Postoperative Changes After Phacoemulsification with Posterior Intraocular Lens Implantation Combined with Goniosynechialysis in Patients with Different Axial Lengths

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Research Article

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Abstract

Background: With the aging of the global population, the incidence of primary angle-closure glaucoma (PACG) or primary angle closure (PAC) with concomitant cataracts has been increasing. We aimed to compare the corneal higher-order aberrations, refractive error and ocular biological parameters changes after phacoemulsification with posterior intraocular lens implantation combined with goniosynechialysis (Phaco-IOL-GSL) was performed in PACG or PAC patients with concomitant cataracts and different axial lengths.

Methods: 83 eyes of 69 patients in cataracts with PACG or PAC were divided into two groups according to the axial length (AL): the short ($AL \leq 22.5$ mm) and normal axial group ($22.5 < AL \leq 24.5$ mm). The intraocular pressure (IOP) and best-corrected visual acuity (BCVA) were measured before surgery and 1-day, 1-week, 1-month, 3-month, 6-month, 12-month after surgery. The corneal higher-order aberrations, antiglaucoma medications, visual fields, refractive diopter and other ocular biological parameters were measured before surgery and at the last follow-up. The difference between the two groups was assessed after surgery.

Results: Compared with the baseline, the BCVA significantly improved, while IOP was decreased in both groups ($P < 0.01$). Both anterior and total cornea HOAs and Z (3,-3) were increased in both groups ($P < 0.05$ and $P < 0.05$, respectively) and the larger increments in Z (3,-3) were found in normal axial group. The anterior chamber depth (ACD) and the AL were increased in both groups after Phaco-IOL-GSL ($P < 0.01$ and $P < 0.01$, respectively); however, no difference was found between two groups ($P = 0.191$, $P = 0.066$). The refractive outcomes were significantly different in both groups ($P = 0.029$), and a slight shift towards hyperopia was observed in normal axial group ($P = 0.002$). Correlation analysis found that refractive error was positively correlated with increments in ACD (r = 0.373, $P = 0.001$) and decrements in AL (r = 0.331, $P = 0.002$).

Conclusions: Phaco-IOL-GSL is an effective surgery for cataract patients with PACG or PAC. After surgery, anterior and total cornea Z (3, -3) varied with different AL at one-year follow-up. The refractive errors such as hyperopic shifts increased when the ACD was increased, and AL was decreased after surgery, especially in patients with normal axial lengths.

Introduction

Cataract and glaucoma are the two leading causes of blindness in the world, while the incidence of primary angle closure (PAC) and primary angle-closure glaucoma (PACG) have been reported to be higher in Asians than Europeans and Africans [1]. It is widely acknowledged that cataracts are the result of aging and are highly prevalent in older people. With the aging of the global population, the incidence of PACG or PAC with concomitant cataracts has been increasing [2]. In recent years, phacoemulsification and posterior intraocular lens implantation combined with goniosynechialysis (Phaco-IOL-GSL) has attracted interest from ophthalmologists. Phaco-IOL-GSL, which involves stripping peripheral anterior synechia (PAS) from the angle wall and restoring the trabecular filtering function, has been reported to lead to fewer subsequent surgical interventions and avoid filtering bleb scarring formation after glaucoma filtration surgery [2, 3]. This procedure is indeed safe and effective for cataract patients with PACG or PAC.

However, an increasing body of evidence suggests that glaucoma and cataract surgery can induce refraction errors and changes in visual function [4, 5, 6, 7]. Higher-order aberrations are major distortions that can produce visual disturbances such as dazzle and starbursts and have been associated with surgeries [7, 8], including Glaucoma filtration surgery [4, 5], cataract extraction [9], and intraocular lens (IOL) implantation. However, to our knowledge, few studies have explored the corneal higher-order aberrations in PACG or PAC patients with cataracts. Goniosynechialysis involves inducing an alteration of the structure of the iris and opening the iridocorneal angle; however, the influence of physically separating the peripheral anterior synechiae from the trabecular meshwork is unclear. This may changes in corneal aberrations and corneal shape, influence ocular parameters. In addition, PACG or PAC eyes have been reported to be different from normal eyes with shallower anterior chambers, shorter axial lengths, zonular weakness and larger lens capsules [10]. This can cause poor prediction of the postoperative intraocular lens location and lead to refractive errors. Interestingly, some studies have found an association between increased axial length (AL) and more unpredictable refractive outcomes after cataract surgery [11, 12], with longer AL associated with greater refractive error after surgery. After glaucoma filtration surgery, a decrease in AL usually occurs [13, 14]. Accordingly, the selection of IOL in these patients should be different from patients with only age-related cataracts.

