• Clinical Research •

Anterior segment OCT application in quantifying posterior capsule opacification severity with varied intraocular lens designs

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Abstract

● **AIM:** To evaluate the application of anterior segment-optical coherence tomography (AS-OCT) in posterior capsule opacification (PCO) severity assessment and analyse the relationship between PCO severity and intraocular lens (IOL) characters.

● **METHODS:** PCO patients were prospectively recruited. Cross-sectional images of the anterior segment at horizontal and vertical meridians were acquired with AS-OCT. The area of the IOL-PC (posterior capsular) space and PCO severity (area, thickness, and density at 3 mm and 5 mm IOL optic regions) were measured. The relationship between PCO severity and visual acuity, comparisons of PCO severity and IOL-PC space using varied IOL designs were analysed.

● **RESULTS:** One hundred PCO eyes were enrolled. IOL-PC space, PCO thickness and area were positively correlated with axial length. In addition, PCO area and thickness were positively correlated with visual acuity when it was ≤0.52 logMAR. The cut-off level of visual acuity should be 0.52 logMAR. With varied IOL designs, 3-piece C haptic IOL showed a smaller PCO area and thickness than the 1-piece 3 haptic IOL and 1-piece 4 haptic IOL. PCO area and thickness values for an IOL with a diameter ≤11.0 mm was greater than for an IOL with a diameter of 12.5 mm, and the differences were statistically significant. PCO area and thickness increased when IOL haptic angulation increased (from 0 to 12 degrees).

● **CONCLUSION:** In PCO eyes, cut-off level of visual acuity is 0.52 logMAR. With more severe PCO, visual acuity maybe not enough to describe the visual function impairment. PCO severity and IOL-PC space are significantly correlated with axial length and IOL design and material.

● **KEYWORDS:** posterior capsule opacification; anterior segment-optical coherence tomography; IOL-posterior capsule space; IOL-posterior capsule distance; severity

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INTRODUCTION

Posterior capsule opacification (PCO) is a major long-term complication of cataract surgery, which normally occurs at several weeks to years after removal of the cloudy lens. The prevalence of PCO is 4.1% at 1y and 22.8%-38.5% at 2-4y[1]. PCO leads to a decrease in visual acuity, contrast sensitivity, and objective visual quality. The effect of PCO on visual function should be related to the PCO location, morphology, and severity. PCO severity could be defined in terms of density, coverage, and thickness.

The existing PCO evaluation methods used to assess PCO include a subjective scoring system, or an objective system, such as the POCO and AQUA systems, which are all based on automated analysis of retro-illumination images. In addition, the Scheimpflug image is an objective method that evaluates the density of the PCO directly. These methods primarily score PCO severity by multiplying the PCO fraction and density, and the latter can be subjectively graded[2]. The methods vary, and a standard method is lacking. Until now, anterior segment-optical coherence tomography (AS-OCT) based on low coherent optical tomography can acquire high-resolution images of the anterior segment[3] and this has been used to evaluate PCO severity based on cross-sectional images of PCO[4-5].

In addition, studies have suggested that surgical factors and the IOL design and material contributed to PCO formation and development[6]. Application of a sharp edged[7], hydrophobic

IOL[8] could reduce PCO occurrence[9]. Adherence of the intraocular lens (IOL)[10], capsule bend formation[11] and capsule crease existence[12] are closely correlated to the formation of PCO. In addition, according to a theory described as no space, no cell and no PCO, the IOL-posterior capsular (IOL-PC) space of an IOL has significant influence on PCO formation. The existence of an IOL-PC space may be related to the size of the capsule, axial length, and IOL design and material, which has not been analysed.

The aim of this study was to evaluate IOL-PC space and PCO severity with AS-OCT (RTVue-100 OCT), including PCO density, PCO coverage (area), and PCO thickness. We also assessed the relation between IOL-PC space, PCO severity, and axial length, evaluated the effect of the IOL design and material on the IOL-PC space and PCO severity.

SUBJECTS AND METHODS

Ethical Approval The study strictly adhered to the tenets of the Declaration of Helsinki, and the study was approved by the Research Review Board of Tianjin Eye Hospital. Before examination, written informed consent was obtained from each patient.

Subjects Patients diagnosed with PCO and anticipated Nd:YAG laser treatment were prospectively enrolled in our cataract centre, totally 100 eyes. In details, patients with observable PCO under bio-microscope, subjective visual disability symptoms and decreased visual acuity were enrolled. The exclusion criteria included late-stage glaucoma, fundus diseases, uveitis, corneal diseases, eye trauma or complicated surgery, IOL tilt and de-centration.

