The effects of peripheral anterior synechiae on refractive outcomes after cataract surgery in eyes with primary angle-closure disease

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Abstract
Objective of the study was to investigate the effects of peripheral anterior synechiae (PAS) on refractive outcomes after cataract surgery in eyes with primary angle-closure disease (PACD).

This is a retrospective, cross-sectional study. Seventy eyes of 70 PACD patients who underwent phacoemulsification and intraocular lens implantation. Patients were divided into 2 groups based on the presence of PAS on preoperative gonioscopy. The predictive power of the intraocular lens was calculated by the SRK/T, Hoffer Q, Haigis, and Holladay formulae. The mean absolute error (MAE) and predicted refractive errors were compared between PAS (+) and PAS (−) groups. We also evaluated the refractive errors with regards to the extent of PAS in the subanalyses.

The mean MAE was greater in the PAS (+) group with all formulae (0.61–0.70 diopters [D] vs 0.33–0.45 D, all P < .05). The eyes with PAS tended towards myopia (−0.30 D to −0.51 D vs −0.05 D to +0.24 D, all P < .05). However, the MAEs or predicted refractive errors were not different, irrespective of the extent of PAS in the subanalyses (all, P > .05).

The presence or absence of PAS may influence the postoperative refractive outcomes in PACD patients.

Abbreviations: ACD = anterior chamber depth, AL = axial length, CCC = continuous curvilinear capsulorrhexis, GON = glaucomatous optic neuropathy, IOL = intraocular lens, IOP = intraocular pressure, LPI = laser peripheral iridotomy, MAE = mean absolute error, PAC = primary angle-closure, PACD = primary angle-closure disease, PACG = primary angle-closure glaucoma, PAS = peripheral anterior synechiae, SE = spherical equivalent.

Keywords: cataract surgery, peripheral anterior synechiae, primary angle-closure, refractive error

1. Introduction
Angle-closure is defined by the presence of iridotrabecular contact. Peripheral anterior synechiae (PAS) are permanent adhesions between the iris and the corneoscleral region of the eye.[1] PAS is one of the pathognomonic signs of angle closure and an important sign for classifying the stage of primary angle-closure disease (PACD). The iridotrabecular contact or PAS obstructs the aqueous outflow through the trabecular meshwork, resulting in an increase in intraocular pressure (IOP). Although the mechanism of PAS formation is not entirely clear, PAS is an important risk factor for uncontrolled IOP and primary angle-closure glaucoma.[2]

Cataract extraction significantly increases the anterior chamber depth (ACD) in eyes with PACD.[3–7] This anatomical change may be beneficial in lowering IOP, thereby normalizing elevated IOP. Cataract extraction has therefore been suggested as an efficient treatment modality for acute and chronic angle-closure glaucoma.[3–7]

However, the intraocular lens (IOL) power predictions in eyes with PACD tend to be less accurate compared with those in nonglaucomatous eyes or glaucomatous eyes with open-angles. Inaccuracy in the IOL power prediction can be caused by a larger capsular volume, loosened lens zonules, or anterior pulling of the lens by the PAS. Unexpected changes in the IOL position induced by postoperative anterior chamber deepening also contribute to refractive errors after cataract extraction.[8] Such unique anatomical conditions of PACD are probably mainly responsible for the greater differences between the predicted refractive error and the actual refractive error after cataract surgery in eyes with PACD.

In the present study, we, therefore, characterized the presence or absence of PAS as a factor that affected the outcomes of refractive error, postcataract surgery in PACD patients.

2. Methods
2.1. Subjects
We retrospectively reviewed the medical records of patients who had PACD and had undergone uncomplicated phacoemulsification and a single piece acrylic IOL implantation at the Korea University Guro Hospital, Seoul, Republic of Korea, from April...
2008 to December 2013. Ethics approval was obtained from the Institutional Review Board of Korea University Guro Hospital. This study adhered to the tenets of the Declaration of Helsinki. PACD patients included primary angle-closure suscepts, and primary angle-closure (PAC) and primary angle-closure glaucoma (PACG) patients. Primary angle-closure suscepts were defined as patients with an eye with an occludable angle and an IOP ≤ 21 mm Hg without PAS or glaucomatous optic neuropathy (GON). PAC was defined as an eye with any degree of PAS or with an occludable angle accompanied by an elevated IOP (>21 mm Hg) and/or iris ischemia (iris whirling and stromal atrophy), but without GON. PACG was defined as an eye with GON in the presence of PAC. 