The purpose of our research was to investigate the influence of corneal higher-order aberrations, ocular biological parameters and refractive error after Phaco-IOL-GSL was performed in patients with different axial lengths and help ophthalmologists in decision making, especially for IOL selection. Given that PACG or PAC patients usually have short eye axial lengths, we mainly studied patients with this particular characteristic.

Patients And Methods

Patients scheduled for Phaco-IOL-GSL surgery at the Daping Hospital of Chongqing, China, from January 2020 and July 2021 were recruited in this prospective group study. All studies and examinations were conducted in accordance with the Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects and approved by the hospital’s Ethics Committee (TDLL 2020–90). Informed consent was obtained from all study participants.

The inclusion criteria for this study were as follows: patients diagnosed with PACG or PAC with concomitant cataracts and aged greater than 50 years old. The diagnosis of PAC and PACG was based on The International Society of Geographic and epidemiologic Ophthalmology definitions [15]: A diagnosis of PAC was established when the iris trabecular contact was at least 180º during a gonioscopic examination, accompanied with raised intraocular pressure or peripheral anterior synechia, but without glaucomatous optic neuropathy. Diagnosis of PACG was established in eyes with PAC and evidence of glaucomatous optic nerve damage. The exclusion criteria included patients with fixed dilated pupils, secondary angle closure due to uveitis, ocular trauma, and lens subluxation. Individuals with a history of ocular surgery or other ocular diseases were also excluded from the study. All recruited patients were classified into two groups according to the axial length: short axial group ($AL \leq 22.5$ mm) and normal axial group ($22.5 < AL \leq 24.5$ mm).

Clinical data measurement

After signing informed consent forms, all patients received a complete ophthalmic examination before surgery, including measurement of intraocular pressure (IOP), manifest refraction, best-corrected visual acuity (BCVA), B-ultrasound, fundus photography, slit-lamp and gonioscopy examinations. The IOP and BCVA measurements were repeated at 1-day, 1-week, 3-month, 6-month, 12-month follow-up visits. The results of manifest refraction, ultrasound biomicroscopy, Humphrey Field Analyzer 750II (Carl Zeiss Meditec), IOL-Master700 (Carl Zeiss Meditec AG), Pentacam and the antiglaucoma medications were recorded before surgery and at the last follow-up examination. IOL-Master was used to measure the ocular axis length (AL) and corneal curvature (K values). The anterior chamber depth (ACD) was measured by Ultrasound biomicroscopy. Corneal higher-order aberrations were measured by a rotating Scheimpflug camera (Pentacam HR, Oculus, Wetzler, Germany) in a dark room. The anterior, posterior, and total corneal wavefront aberrations for the 6.0-mm pupillary diameter were measured. Select the image when the instrument displays “OK”. The measured parameters included the root-mean-square (RMS) of high-order aberrations (HOAs), primary spherical aberration Z (4, 0), horizontal coma Z (3, 1), vertical coma Z (3,-1), oblique trefoil Z (3, 3), and vertical trefoil Z (3,-3) of the total cornea, anterior cornea surface, and posterior cornea surface.

Surgical technique

All the Phaco-IOL-GSL surgeries were performed by a single experienced surgeon (LY). After topical anesthesia, standard phacoemulsification was executed with a 2.8mm clear corneal track at the 10 o’clock position and 1mm lateral incision, followed by posterior chamber IOL implantation into the capsule. Then, the operating microscope was tilted at approximately 45°; a Swan Jacobs direct gonio lens (Ocular Instruments, Bellvue, WA, USA) was placed on the cornea to make the angle visible. Viscoelastic was injected along the peripheral anterior chamber to open PAS. A modified iris repositor was then used to separate residual PAS to expose the trabecular meshwork. The viscoelastic was thoroughly removed and the incision sealed by corneal stromal hydration. After surgery, all patients were prescribed Pranoprofen Eye Drops (Pranopulin) and tobramycin dexamethasone eyedrops (TobraDex) four times daily, tapered over four to six weeks.