Routine examinations were done by one expert ophthalmologist. Besides, visual acuity, intraocular pressure, slit lamp examination, fundus checking, and AS-OCT examination after pupil dilation were performed before Nd:YAG laser treatment. The visual acuity was valued using a logarithmic visual acuity chart. For further correlation analysis, visual acuity was converted to the logarithm of the minimum angle of resolution (logMAR).

With reference to medical records, patients were classified into different groups based on the IOL material, haptic design, haptic angulation and IOL diameter. The implanted IOLs included Bausch & Lomb ADAPT AO (*n*=33), ZEISS Bigbag (*n*=15), CT ASPHINA 603P ZO (*n*=15), Sensar AR40e (*n*=14), HQ-201hep (*n*=10).

AS-OCT (RTVue-100 OCT) Examinations Before RTVue-100 (Optovue Inc., Fremont, CA, USA) image acquisition, a corneal anterior module long adaptor lens was fixed to a detecting probe and software was adjusted to the cornea cross line scan mode. Patients were required to look ahead at the red indicator light with the contralateral eye after pupil dilation. Cross-sectional images of the anterior segment

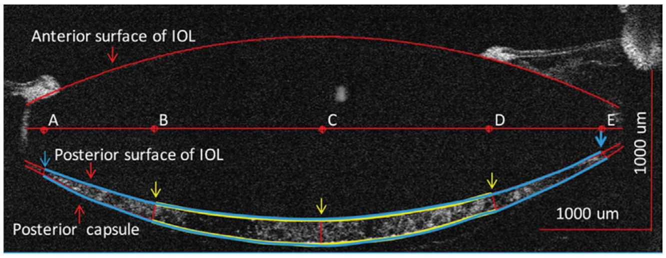

Figure 1 Illustration graph of PCO severity evaluation method with RTVue-100 OCT PCO severity evaluates in one cross-sectional image. Point C is the center of the line (red, horizontal) that passed optic center of IOL. Distance between point A and point E is the 5 mm range of IOL optic region. Distance between point B and point D is the 3 mm range of IOL optic region. The crescent-shaped region between posterior surface and posterior capsule is the IOP-PC space. The region between the yellow lines is the PCO coverage at 3 mm range of the IOL optic region. The region between the blue lines is the PCO coverage at 5 mm range of the IOL optic region. The yellow and blue arrows refer to the PCO thickness at the specific points, including the 3 and 5 mm points of the IOL optic region.

on the horizontal and vertical meridians were acquired after blinking, which were then transferred to a personal computer for further analysis with Image Pro Plus software. We defined the scale of horizontal and vertical meridians separately before measurement. The size of the IOL-PC space, IOL-PC distance, and PCO coverage (area), thickness, and density at the 3 and 5 mm IOL optic regions on horizontal and vertical meridians (Figure 1) were measured and recorded. PCO density was expressed based on the computer compatible tape, intensity of the scatter light ranged from 0 to 255. The scatter light of IOL was subtracted before analysis to eliminate the influence of IOL itself (Assessment details could be checked in our previous study[5]).

We analysed and calculated the mean and median values of the size of IOL-PC space, IOL-PC distance, and PCO coverage (area), thickness, and density. Before comparison we averaged the IOL-PC space, IOL-PC distance, and PCO coverage (area), thickness, and density on horizontal and vertical meridians, then we made comparisons of the IOL-PC space, IOL-PC distance, and PCO area, thickness, and density with various IOL designs and materials.

Statistical Analysis IBM SPSS Statistics 23.0 was adopted to analyse all the data. The data distribution was analysed with a Kolmogorov-Smirnov test. Normally distributed data were described as the mean±SD, and skewed distributed data were described as the median and quartile (Q1, Q3). A Kruskal Wallis test and Mann-Whitney *U* non-parametric test were used to compare differences in PCO severity with different IOL material, haptic design, haptic angulation, and IOL diameter groups. Pearson's correlation test and the