Angle status was confirmed by gonioscopy. In each patient, gonioscopy was performed by a single glaucoma specialist (YYK) at presentation or repeated after the clarity of the cornea was restored. The examination was performed at the lowest level of ambient illumination of a slit lamp with a Goldmann-type three mirror lens (OG3MS; Ocular Instruments, Bellevue, WA), avoiding any light passing through the pupil. To distinguish PAS from appositional angle-closure, dynamic gonioscopy was also performed using a four mirror contact lens (Zeiss, Oberkochen, Germany). The direction of a patient’s gaze to a certain mirror and exertion of pressure on the cornea were conducted to widen the angle. PAS was considered present when the adhesion reached to the midtrabecular meshwork upon compression gonioscopy. In eyes with PAS, the location and extent of PAS were also recorded. The patients were classified according to the presence (PAS [+]) group or absence of PAS (PAS [–] group) on gonioscopy.

Exclusion criteria included any identifiable ocular pathology that may have induced PAS formation, such as uveitis, iris neovascularisation, and a previous history of trauma or intraocular surgery. Eyes with phacodonesis on slit-lamp examination, phacocomplicated cataract surgery (eg, posterior capsular ruptures), sulcus-fixed IOLs, combined angle surgery (eg, goniosynechialysis), or postoperative complications (eg, uncontrolled IOP spikes or anterior capsular phimosis) were excluded. Eyes with posterior synchiae with the iris adherent to the anterior lens capsule or a small pupil requiring the use of any pupil dilating device during the surgery were also excluded.

2.2. Surgical procedures

All cataract surgeries (phacoemulsification and IOL implantation) were performed by a single experienced surgeon (YYK). After topical anesthesia with 0.5% proparacaine hydrochloride (Alcaine; Alcon Laboratories, Fort Worth, TX), a 2.2- or 2.75-mm temporal clear corneal incision was made, and a viscoelastic agent was introduced to maintain the anterior chamber. A continuous curvilinear capsulorhexis (CCC) was created slightly smaller than the IOL optic size with a bent 26-gauge needle. Phacoemulsification was performed with an Infinity Vision System (Alcon Laboratories). Cortical remnants were removed by irrigation/aspiration, and a foldable acrylic 1-piece IOL was inserted into the capsular bag. The corneal incision was closed with a single 10-0 nylon suture, and the suture was removed at 1 week after surgery.

2.3. Data collection and analysis

Preoperative corneal power, axial length (AL), and ACD were measured using an IOL Master (Carl Zeiss Meditec, Jena, Germany). The IOL power was calculated using the SRK/T, Hoffer Q, Haigis, and Holladay formulae. The formula used to select the IOL power was determined by the surgeon for each patient. The refractive error was measured using an automated keratometer (RK-F1; Canon, Tokyo, Japan) at postoperative visits between 1 and 3 months, and the spherical equivalent (SE) was calculated from the measured refractive errors.

The mean absolute error (MAE) was defined as the absolute value of the predicted refractive error. The predicted refractive error was defined as the difference between the actual postoperative SE and the preoperative SE of the refraction predicted by the IOL Master using each formula (predicted refractive error = postoperative SE – preoperative SE of the predicted refraction).

To determine whether the extent of PAS affected the refractive error after cataract surgery, we divided the PAS (+) group into 2 subgroups based on the extent of PAS. The patients with PAS <180° were classified into subgroup 1, and those with PAS ≥180° were classified into subgroup 2.

All statistics were calculated using the Statistical Package for the Social Sciences, version 21.0 (SPSS, Chicago, IL). The independent sample t-test was used to compare the differences in the refractive errors between the PAS (+) and PAS (–) groups. Because the data distribution did not show normality in the subanalyses, the Mann–Whitney U-test was used to compare the differences in the refractive errors between subgroups. A value of *P* < .05 was considered statistically significant.