Statistical analysis

The data were performed by SPSS version 17.0 (SPSS Inc., Chicago, IL, USA). A paired *t*-test was used to compare IOP and BCVA measurements at 1-day, 1-week, 3-month, 6-month, 12-month follow-up after

Phaco-IOL-GSL with the baseline values and comparison before and after surgery. When the data were normally distributed, the independent-sample *t*-test was used to compare the data between the short axial group ($AL \leq 22.5$ mm) and normal axial group ($22.5 < AL \leq 24.5$ mm); otherwise, the Mann-Whitney U test was used. Pearson correlation coefficient was used to analyze the correlation between refractive errors and increments in ACD. The Spearman correlation coefficient was used to analyze the correlation between refractive errors and decrements in AL. Data were expressed as mean ± standard deviation. A *P*-value less than 0.05 was considered statistically significant.

Result

119 eyes of 86 patients who underwent Phaco-IOL-GSL surgery from January 2020 to July 2021 participated in this study. 36 eyes of 25 patients were excluded due to non-compliance for follow-up visits. Finally, 83 eyes of 69 patients were included and separated into short (n=37, mean age 63.68 ± 6.60) and normal axial groups (n=46, mean age 67.59 ± 8.36). A higher proportion of female patients was found in the short (33/37) and the normal axial (32/46) groups. Furthermore, no intraoperative or postoperative complications occurred in both groups.

Figure 1 shows the time-dependent changes in BCVA (LogMAR chart records) and IOP. The mean IOP with preoperative drug treatment was 23.07 ± 9.21 mmHg in the short axial group and 22.20 ± 8.03 mmHg in the normal axial group. Significantly lower IOP was found at each follow-up than baseline values in both groups ($P < 0.01$). The postoperative IOP at 1-day, 1-week, 1-month, 3-month, 6-month, 12-month follow-up was 15.66 ± 4.65 mmHg, 16.06 ± 4.76 mmHg, 13.73 ± 2.91 mmHg, 13.76 ± 2.77 mmHg, 14.78 ± 3.86 mmHg and 14.99 ±4.34 mmHg, respectively in the short axial group and 14.90 ± 4.35 mmHg, 16.05 ± 5.16 mmHg, 14.32 ± 3.73 mmHg, 14.31 ± 3.31 mmHg, 14.04 ± 2.89 mmHg and 15.26 ± 3.51 mmHg, respectively in the normal axial group. The IOP was stable at one-month follow-up in both groups. Moreover, the mean preoperative BCVA was 0.46 ± 0.50 in the short axial group and 0.40 ± 0.35 in the normal axial group. The BCVA was significantly improved at each postoperative follow-up compared to the baseline in both groups ($P < 0.01$, respectively). The postoperative BCVA at 1-day, 1-week, 1-month, 3-month, 6-month, 12-month follow-up was 0.20 ± 0.15, 0.25 ± 0.22, 0.22 ± 0.19, 0.22 ± 0.19, 0.22 ± 0.20 and 0.22 ±0.18, respectively in the short axial group while the corresponding BCVA measurements in the normal axial group were 0.20 ± 0.15, 0.17 ± 0.12, 0.16 ± 0.13, 0.17 ± 0.12, 0.18 ± 0.14 and 0.18 ± 0.13, respectively. The BCVA was stable one week after surgery in both groups. At the last follow-up, the number of antiglaucoma drugs decreased from 2.73 ± 1.02 to 0.89 ± 0.97 in the short axial group and from 2.85 ± 0.82 to 0.72 ± 0.86 in the normal axial group; however, no statistically significant difference was found between both groups. The success rate at the last follow-up was 95.2%, including the complete success ($6 \text{ mmHg} \leq IOP \leq 21 \text{ mmHg}$ and IOP of 20% or lower than baseline IOP without any glaucoma medications) of 48.19% and qualified success ($6 \text{ mmHg } IOP \leq 21 \text{ mmHg}$ and IOP of 20% or lower than baseline with glaucoma medications) of 46.99%. The failure rate was 4.82% ($IOP > 21$ mmHg on maximally tolerated medications).

