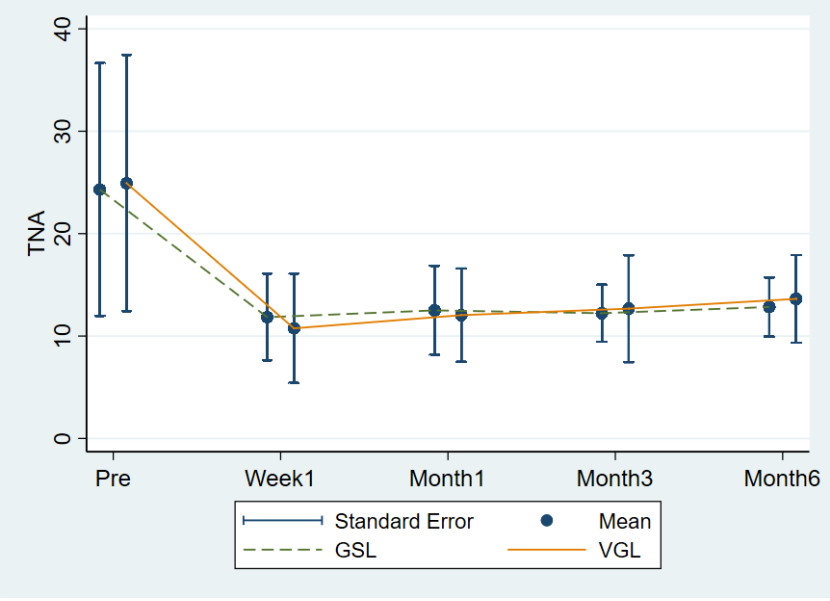

Fig 1. Shows the IOP between the Phaco-GSL and the Phaco-VGP groups.

observed in both groups at the 3 months compared to pre-operation. However, the difference between the two groups was not significant.

Surgical safety was assessed, and all patients were evaluated for complications. Three cases of hyphema were found: two in the Phaco-GSL group and one in the Phaco-VGP group. One case of Toxic anterior segment syndrome (TASS) was found in the Phaco-GSL group. No other complications were found in either group.

Fig 2 presents Kaplan-Meier survival curves for a success rate defined as an IOP of 21 mmHg or less after surgery. The hazard ratio was 4.29, with a P-value of 0.066 and a 95% confidence interval (CI) of 0.91 to 20.18.

DISCUSSION

GSL and VGP are commonly used procedures to separate ITC. The role of GSL in angle closure, such as PACG and AAC, has been well described in many studies,[2,16-21] while the role of VGP has been described in fewer studies.[21-24] However, there are limited comparative studies between phacoemulsification with GSL and phacoemulsification with VGP.

In our study, the mean age was not significantly different between the two groups, similar to the findings of Wanichwecharungruang et al.,[18] Eslami et al.,[25] and Moghimi et al.[26] However, the mean age in our study was higher compared to that reported by Teekhasaenee et al.[2] (59.6±10.6 years) and Angmo et al.[22] (57.50±9.17 years). The VA showed significant differences between the groups preoperatively, likely due to differences in cataract severity. However, after phacoemulsification and intraocular lens implantation, VA improved, and there was no significant difference between the groups (P=0.24). The mean baseline IOP was not significantly different between the two groups (P=0.85) and significantly improved in both groups postoperatively. Our results in the Phaco-GSL group are consistent with other studies, as indicated in Table 3. Additionally, our findings in the Phaco-VGP group show similar postoperative IOP at 6 months. Our baseline use of glaucoma medications was similar to that reported by Angmo et al.,[22] but higher than in other studies.[2,18,20,24-26] Similarly, our postoperative use of glaucoma medications was comparable to that of Angmo et al.[21] and remained higher than in other studies.[2,18,20,24-26]

When comparing the success rate, which targeted IOP at last follow up less than 21 mmHg. In Group 1, our results compare favorably to Teekhasaenee et al.,[2] who reported 90.4% (47/52) success without medications. Our results are comparable to Husain et al.,[20] who achieved a target pressure of 21 mmHg with a 92.1% success rate, and to Angmo et al.,[22] who reported a 91.18% success rate with a 20% reduction in IOP from baseline. In Group 2, our results are comparable to those of Moghimi et al.,[26] who reported a 38% reduction in IOP after surgery.

Our results for glaucoma medication usage in Group 1 are higher than those reported by Teekhasaenee et al.,[2] Wanichwecharungruang et al.,[18] and Husain et al.[20] but similar to those reported by Angmo et al.[22] In Group 2, our findings are higher than those reported by Eslami et al.[25] and Moghimi et al.[26] This may be due to the higher preoperative medication usage in our study compared to other studies.

After 3 months, we observed a significant widening in anterior chamber parameters on AS-OCT, including ACD, LV, AOD500, AOD750, TISA500, TISA750, and SSA, in both groups. However, there were no significant