3. Results

Seventy eyes of 70 patients (59 females) were enrolled in this study. Among them, 43 eyes had PAS and 15 of these had an extensive PAS ≥180°. An Acrysof IQ (SN60WF; Alcon Laboratories) IOL was implanted in 41 eyes, and a Tecnis (ZC800; Abbott Medical Optics, Santa Ana, CA) IOL was implanted in 29 eyes. Table 1 shows comparisons of the demographics and refractive errors between PAS (+) and PAS (–) groups. There was no significant difference in age, central corneal thickness, AL, ACD, or mean keratometry readings between the PAS (+) and PAS (–) groups (*P* = .789, .234, .069, .498, and .079, respectively).

In the PAS (+) group, the MAE was significantly larger than in the PAS (–) group using all formulae (SRK/T; *P* = .023, Hoffer Q; *P* < .001, Haigis; *P* = .009, and Holladay: *P* = .001). The refractive error shifts were also significantly different between the 2 groups. The PAS (+) group had a greater degree of myopic shift than that in the PAS (–) group for all formulae (SRK/T; *P* = .001, Hoffer Q; *P* = .002, Haigis; *P* = .001, and Holladay: *P* = .001).

Table 2 lists the demographics and refractive errors in 2 PAS (+) subgroups (PAS <180° and PAS ≥180°). There was no significant difference in age, central corneal thickness, AL, ACD, or mean keratometry between the 2 subgroups (*P* = .888, .333, .665, .949, and .919, respectively). No significant differences were found in the MAE between the 2 subgroups using all of the formulae (SRK/T; *P* = .656, Hoffer Q; *P* = .929, Haigis; *P* = .959, and Holladay: *P* = .740). Although subgroup 2 tended to have more myopic shift than subgroup 1, there was no significant difference from predicted refractive errors between the 2 subgroups using all of the formulae (SRK/T; *P* = .251, Hoffer Q; *P* = .422, Haigis; *P* = .346, and Holladay: *P* = .475).

Because 2 IOLs were implanted in the study patients, we compared the refractive errors between them. There was no
Comparison of demographics and refractive errors of eyes with peripheral anterior synechiae and without peripheral anterior synechiae (values represent the mean ± standard deviation).

| Factors                  | PAS (+) | PAS (-) | P-value |
|--------------------------|---------|---------|---------|
| Age, yr                  | 70.1±5.1| 69.8±4.6| .789    |
| Sex (male: female)       | 9: 34   | 2: 25   | .183    |
| CCT, µm                  | 530.7±34.3| 541.6±40.9| .234    |
| AL, mm                   | 22.66±0.64| 22.38±0.55| .069    |
| ACD, mm                  | 2.42±0.24| 2.38±0.25| .498    |
| Mean K, D                | 44.17±1.65| 44.67±1.48| .079    |
| IOL (Acrysof: Tecnis)    | 25: 18  | 16: 11  | >.90    |
| Mean absolute errors, D  |         |         |         |
| SRK/T                    | 0.65±0.38| 0.45±0.29| .023    |
| Hoffer Q                 | 0.70±0.46| 0.34±0.20| <.001   |
| Haigis                   | 0.61±0.43| 0.37±0.27| .009    |
| Holladay                 | 0.63±0.41| 0.33±0.19| .001    |

Comparison of refractive errors between Acrysof IQ and Tecnis IOL in MAE (SRK/T; P = .341, Hoffer Q; P = .976, Haigis; P = .689, and Holladay: P = .977) and predicted refractive error (SRK/T; P = .102, Hoffer Q; P = .414, Haigis; P = .270, and Holladay: P = .166) (Table 3).