Compared with the baseline, for individual Zernike terms in the anterior surface and total cornea, HOAs and Z (3,-3) were increased in both groups at last follow-up ($P < 0.05$). Significant changes in posterior corneal surface HOAs were found in the normal axial group ($P = 0.031$), and Z (4, 0) changes in the short axial group ($P = 0.041$). As shown in Table 1, an anterior corneal Z (3,-3) increment of 0.113 ± 0.033 was found in the short axial group and 0.210 ± 0.029 in the normal axial group. Total cornea Z (3,-3) increment was 0.098 ± 0.032 in the short axial group and 0.198 ± 0.031 in the normal axial group. The difference between the two groups was statistically significant ($P = 0.03$, respectively). This finding indicated that Z (3,-3) increments in the anterior and total cornea varied according to the AL.

Table 1

Comparison of the changes in postoperative corneal high-order aberration between the two groups. Changes in corneal higher-order aberrations are expressed as the postoperative high-order aberrations-preoperative higher-order aberrations. *P* < 0.05 was considered statistically significant.

Parameter		**AL≤22.5mm**	**22.5<AL≤24.5mm**	***P* Value**
anterior cornea surface	HOAs	0.120±0.042	0.148±0.065	0.237
	Z (4, 0)	0.021±0.021	0.026±0.018	0.428
	Z (3,-3)	0.113±0.033	0.210±0.029	0.030
	Z (3,-1)	0.015±0.025	0.008±0.023	0.845
	Z (3, 1)	0.006±0.017	0.018±0.017	0.621
	Z (3,3)	0.037±0.023	0.032±0.034	0.912
posterior cornea surface	HOAs	0.015±0.011	0.021±0.010	0.640
	Z (4, 0)	0.012±0.006	0.010±0.005	0.807
	Z (3,-3)	-0.007±0.011	0.001±0.007	0.547
	Z (3,-1)	-0.004±0.005	-0.006±0.006	0.436
	Z (3, 1)	-0.003±0.004	-0.005±0.005	0.826
	Z (3,3)	0.006±0.007	-0.006±0.010	0.605
total cornea	HOAs	0.109±0.043	0.177±0.042	0.331
	Z (4, 0)	0.019±0.023	0.023±0.018	0.913
	Z (3,-3)	0.098±0.032	0.198±0.031	0.030
	Z (3,-1)	-0.004±0.030	-0.003±0.022	0.687
	Z (3, 1)	0.027±0.016	0.026±0.016	0.810
	Z (3,3)	0.027±0.021	0.037±0.032	0.851

At the last follow-up examination, the manifest refraction was converted into a spherical equivalent (SE) for analysis. Refractive error was defined as the difference between the predicted SE and the actual postoperative SE. There were significant differences in the postoperative refractive errors between both groups ($P = 0.029$). The showed a slight hyperopic shift in the normal axial group ($P = 0.002$), which was not significant in the short axial group ($P = 0.556$). As shown in Figure 2, Pearson analysis found the refractive error was positively correlated with ACD increments (r = 0.373, $P = 0.001$). Spearman analysis found the refractive error has a positive correlation with decrement of AL (r = 0.331, $P = 0.002$). This finding indicated the hyperopic shifts, could increase with an increase in ACD and a decrease in AL after Phaco-IOL-GSL surgery, especially in the normal axial group. As shown in Table 2, a shorter AL ($P < 0.01$) and increased ACD ($P < 0.01$) were obtained postoperatively, however no significant difference in these parameters was found between both groups ($P = 0.191$, $P = 0.066$). The difference in K values was not significant during preoperative and postoperative comparison ($P > 0.05$), and intergroup comparison ($P = 0.579$).

Table 2

Comparison of other parameters changes between two groups.

Changes of the parameters are expressed as the postoperative-preoperative. $P < 0.05$ was considered statistically significant.