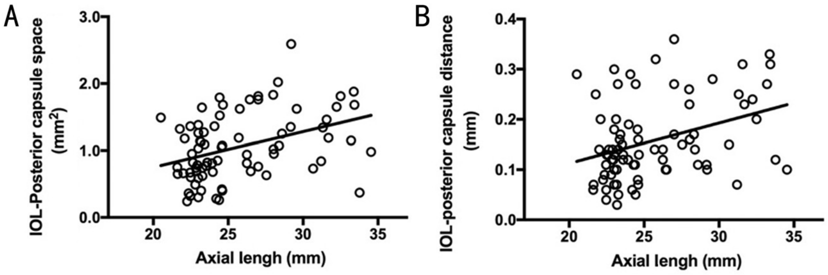

Figure 2 Relationship between axial length and IOL-PC space area and distance A: Correlation between axial length and IOL-PC area, the correlation coefficient is 0.41, *P*=0.00. B: Correlation between axial length and IOL-PC distance, the correlation coefficient is 0.34, *P*=0.003.

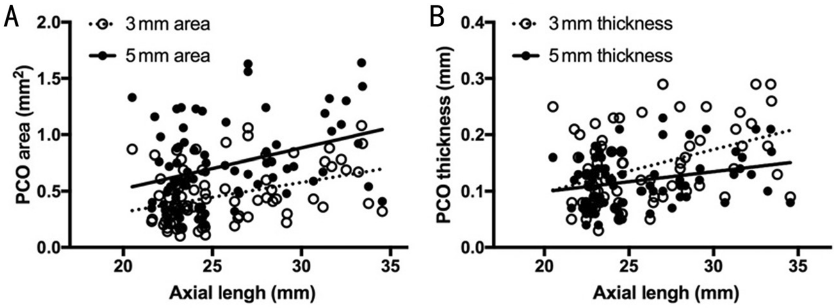

Figure 3 Relationship between axial length and PCO area and thickness A: Correlation between axial length and PCO area at 3 and 5 mm IOL optic region, the correlation coefficient is 0.34 (*P*=0.002) and 0.32 (*P*=0.005); B: Correlation between axial length and PCO thickness at 3 and 5 mm IOL optic region, the correlation coefficient is 0.37 (*P*=0.001) and 0.22 (*P*=0.06).

nonparametric Spearman correlation test were used to analyse the relationship between different variables. $P<0.05$ was considered statistically significant.

RESULTS

The study enrolled 100 eyes (96 patients) diagnosed with PCO, including 36 males (38 eyes) and 60 females (62 eyes). The average age of the patients was 66.98±10.30y (range 37-91y). The PCO time was 35.13±19.78mo (range 10-92mo).

IOL-PC Space, IOL-PC Distance, PCO Area and Thickness at the 3 and 5 mm IOL Optic Regions This study enrolled 100 PCO eyes. The median size of the IOL-PC space was 0.93 mm^2 (range 0.63-1.36 mm^2) and the IOL-PC distance was 0.13 mm (range 0.10-0.19 mm). PCO coverage was 0.36 mm^2, the PCO thickness was 0.12 mm, and the density was 41.93 at the 3 mm IOL optic region. At the 5 mm IOL optic region, PCO coverage, thickness, and density were 0.63 mm^2, 0.12 mm, and 37.52, respectively. In the 100 eyes, there were 29 high myopia eyes, which were accompanied by a larger IOL-PC space; the average size of the IOL-PC space was 1.25 mm^2 (range 0.89-1.76 mm^2), and the IOL-PC distance was 0.17 mm (range 0.12-0.26 mm). PCO coverage, thickness and density were 0.44 mm^2, 0.16 mm, and 39.11 at the 3 mm IOL optic region and were 0.75 mm^2, 0.12 mm, and 36.20 at the 5 mm IOL optic region, respectively (Tables 1 and 2).

Relationship Between Axial Length and IOL-PC Space, IOP-PC Distance, and PCO Area and Thickness Axial length was positively correlated with the size of the IOL-PC space and IOL-PC distance, and the Spearman's correlation

Table 1 IOL-PC space and IOL-PC distance of different eyes

IOL-PC region	All eye, *n*=100	High myopia, *n*=29
IOL-PC area, mm^2	0.93 (0.63, 1.36)	1.25 (0.89, 1.76)
IOL-PC distance, mm	0.13 (0.10, 0.19)	0.17 (0.12, 0.26)

coefficients were 0.41 (*P*=0.00) and 0.34 (*P*=0.003), respectively (Figure 2). Axial length was also positively correlated with PCO area and thickness at the 3 mm. The Spearman's correlation coefficients were 0.34 (*P*=0.002) and 0.37 (*P*=0.001) at the 3 mm IOL optic region. And the Spearman's correlation coefficients were 0.32 (*P*=0.005) and 0.22 (*P*=0.06) at the 5 mm IOL optic region (Figure 3). Besides, axial length was not correlated with PCO density at 3 mm (*P*=0.09) and 5 mm IOL optic region (*P*=0.15).