Comparison of demographics and refractive errors depending on the extent of peripheral anterior synechiae (values represent the mean ± standard deviation).

| Factors                  | PAS <180° | PAS ≥180° | P-value |
|--------------------------|-----------|-----------|---------|
| Age, yr                  | 70.3±5.6  | 69.9±1.4  | .888    |
| Sex (male: female)       | 7: 21     | 2: 13     | .453    |
| CCT, µm                  | 535.1±54.1| 522.3±54.2| .333    |
| AL, mm                   | 22.63±0.70| 22.73±0.53| .665    |
| ACD, mm                  | 2.41±0.22 | 2.44±0.26 | .949    |
| Mean K, D                | 44.15±1.76| 44.22±1.46| .919    |
| IOL (Acrysof: Tecnis)    | 17: 11    | 8: 7      | .750    |
| Mean absolute errors, D  |           |           |         |
| SRK/T                    | 0.65±0.39 | 0.66±0.37 | .656    |
| Hoffer Q                 | 0.72±0.47 | 0.68±0.45 | .929    |
| Haigis                   | 0.62±0.42 | 0.62±0.45 | .969    |
| Holladay                 | 0.64±0.41 | 0.61±0.42 | .740    |

4. Discussion

The present study found that IOL power prediction was less accurate in PACD eyes with PAS than in those without PAS. Compared with the PACD eyes without PAS, those with PAS showed more myopic outcomes following uncomplicated phacoemulsification and IOL implantation. However, the postoperative refractive errors were not significantly different between eyes with moderate (PAS <180°) versus severe (PAS ≥180°) extents of PAS in the subanalyses. To our knowledge, this was the first study to report the effect of PAS on the inaccuracy of IOL power predictions in eyes with PACD.

Compared to normal eyes, eyes with angle closure presented the following ocular biometric features: shorter AL, shallower ACD, greater lens thickness, a more anterior lens position, and smaller radius of the anterior and posterior corneal curvature.[10-21] In addition, eyes with PACD often had large intracapsular volume and looser zonules.[11,18,22] These structural characteristics often induced not only anterior chamber angle crowding but also led to the inaccuracy of IOL power predictions. After cataract extraction, angle crowding may improve with deepening of the anterior chamber angle along with posterior shifting of the capsular bag. Such posterior displacement of the IOL position and a decrease in AL caused by IOP reduction after cataract surgery may cause a hyperopic shift in IOL power. However, a myopic shift has also been shown to occur as often as a hyperopic shift after cataract surgery in eyes with angle-closure glaucoma.[8]

The reasons for the greater MAE and more myopic shift in eyes with PAS are unclear. A number of factors may explain this result. First, the presence of PAS may be evidence of the structural difference between the 2 groups. Prolonged apposition and repeated angle-closure attacks may lead to the development of PACD. Because there was no significant difference in age, AL, ACD, and mean keratometry between the two groups, eyes with PAS may have other structural abnormalities such as zonular loosenings or a larger intracapsular bag to account for the difference. Unstable IOL positions (tilting or decentralization) due to large intracapsular bags or loose zonules may have induced more refractive error in eyes with PAS.[8] Song et al reported that increased choroidal thickness was associated with a significant myopic shift after cataract surgery in PACD.[23]
Recently, there have been several studies on increasing choroid thickness in PACD, and these results indicate that the choroid is another structure involved in the pathogenesis of PACD. The presence of PAS might be the result of these various anatomical risk factors and further investigation is needed to prove their relationship. Second, the deepening of the anterior chamber after cataract surgery may have differed between the 2 groups. Lin et al quantified the effect of laser peripheral iridotomy (LPI) on angle widening in PACD with and without PAS. They found that the changes in anterior chamber angle after LPI were inversely correlated with the presence of PAS, and the parameters of ultrasound biomicroscopy did not change in quadrants with PAS. Although the effects of LPI and cataract extraction on the anterior chamber were not expected to be identical, deepening of the ACD after cataract surgery may have been affected by the presence of PAS. The posterior shifting of the IOL plane may have been limited by the presence of PAS; such limitation of posterior shifting of the IOL plane may have explained our observation of more myopic shift in eyes with PAS compared with eyes without PAS (Fig. 1). Consistent with this possibility, Yoo et al compared

Figure 1. Possible mechanisms of refractive errors after cataract surgery in eyes with primary angle-closure with or without peripheral anterior synechiae (PAS) and representative images of anterior segment optical coherence tomography. (A) Eyes without PAS. (B) Eyes with PAS. Anterior chamber deepening was limited by PAS, consequently myopic shift could occur.
ultrasound biomicroscopy findings between eyes with PAS and without PAS, and reported that the trabecular-ciliary process distance was shorter in PACD eyes with PAS than in those without PAS, suggesting that anterior placement of the ciliary process may have played a role in the development of PAS.