Parameter	AL≤22.5mm	22.5<AL≤24.5mm	*P* Value
AL	-0.091±0.082	-0.126±0.094	0.191
ACD	1.679±0.388	1.857±0.468	0.066
K Value	-0.04±0.304	-0.078±0.322	0.579
VFI	2.472±0.692	2.429±8.713	0.860
MD	1.855±3.111	0.745±3.138	0.100
PSD	-0.538±1.530	0.188±1.507	0.149
Refractive error	-0.077±0.787	0.263±0.541	0.029

The 24-2 SITA standard test was used to assess visual fields and required fixation losses and false negatives less than 20% considered clinically valuable. After surgery, in the short axial group, the mean deviation (MD) changed from -9.16 ± 9.11 dB to -7.38 ± 9.54 dB ($P = 0.001$), the visual field index (VFI) changed from 79.17% ± 29.24 to 81.54% ± 30.18 ($P = 0.039$), the pattern standard deviation (PSD) changed from 4.08 ± 3.21 to 3.64 ± 3.20 ($P = 0.042$). In the normal axial group, the MD changed from -9.68 ± 9.58 dB to -8.42 ± 8.59 dB ($P = 0.123$), the VFI changed from 75.69 ± 30.65% to 79.72 ± 26.67% ($P = 0.078$), the PSD changed from 4.79 ± 3.62 to 4.70 ± 3.64 ($P = 0.413$). However, no significant difference in MD ($P > 0.05$), PSD ($P > 0.05$) and VFI ($P > 0.05$) was found in both groups (Table2).

Discussion

At present, surgery is the mainstay for clinical treatment of PAC or PACG with coexisting cataracts. However, the discrepancy between the expected and the postoperative visual image quality is a source of patient dissatisfaction [13, 16]. In a retrospective case-control study, more refractive errors were found in PACG patients than in single cataract and primary open-angle glaucoma patients after phacoemulsification; it was thought that the shallow ACD and short AL structure of PACG resulted in poor accuracy of refraction [17]. Meanwhile, high-order aberrations have been documented to affect postoperative visual quality [7, 8]. There is a paucity of studies assessing the corneal high-order aberrations and ocular biological characteristics changes in PAC or PACG patients with concomitant cataracts in different axial eye lengths. In the present study, we focused on the changes after Phaco-IOL-GSL, sought to better understand the variations in outcomes and help ophthalmologists select appropriate IOLs to improve the visual quality of this patient population.

Several studies have demonstrated that surgery could increase the risk of corneal higher-order aberrations, mainly due to the size and location of the incision and subsequent corneal tissue deformation and endothelial damage [9, 18, 19]. In a randomized controlled trial, *Marcos et al.* [19] inserted two types of monofocal IOLs through 3.2 mm superior corneal incisions during cataract surgery in patients. They found corneal trefoil and tetrafoil were significantly increased, and neither spherical aberration nor coma have this phenomenon. More comprehensive results were obtained in the present study since we measured the changes of the anterior surface, posterior surface, and total cornea aberrations. We found an increase in HOAs in the anterior surface and total cornea in both groups, especially for Z (3,-3). The change in anterior corneal surface HOAs was consistent with the total cornea, while the posterior corneal surface HOAs contributed only a small proportion to the total corneal, suggesting changes in posterior corneal aberration exerted little effect on long-term visual quality. It has been reported that corneal inflammation, edema or the remolding of the endothelial cells may lead to HOA changes on the posterior corneal surface during the early stages of surgery; however, these changes gradually disappear over time [18, 20]. Our study have neglected the impact of time on these changes since longer follow-up times. In addition, we found that increments of the anterior surface and total cornea Z (3,-3) differed in both groups while the changes of other HOAs were similar. Previous studies have found that trefoil was related to AL and axial elongation, and it usually is fortified after surgery and would not compensate by the internal optics of the eye [21, 22]. A recent study compared two types of incisions in cataract surgery and found that minimizing the incision size could reduce the aberrations, especially trefoil [18]. Our study indicated the HOAs increased after Phaco-IOL-GSL, especially anterior cornea surface and total cornea Z (3,-3) at one-year follow-up, and varied according to the AL.