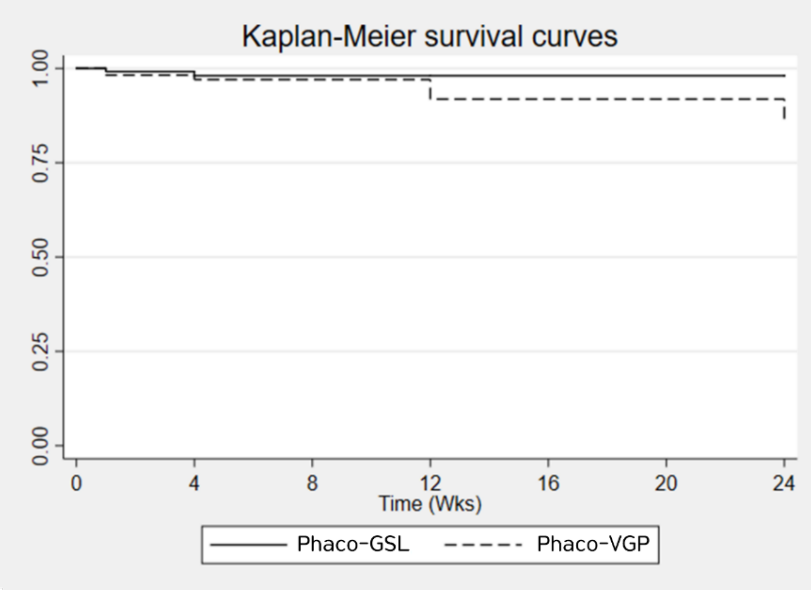

Fig 2. Shows the IOP between the Phaco-GSL and the Phaco-VGP groups in Kaplan-meier survival curves

TABLE 3. Our results compared to other studies.

	Intervention	Participation	Follow-up (Month)	Preoperative IOP (mmHg)	Postoperative IOP (mmHg)	Preoperative Medications	Post operative Medications
Our study	GSL	30	6	24.31±12.34	12.84±2.88	3.47±0.94	1.93±1.20
	VGP	28	6	24.92±12.50	13.62±4.28	3.54±0.58	1.46±1.37
Teekhasaenee[2]	GSL	52	6	29.7±7.9	13.2±2.9	2.4±0.9	0.1±0.3
Wanichwecharungruang[17]	GSL	76	6	24.5	13	3	0
Husain[19]	GSL	33	12	22.9	15.9	1.9	0.6
Angmo[21]	GSL	34	6	30.72±3.88	13.21±1.97	4.03±0.41	2.05±0.46
Varma[23]	VGP	25	12	30.12±7.03	13.7±2.89	-	-
Eslami[24]	VGP	33	1.5	24.5±6.8	16.9±4.9	1.3±1.2	0.1±0.4
Moghimi[25]	VGP	45	12	23.3±7.3	14.5±2.5	1.7±1.1	0.4±0.8

differences between the two groups. In Group 1, similar findings were reported by Angmo et al.[22] In Group 2, comparable results were reported by Eslami et al.[25] and Moghimi et al.[26]

Our findings from the Kaplan-Meier survival curves, where the success rate was defined as achieving a target IOP of 21 mmHg or less after surgery, were not statistically significant. However, when observing the trends in the graphs for the Phaco-GSL and Phaco-VGP groups, there appears to be a tendency towards a higher success rate in the Phaco-GSL group. This may be due to the higher rate of PAS re-adhesion in the Phaco-VGP group. Additionally, the severity of PAS may play an important role in the outcomes of the study. In this study, we did not differentiate the severity of synechiae between the two groups for analysis. Furthermore, since this surgical technique was performed by a single surgeon, it may also have influenced the outcomes. Further studies with longer follow-up periods, larger sample sizes, and stratified analyses of synechiae severity are necessary to validate these findings.

We observed three cases of hyphema: two in the Phaco-GSL group and one in the Phaco-VGP group. Additionally, there was one case of Toxic Anterior Segment Syndrome (TASS) in the Phaco-GSL group, which was effectively managed with steroids and resolved within a week. Our complication profile aligns with that reported by Teekhasaenee et al.[2], who noted plasmoid or fibrinoid aqueous as the most common complication, with hyphema being relatively limited.

The case of TASS in our study occurred in a patient who presented with a refractory acute angle-closure attack and severe inflammation prior to surgery. On the first postoperative day, plasmoid aqueous filled approximately half of the anterior chamber, and routine postoperative medications, including 1% prednisolone acetate every two hours, were initiated. However, two days after discharge, the patient returned with hypopyon and was readmitted. The treatment regimen was adjusted to include oral steroids (15 mg, four times daily) alongside topical steroids every two hours. With close monitoring, the symptoms improved. Based on our experience, we suggest that in cases of severe preoperative inflammation, the use of oral steroids may play a crucial role in reducing inflammation and minimizing postoperative complications.

Both Phaco-GSL and Phaco-VGP have demonstrated similar efficacy in widening the angle and lysing synechiae at the trabecular meshwork. In cases of extensive peripheral anterior synechiae (PAS), Phaco-GSL has shown greater efficacy in reducing intraocular pressure (IOP), as reported by Tian et al.[26] However, Phaco-VGP has not yet been extensively studied in this context, indicating the need for further research. In our view, for patients with extensive PAS where synechiae observed during gonioscopy do not

respond to VGP, Phaco-GSL may offer a more effective option for the mechanical removal of synechiae compared to the pressure exerted by viscoelastics.

Study limitations

Our study's limitations include the short follow-up period and the lack of postoperative gonioscopy documentation. For further evaluation, long-term follow-up with a larger population may be required.

CONCLUSION

According to our results, both phacoemulsification with GSL and phacoemulsification with VGP effectively reduce IOP and decrease the use of glaucoma medications. Additionally, both procedures similarly widen the ocular angle with comparable effects. In cases of extensive PAS, Phaco-GSL may sustain IOP reduction longer than Phaco-VGP. However, further studies are needed to confirm this observation.

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DECLARATION

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Conflicts of Interest

The author declares no conflict of interest and declares that the research was conducted in the absence of any commercial or financial relationships that could beconstructed as a potential conflict of interest.

Author Contributions

D.A. was solely responsible for the conceptualization, methodology, data collection, analysis, manuscript drafting, and final approval of the study.

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