Postoperative changes in anterior segment anatomy after phacoemulsification with IOL implantation may be an impediment to achieving consistent and precise refractive outcomes in PACD. The changes in cornea–iris–IOL relationships after cataract surgery are complicated and the position of the iris and IOL after surgery change differently according to AL. Although further studies are necessary to evaluate the effect of PAS on refractive outcomes associated with changes of anterior segment anatomy after surgery, our results suggest that the presence of PAS may be another factor affecting the outcomes of cataract surgery in PACD. Indaram et al reported 3 cases of myopic surprise after cataract surgery in plateau iris configuration patients. These cases also suggest that the angle configuration have an impact on the postoperative IOL position. Notably, the MAEs or predicted refractive errors were not statistically different depending on the extent of PAS in the subanalyses, although the MAE of subgroup 2 (PAS ≥180°) tended to be larger than those of subgroup 1 (PAS <180°), and a more myopic shift was also found in subgroup 2. However, the sample size of the current study was too small to identify subtle differences in refractive error after cataract surgery between the 2 subgroups.

The present study had several limitations. First, the retrospective nature of this study may have introduced biases. Although we hypothesized that the limitation of posterior shifting of the IOL plane may have been the cause of the myopic shift in eyes with PAS, there was no objective evidence to support this possibility. Second, the timing of refractive error measurement after surgery was not identical among the study patients. However, several studies have reported that the refractive value stabilizes within 2 weeks after uncomplicated cataract surgery. Third, postoperative changes of PAS status or extent were not evaluated. Some investigators have reported a reduction in PAS after phacoemulsification in PACD. However, the amount of PAS change after phacoemulsification was different depending on the extent of the preoperative PAS and the effects of postoperative PAS on refractive errors were not investigated. The present study suggested that further studies on postoperative gonioscopic findings and the effects of postoperative PAS on refractive errors are warranted to validate our hypotheses. Fourth, the variability of the CCC size may have affected the refractive outcomes after phacoemulsification. Nanavaty et al reported that the size of the CCC and the area of anterior capsular-IOL overlap influenced the IOL position. A larger CCC may lead to decentralization of the IOL, and a smaller CCC can increase the risk of anterior capsule fibrosis, which can lead to anterior capsular phimosis. However, it is not possible to create a constant CCC size or shape using the conventional manual method, especially in PACD eyes with loose zonules. In our study, the surgeon’s goal was to create a CCC slightly smaller than the IOL optic margin; also, we excluded cases with anterior capsular phimosis after surgery to avoid bias. Fifth, the intervals between gonioscopy and cataract surgery were not controlled. PAS is not a stationary condition. Choi et al reported progression of PAS even after successful LPI, which may have led to the classification of eyes with PAS as eyes without PAS at the time of the cataract surgery. Sixth, the examination of PAS with gonioscopy was subjective and could have varied between observations. However, gonioscopy is still the gold standard to evaluate PAS, and it was performed by a single experienced investigator. Finally, suturing of the corneal wound may have affected refractive outcomes. However, we believe the effect of the corneal suture on the refractive outcomes was minimal because the corneal suture was removed as early as 1 week after surgery.

In conclusion, our study suggests that the IOL power prediction can be less accurate in PACD eyes with PAS compared with eyes without PAS. The presence or absence of PAS may influence the postoperative refractive outcomes in PACD patients; thus, it should be considered at the time of cataract surgery in these eyes. However, a further prospective study is needed to better assess the effects of the PAS on refractive outcomes after cataract surgery.