Correlation Analysis Between Visual Acuity and PCO Severity (PCO Area and Thickness) PCO area and thickness were positively correlated with visual acuity when visual acuity was equal to or smaller than 0.52 logMAR (Figure 4). At the 3 mm IOL optic region, the Spearman's correlation coefficients were 0.30 (*P*=0.03; PCO area and visual acuity) and 0.27 (*P*=0.049; PCO thickness and visual acuity). At the 5 mm IOL optic region, the Spearman's correlation coefficients were 0.32 (*P*=0.02; PCO area and visual acuity) and 0.29 (*P*=0.04; PCO thickness and visual acuity).

There was no significant correlation between PCO area, thickness, and visual acuity when visual acuity was larger than 0.52 logMAR (Figure 5). At the 3 mm IOL optic region, the Spearman's correlation coefficients were 0.01 (*P*=0.93; PCO

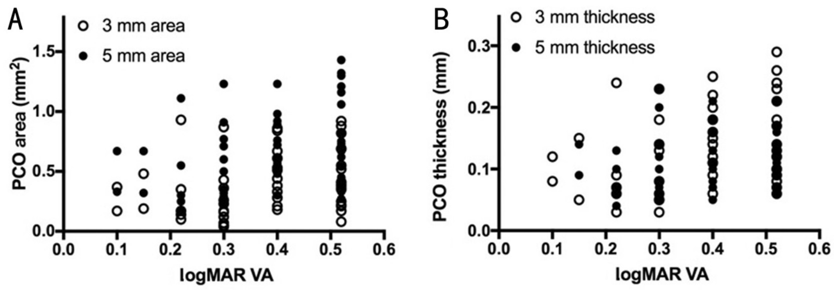

Figure 4 Relationship between visual acuity and PCO area and thickness when visual acuity is <0.52 logMAR A: Correlation of visual acuity & PCO area at 3 and 5 mm IOL optic region, the correlation coefficient is 0.30 (P=0.03) and 0.32 (P=0.02), respectively; B: Correlation of visual acuity & PCO thickness at 3 and 5 mm IOL optic region, the correlation coefficient is 0.27 (P=0.049) and 0.29 (P=0.04), respectively.

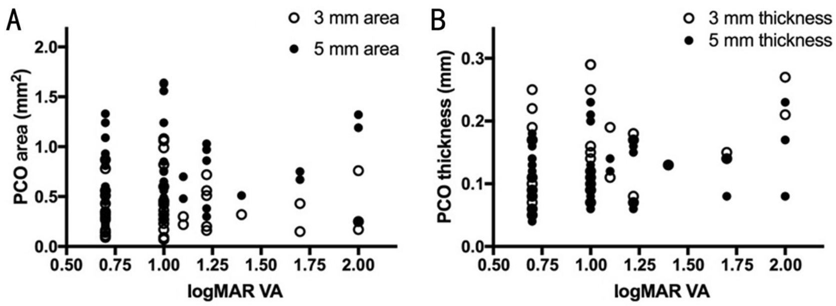

Figure 5 Relationship between visual acuity and PCO area and thickness when visual acuity is ≥0.52 logMAR A: Correlation of visual acuity & PCO area at 3 and 5 mm IOL optic region, the correlation coefficient is 0.01 (P=0.93) and 0.10 (P=0.52), respectively; B: Correlation of visual acuity & PCO thickness at 3 and 5 mm IOL optic region, the correlation coefficient is 0.26 (P=0.10) and 0.14 (P=0.36), respectively.