The last postoperative manifest refraction showed that both groups were inclined to drift towards hyperopia. However, only changes in the normal axial group were statistically significant ($P = 0.002$). Cataract surgery is a procedure where the lens is removed, and a pupillary block is relieved, deepening the anterior chamber. According to *Ning et al.* [23], patients with shorter preoperative ACD and AL would experience greater changes in ACD and hence be prone to drift towards myopia after cataract surgery. In contrast, patients with deep preoperative anterior eye chambers and long AL were prone to drift towards hyperopia. These findings indicated that ACD was a predictor of refractive outcomes after age-related cataract surgery. Many studies considered that ACD was an indicator of the position of the IOL postoperatively, and each additional 1 mm change in the ACD could lead to at least 0.32D of refractive shift [23, 24]. In the present study, we found that hyperopic drift positively correlated with the increment of ACD ($r = 0.373$, $P = 0.001$) and the decrement in AL after glaucoma surgery was positively correlated with the hyperopic drift ($r = 0.331$, $P = 0.002$).

Interestingly, changes in AL after glaucoma surgery have been associated with the use of antimetabolites, decreased IOP accompanied by choroidal thickening and surgical complications such as hypotony maculopathy [25]. This process may not be observed in patients with only age-related cataracts without PAC or PACG. *Osamah Saeedi et al.* found that as IOP decreased after trabeculectomy, the AL became shorter, and the choroidal thickness increased in all PACG patients. It was thought that scleral relaxation after decreased IOP and decreased pressure exerted on the choroid caused the decrease in AL [26]. Moreover, *Maul et al.* examined glaucoma patients with spectral-domain optical coherence tomography and found that the ocular perfusion pressure level influenced the choroidal thickness. As the IOP was decreased, the blood volume of the choroid increased, and the choroid became thicker [27]. As we know, AL and ACD are two important factors which impact refractive errors after Phaco-IOL-GSL, while choroid thickness and IOP influence maybe the reasons for those changes. Moreover,removal of cataract can lead to deepening of ACD and subsequent hyperopia shift in PACG when an IOL is implanted in a more posterior plane than preoperatively planned [10]. Although both groups exhibited an incline to drift towards hyperopia after the operation, the individual refractive direction was uncertain. Perhaps the large size of the lens capsule or the tilt or eccentricity of the IOL resulted into an ineffective lens position [23]. Many researchers agree that postoperative refractive shifts occur [23, 28]; however, no consensus has been reached on their underlying mechanisms. After cataract surgery, a hyperopic shift has often been reported in PACG patients due to the shallower anterior eye chambers and shorter AL. However, few studies have sought to investigate refractive shifts in patients with different AL. Our results showed an increased incidence of hyperopia after Phaco-IOL-GSL, especially in patients with normal axial length. Further studies involving a larger number of cases could reveal other factors that can influence refractive shift.

In addition, visual field examination showed that the PSD, MD, and VFI improved in the short axial group after surgery but no statistically significant in the normal axial group. This finding may be accounted for by the varying degree of severity of cataracts in the two groups. By conducting visual field evaluation in patients with glaucoma after cataract surgery, *Zhao et al.* found a significant increase in mean visual field sensitivity; however, the difference in the severity and distribution of visual field defects at baseline led to differences in the improvement in visual fields after cataract surgery [29]. Besides, a decrease in the use of postoperative antiglaucoma medications was found. The success rate of Phaco-IOL-GSL has been reported to be 80–100% [30, 31]. In our study, the success rate at the last follow-up was 95.2%, including the complete success of 48.19% and qualified success of 46.99%. However, four unsuccessful cases were found in our study that were managed with a drainage valve or by implantation of an EXPRESS filtration device. The uncontrollable IOP may be accounted for the PAS recurring. Moreover, prolonged uncontrolled IOP accompanied with chronic inflammation of the trabecular meshwork also disrupted the normal function of the trabecular meshwork.