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References
[1] Inoue T. Distribution and morphology of peripheral anterior synchia in primary angle-closure glaucoma. Nihon Ganka Gakkai Zasshi 1993; 97:78–82.
[2] Choi JS, Kim YY. Relationship between the extent of peripheral anterior synchiae and the severity of visual field defects in primary angle-closure glaucoma. Korean J Ophthalmol 2004;18:100–5.
[3] Yang CH, Hung PT. Intraocular lens position and anterior chamber angle changes after cataract extraction in eyes with primary angle-closure glaucoma. J Cataract Refract Surg 1997;23:1109–13.
[4] Hayashi K, Hayashi H, Nakao F, et al. Changes in anterior chamber angle width and depth after intraocular lens implantation in eyes with glaucoma. Ophthalmology 2000;107:698–703.
[5] Ming Zhi Z, Lim ASM, Yin Wong T. A pilot study of lens extraction in the management of acute primary angle-closure glaucoma. Am J Ophthalmol 2003;135:534–6.
[6] Musch DC, Gillespie BW, Nuzil LM, et al. Collaborative Initial Glaucoma Treatment Study Group.Cataract extraction in the collaborative initial glaucoma treatment study: incidence, risk factors, and the effect of cataract progression and extraction on clinical and quality-of-life outcomes. Arch Ophthalmol 2006;124:1694–700.
[7] Nonaka A, Kondo T, Kikuchi M, et al. Angle widening and alteration of ciliary process configuration after cataract surgery for primary angle closure. Ophthalmology 2006;113:437–41.
[8] Kang SY, Hong S, Won J, et al. Inaccuracy of intraocular lens power prediction for cataract surgery in angle-closure glaucoma. Yonsei Med J 2009;50:206–10.
[9] Foster PJ, Bohrmann R, Quigley HA, et al. The definition and classification of glaucoma in prevalence surveys. Br J Ophthalmol 2002;86:238–42.
[10] Tomlinson A, Leighton DA. Ocular dimensions in the heredity of angle-closure glaucoma. Br J Ophthalmol 1973;57:475–86.
[11] Lowe RF. Aetiology of the anatomical basis for primary angle-closure glaucoma. Biometrical comparisons between normal eyes and eyes with primary angle-closure glaucoma. Br J Ophthalmol 1970;54:161–9.
[12] Lowe RF, Clark BA. Posterior corneal curvature. Correlations in normal eyes and in eyes involved with primary angle-closure glaucoma. Br J Ophthalmol 1973;57:464–70.

[13] Grieten J, Weckers R. Study of the dimensions of the anterior chamber of the human eye. III. In closed-angle glaucoma and in open-angle glaucoma. Ophthalmologica 1962;143:409–22.

[14] Clemenmes V, Luntrz MH. Lens thickness and angle-closure glaucoma. A comparative oculometric study in South African Negroes and Danes. Acta Ophthalmol 1976;54:193–7.

[15] Alsbirk PH. Primary angle-closure glaucoma. Oculometry, epidemiology, and genetics in a high risk population. Acta Ophthalmol Suppl 1976;54:193.

[16] Coakes RL, Lloyd-Jones D, Hitchings RA. Anterior chamber volume. Its measurement and clinical application. Trans Ophthalmol Soc U K 1979;99:78–81.

[17] Lee DA, Brubaker RF, Ilstrup DM. Anterior chamber dimensions in patients with narrow angles and angle-closure glaucoma. Arch Ophthalmol 1984;102:46–50.

[18] Markowitz SN, Morin JD. Angle-closure glaucoma: relation between lens thickness, anterior chamber depth and age. Can J Ophthalmol 1984;19:300–2.

[19] Qi Y. Ultrasonic evaluation of the lens thickness to axial length factor in eyes and in eyes involved with primary angle-closure glaucoma. Br J Ophthalmol Vis Sci 2013;54:1971–8.

[20] Saxena S, Agrawal PK, Pratap VB, et al. The predictive value of the relative lens position in primary angle-closure glaucoma. Ann Ophthalmol 1999;31:453–6.

[21] Salmon JF, Swanevelder SA, Donald MA. The dimensions of eyes with chronic angle-closure glaucoma. J Glaucoma 1994;3:237–43.

[22] Marchini G, Pagliarusco A, Toscano A, et al. Ultrasound biomicroscopic and conventional ultrasonographic study of ocular dimensions in primary angle-closure glaucoma. Ophthalmology 1998;105:2091–8.