Table 2 PCO area, thickness, and density at 3 and 5 mm IOL optic region

PCO	3 mm IOL optic region M (Q1, Q3)			5 mm IOL optic region M (Q1, Q3)		
	Area, mm^2	Thickness, mm	Density	Area, mm^2	Thickness, mm	Density
All eye, *n*=100	0.36 (0.18, 0.56)	0.12 (0.08, 0.18)	41.93 (36.07, 55.27)	0.63 (0.43, 0.93)	0.12 (0.08, 0.15)	37.52 (32.00, 49.33)
High myopia, *n*=29	0.44 (0.34, 0.80)	0.16 (0.10, 0.24)	39.11 (33.45, 49.87)	0.75 (0.58, 1.22)	0.12 (0.10, 0.17)	36.20 (28.60, 42.40)

area and visual acuity) and 0.26 (P=0.10; PCO thickness and visual acuity). At the 5 mm IOL optic region, the Spearman's correlation coefficients were 0.10 (P=0.52; PCO area and visual acuity) and 0.14 (P=0.36; PCO thickness and visual acuity).

The cut-off level of visual acuity could be defined as 0.52 logMAR.

Comparison of IOL-PC Space, IOP-PC Distance, and PCO Coverage and Thickness Between Different IOL Designs

There were 87 eyes that had a medical record to reference and were grouped according to the IOL design and material. Comparisons of details for the different groups are shown in Tables 3 and 4.

Three-piece C haptic IOLs had a smaller IOL-PC space and IOL-PC distance than 1 piece-3 haptic IOLs and 1 piece-4 haptic IOLs, and the differences in IOL-PC distances were statistically significant (P=0.001). Similar trends could be observed in PCO coverage and thickness results, such that 3-piece C haptic IOLs had significantly less and thinner PCOs compared with the 1 piece-3 haptic IOLs and 1 piece-4 haptic IOLs (at the 3 mm IOL optic region, P=0.001 and P=0.011; at the 5 mm IOL optic region, P=0.016 and P=0.003).

IOL diameters equal to or less than 11.00 mm had larger IOL-PC spaces (P=0.089) and IOL-PC distances (P=0.001) when compared to IOLs with diameters equal to or larger than 12.5 mm. The IOL diameter equal to or less than 11.00 mm group showed higher PCO coverage and thickness when compared to the IOL diameters equal to or larger than 12.5 mm group, and the differences of PCO coverage and thickness were statistically significant (at the 3 mm IOL optic region, P=0.001 and P=0.005; at the 5 mm IOL optic region, P=0.009 and P=0.003).

The IOL-PC space and distance increased along with an increase in the haptic angulation from 0 degrees to 12 degrees, which were classified into 3 groups (group 1 haptic angulation <10°; group 2 haptic angulation =10°; group 3 haptic angulation=12°). The same trend could be observed in PCO coverage and thickness results. The differences in PCO coverage and thickness between these three groups were

Table 3 Comparison of area of IOL-PC space and PCO coverage at 3 and 5 mm IOL optic region with varied IOL designs

Area	IOL-PC area M (Q1, Q3)	3 mm PCO area M (Q1, Q3)	5 mm PCO area M (Q1, Q3)
Haptic			
3-piece C haptic	0.74 (0.42, 1.19)	0.29 (0.17, 0.40)	0.49 (0.30, 0.70)
1 piece-3 haptic	0.90 (0.66, 1.46)	0.46 (0.32, 0.78)	0.76 (0.41, 1.19)
1 piece-4 haptic	1.08 (0.74, 1.38)	0.47 (0.27, 0.69)	0.72 (0.54, 1.06)
P	0.13	0	0.02
IOL diameter			
≤11 mm	1.04 (0.70, 1.38)	0.46 (0.27, 0.75)	0.75 (0.48, 1.11)
≥12.5 mm	0.76 (0.41, 1.21)	0.30 (0.17, 0.41)	0.50 (0.30, 0.71)
P	0.09	0	0.01
Haptic angulation			
<10°	0.74 (0.39, 1.15)	0.31 (0.17, 0.43)	0.50 (0.30, 0.72)
10°	1.06 (0.74, 1.41)	0.45 (0.26, 0.71)	0.70 (0.48, 1.07)
12°	1.19 (0.95, 1.68)	0.69 (0.43, 0.82)	1.03 (0.67, 1.30)
P	0.01	0	0
Material			
Hydrophilic	1.02 (0.69, 1.37)	0.44 (0.27, 0.69)	0.72 (0.49, 1.08)
Hydrophobic	0.60 (0.34, 1.16)	0.20 (0.17, 0.35)	0.44 (0.30, 0.61)
P	0.05	0	0.01

Table 4 Comparison of distance of IOL-PC space and PCO thickness at 3 and 5 mm IOL optic region with varied IOL designs