The limitations of our study are the lack of cases with AL > 24.5 mm. It remains uncertain whether the same changes found in our study would occur in this particular patient population. The sample size of each group was small and we did not consider confounding factors that may affect the postoperative refractive outcome, including the formula for calculating IOL power, surgical technique, and IOL material. Our study also lacked some dynamic observations of postoperative indicators, like corneal high-order aberrations and manifest refraction. Studies with larger sample sizes are required to further explore the mechanisms underlying changes in corneal high-order aberrations and refractive errors after surgery in PAC or PACG with concomitant cataract patients with different AL.

Conclusion

In conclusion, Phaco-IOL-GSL is an effective operation for cataract patients with PACG or PAC. In most cases, satisfactory IOP and good vision can be achieved to improve patient visual field sensitivity. Large surgical incisions may cause corneal high-order aberrations increased, especially trefoil at one-year follow-up. These changes may vary with different AL after surgery and could be minimized by reducing the incision size. The variations in ACD and AL after Phaco-IOL-GSL could cause hyperopic drift, especially in populations with normal axis lengths. Further prospective studies with large sample sizes are required to substantiate the role of different AL on the ocular changes.

Abbreviations

PAC: primary angle closure; PACG: primary angle closure glaucoma; Phaco-IOL-GSL: phacoemulsification and posterior intraocular lens implantation combined with goniosynechialysis; PAS: peripheral anterior synechia; IOL: intraocular lens; AL: axial length; IOP: intraocular pressure; BCVA: best-corrected visual acuity; ACD: anterior chamber depth; MD: mean deviation; VFI: visual field index; PSD: pattern standard deviation

Declarations

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Authors’ contributions

Contributions of authors involved in conception and design of study (JY, LY); Collection, analysis and interpretation of data (JLX, FH); Writing the article (JLX); Critical revision of the article (JY, LY); Patients referring (FH, LQF).

All authors have read and approved the manuscript in its current state.

Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The study protocol was reviewed and approved by the Ethics Committee of Ethics Committee of Daping Hospital of the Army Medical Center of PLA, Chongqing, China (TDLL 2020–90). Written informed consent was obtained from all participants prior to study enrolment.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Figures