[23] Song WK, Sung KR, Shin JW, et al. Effects of choroidal thickness on refractive outcome following cataract surgery in primary angle closure. Korean J Ophthalmol 2018;32:382–90.

[24] Wang W, Zhou M, Huang W, et al. Does acute primary angle-closure cause an increased choroidal thickness? Invest Ophthalmol Vis Sci 2013;54:3538–345.

[25] Zhou M, Wang W, Dong X, et al. Choroidal thickness in fellow eyes of patients with acute primary angle-closure measured by enhanced depth imaging spectral-domain optical coherence tomography. Invest Ophthalmol Vis Sci 2013;54:1971–8.

[26] Zhou M, Wang W, Huang W, et al. Is increased choroidal thickness association with primary angle closure? Acta Ophthalmol 2014;92: e514–20.

[27] Gao K, Li F, Li Y, et al. Anterior choroidal thickness increased in primary open-angle glaucoma and primary angle-closure disease eyes evidenced by ultrasound biomicroscopy and SS-OCT. Invest Ophthalmol Vis Sci 2018;59:1270–7.

[28] Lin Z, Liang Y, Wang N, et al. Peripheral anterior synchia reduce extent of angle widening after laser peripheral iridotomy in eyes with primary angle closure. J Glaucoma 2013;22:374–9.

[29] Yoo C, Oh JH, Kim YY, et al. Peripheral anterior synchiae and ultrasound biomicroscopic parameters in angle-closure glaucoma suspects. Korean J Ophthalmol 2007;21:106–10.

[30] Muzika-Woźniak M, Ogar A. Anterior chamber depth and iris and lens position before and after phacoemulsification in eyes with a short or long axial length. J Cataract Refract Surg 2016;42:563–8.

[31] Indaram M, Yarlagadda J, Babic K, et al. Effect of plateau iris configuration on effective lens position and intraocular lens power calculation: report of 3 cases. JCRS Online Case Rep 2015;3:59–62.

[32] Caglar C, Batur M, Eser E, et al. The stabilisation time of ocular measurements after cataract surgery. Semin Ophthalmol 2016;32:412–7.

[33] de Juan V, Herreras J, Perez I, et al. Refractive stabilisation and corneal swelling after cataract surgery. Optom Vis Sci 2013;90:31–6.

[34] Lake D, Fong K, Wilson R. Early refractive stabilisation after temporal iridotomy. Am J Ophthalmol 2005;140:1125.

[35] Indaram M, Yarlagadda J, Babic K, et al. Effect of plateau iris configuration on effective lens position and intraocular lens power calculation: report of 3 cases. JCRS Online Case Rep 2015;3:59–62.

[36] Lati M, Moghimi S, Eslami Y, et al. Effect of phacoemulsification on drainage angle status in angle closure eyes with or without extensive peripheral anterior synchiae. Eur J Ophthalmol 2013;23:70–9.

[37] Tham CC, Leung DY, Kwong YY, et al. Effects of phacoemulsification versus combined phaco-trabeculectomy on drainage angle status in primary angle closure glaucoma (PACG). J Glaucoma 2010;19:119–23.

[38] Nanavaty MA, Raj SM, Vasavada VA, et al. Anterior capsule cover and conventional ultrasonographic study of ocular dimensions in primary angle-closure glaucoma. Ophthalmology 1998;105:2091–8.

[39] Choi JS, Kim YY. Progression of peripheral anterior synchiae after laser iridotomy. J Cataract Refract Surg 2005;31:1845.

[40] Tham CC, Leung DY, Kwong YY, et al. Effects of phacoemulsification on drainage angle status in angle closure eyes with or without extensive peripheral anterior synchiae. Eur J Ophthalmol 2013;23:70–9.

[41] Indaram M, Yarlagadda J, Babic K, et al. Effect of plateau iris configuration on effective lens position and intraocular lens power calculation: report of 3 cases. JCRS Online Case Rep 2015;3:59–62.

[42] Caglar C, Batur M, Eser E, et al. The stabilisation time of ocular measurements after cataract surgery. Semin Ophthalmol 2016;32:412–7.