Thickness	IOL-PC distance M (Q1, Q3)	3 mm PCO thickness M (Q1, Q3)	5 mm PCO thickness M (Q1, Q3)
Haptic			
3-piece C haptic	0.11 (0.07, 0.13)	0.10 (0.07, 0.13)	0.08 (0.07, 0.12)
1 piece-3 haptic	0.16 (0.10, 0.25)	0.15 (0.09, 0.23)	0.12 (0.08, 0.16)
1 piece-4 haptic	0.16 (0.11, 0.25)	0.15 (0.09, 0.22)	0.13 (0.10, 0.17)
P	0	0.01	0
IOL diameter			
≤11 mm	0.16 (0.10, 0.25)	0.15 (0.09, 0.21)	0.13 (0.09, 0.17)
≥12.5 mm	0.11 (0.08, 0.13)	0.10 (0.07, 0.13)	0.08 (0.07, 0.12)
P	0	0.01	0
Haptic angulation			
<10°	0.11 (0.07, 0.13)	0.10 (0.07, 0.14)	0.09 (0.70, 0.13)
10°	0.16 (0.10, 0.25)	0.12 (0.08, 0.20)	0.13 (0.10, 0.17)
12°	0.23 (0.15, 0.27)	0.18 (0.14, 0.25)	0.13 (0.09, 0.17)
P	0	0	0
Material			
Hydrophilic	0.15 (0.10, 0.24)	0.14 (0.09, 0.20)	0.12 (0.08, 0.16)
Hydrophobic	0.09 (0.07, 0.12)	0.09 (0.06, 0.13)	0.09(0.07, 0.13)
P	0	0.02	0.13

significantly different (at the 3 mm IOL optic region, P=0.00 and P=0.00; at the 5 mm IOL optic region, P=0.001 and P=0.002). Hydrophilic IOLs showed larger IOL-PC spaces and distances than hydrophobic IOLs, and the differences of IOL-PC spaces and distances were statistically significant (P=0.046 and P=0.001). Hydrophilic IOLs were also accompanied by more severe PCOs when compared with hydrophobic IOLs (PCO coverage and thickness comparison at the 3 mm IOL optic region, P=0.001 and P=0.021; at the 5 mm IOL optic region, P=0.005 and P=0.13).

In addition, the PCO density variation was small and had no significant meaning among different groups.

DISCUSSION

In this study, we first analysed the size of IOL-PC space with cross-sectional anterior segment images that were acquired with RTVue-100 OCT. It was reported that IOL-PC spaces should be gradually decreased and closed in 2wk after IOL implantation[13-14]. In our study, we reported the median value of the size of IOL-PC space was 0.93 (range 0.63-1.36) mm^2 in all these PCO eyes. Besides, it was 1.26 (range 0.83-1.79) mm^2 in 23 PCO eyes which still showed unoccupied residual IOL-PC space. In high myopia eyes, there was a larger IOL-PC space and more severe PCO. The existence of obvious residual IOL-PC should be closely correlated with PCO formation and severity.

We also reported that IOL-PC space was positively correlated with axial length. As reported, capsule space was positively related to axial length, the longer eyes had a larger capsule[6] and the implanted IOL was thinner, which tended to have less convexity of the IOL back surface. In addition, IOL apposition to capsule was negatively correlated with axial length[15]. These factors resulted in a larger IOL-PC space and higher PCO occurrence rate which could be supported by our results as well. In addition, PCO area and thickness were positively correlated with axial length.

The existence of PCO resulted in deceasing of visual acuity. In our study, logMAR visual acuity was positively correlated with PCO area and thickness at the 3 and 5 mm IOL optic regions when visual acuity was ≤0.52 logMAR. There was no significant correlation when visual acuity was >0.52 logMAR. So we believed the cut off level of visual acuity could be 0.52 logMAR in these PCO eyes. These results suggested that the decrease of visual acuity could describe the PCO severity (PCO area and thickness) to some degree. However, with severe PCO more items may be needed to describe the decreased visual function. Besides, In visual acuity >0.52 logMAR group, pear type PCO comprised the major part, the high light scattering of pear type PCO cause more severe visual function impairment, which may influence the results[16]. In previous study, Moreno-Montañés *et al*[17] analysed PCO peak density and posterior capsule thickening (PCT) with OCT-1 and reported that logMAR visual acuity was positively correlated with PCT (Spearman correlation coefficient r=0.66). This agreed with our results. However, van Bree *et al*[18] reported a curvilinear correlation between logMAR and PCO severity (EPCO score), the curvilinear correlation indicated that logMAR is not affected by low PCO severity. This was different from our result. The reason might be the varied PCO severity and different evaluation methods.