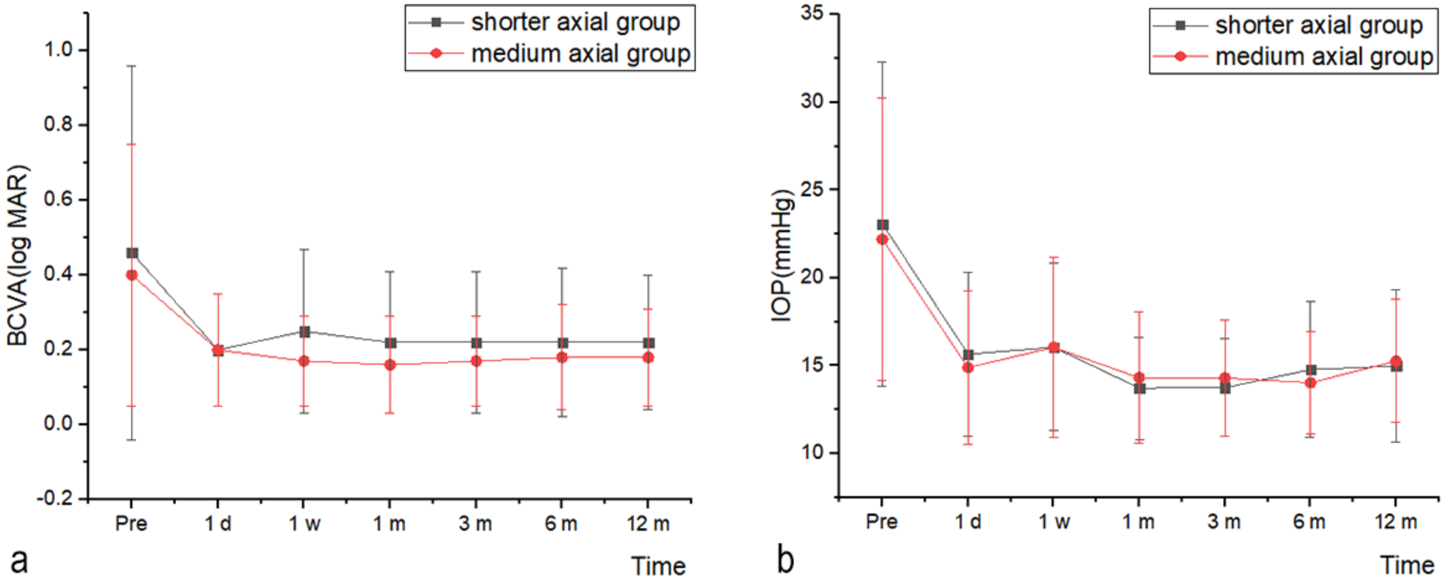

Figure 1

Time-dependent changes of BCVA (LogMAR chart records) and IOP in two groups. (a) Time-dependent changes in BCVA, the postoperative IOP was significantly lower than the baseline in both groups at each time point. (b) Time-dependent changes of IOP, the postoperative BCVA remained stable at each time point after surgery. Standard error values were used as error bars.

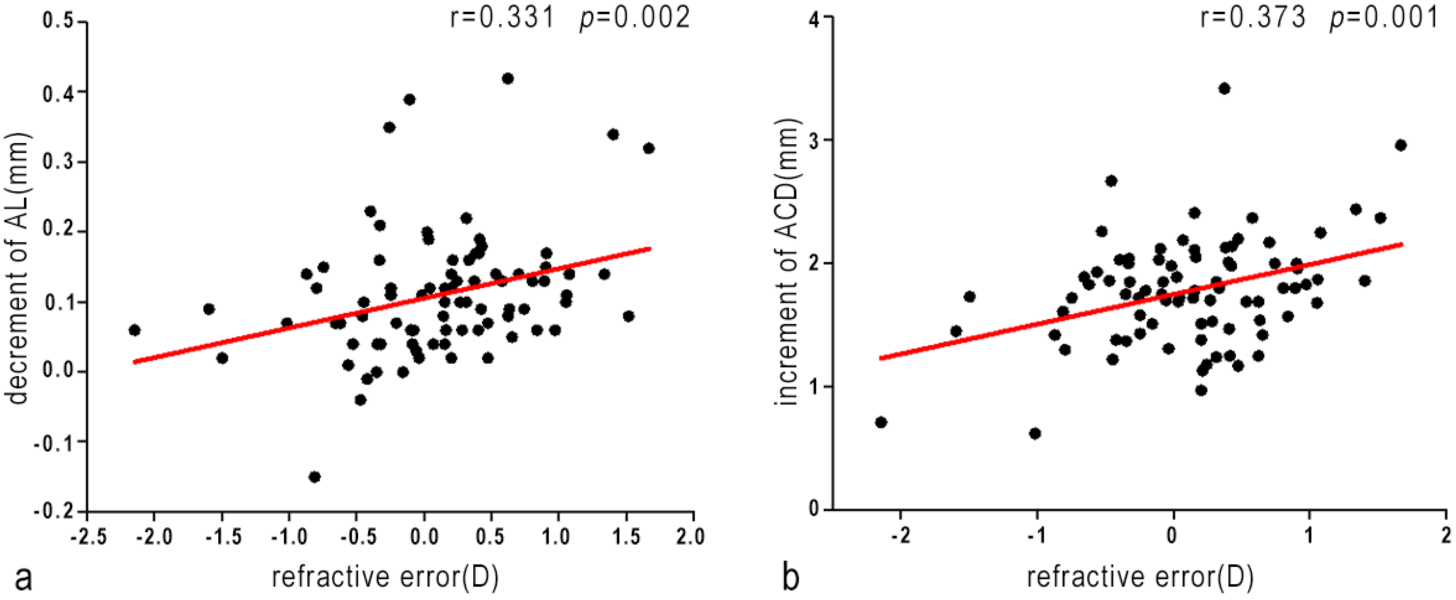

Figure 2

Correlation analysis of the postoperative refractive errors. (a) The relationship between decrements of AL and the refractive error (r = 0.331, P = 0.002). (b) The relationship between increments of ACD and the refractive error (r = 0.373, P = 0.001) ACD: anterior chamber depth; AL: axial length; D: diopter