We believed that residual IOL-PC and PCO severity could be also attributed to the varied IOL designs and materials. As reported, acrylic, silicone, and poly-methyl methacrylate IOLs showed various capsule closure times, the delayed closure of capsule could facilitate the migration and accumulation of lens epithelia cells (LECs)[11]. As it was reported that the rapid proliferation speed of LECs for patients younger than 40y was only 5.8±0.6d, for those who were older than 60y was 7.2±0.7d. Hence, theoretically, LECs could migrate to and proliferate on the posterior capsule before capsular bend formation and IOL apposition to a capsule (within 2wk for normal eyes[13-14] and en-longed for high myopia eyes[15]). In addition, Elgohary *et al*[19] reported closer apposition between IOL optic and mid-peripheral posterior capsules when comparing hydrophobic acrylic IOLs and PH silicone IOLs. When this apposition was missing with a PH silicone IOL, there was high reflectance material that accumulated between the IOL and posterior capsule, which was considered as LECs and extracellular matrix. In our study, we not only observed these materials but also quantified these high reflectance materials (including PCO area, thickness, and density) in the IOP-PC space and proved that there was a positive relation between the size of the IOL-PC space and PCO severity (PCO area and thickness) with RTVue-100 OCT.

In addition, in these PCO eyes recruited in our study, we analysed the correlation between PCO severity and IOL designs and materials.

In our study, the 1 piece IOL had a larger IOL-PC space and PCO area and thickness than the 3 piece IOL, this might be due to poor axial stability and efficiency of IOL adherence, which was agreed with a previous study[20]. Further more, haptic junction points interrupted the 360-degree sharp edge that hampered capsule bend formation, weakened the mechanical barrier effect of the IOL optic edge[21], and the high multi-crease occurrences[22-23] which may be the channel for LEC migrations[8,12].

We also found more severe PCOs with hydrophilic IOLs than hydrophobic IOLs. This was agreed with the higher PCO occurrences, PCO scores and Nd:YAG laser surgery rates in previous hydrophilic IOLs related studies[1,15]. This might be due to the surface of hydrophilic IOLs, which was more suitable for migration and proliferation of LECs[24]. While, the surface of hydrophobic IOLs showed stiffer adherence with the capsule, and the fibronectin and laminin strengthened the adherence to eliminate the IOL-PC space[10].

It was believed that IOLs suited to the capsule could prevent PCO, anterior capsule opacification (ACO), and IOL tile and decentration[6]. In our study, when the implanted IOL diameter was ≤11.00 mm, the IOL-PC space and PCO area and thickness increased compared with the IOL diameter ≥12.5 mm group. This might be due to poor IOL adherence and multi-capsule creases. It was reported that the diameter of the empty capsule for emmetropia eyes was 10-10.8 mm, when the

IOL implanted capsule diameter was 10 mm or could be stretched to 12.0 mm[25]. With an IOL diameter ≥12.5 mm, the capsule could be stretched to eliminate creases and IOL-PC space. Meanwhile, the powerful mechanical stress of the IOL optic edge prevented the migration of LECs. However, with an IOL diameter increase, PCO may increase. As Moreno-Montañés *et al*[4] reported, when the IOL diameter was ≤12.0, 12.5, or ≥13.0 mm, PCTs were 0 (0-37), 56 (17.33-78.66), and 78.66 (12-133.33) μm, respectively. A thicker PCO in the ≥13.0 mm group might be due to over stretching and could have caused more creases on the haptic axial, which induced the migration of LECs. However, a study also reported that there was no effect of the IOL diameter on PCO formation[6,26].

We also found that PCO area and thickness were increased along with the increases in IOL haptic angulation. This agreed with Moreno-Montañés *et al*[4] results, which were IOL haptic angulation of 0, 5, and 10 degrees when the PCTs were 0 (0-37.33), 58.67 (17.33-92.00), and 59.33 (0.67-110.50) μm, respectively, which were significantly different. It was reported that AcrySof® MA60BM with 10-degree haptic angulation showed axial movement at 3mo after surgery. The poor axial stability hampered the closing of the capsule, which may promote PCO formation. However, it was believed that haptic angulation could increase the contact between the IOL and capsule and that 10-degree haptic angulation was preferable[27]. Some others also suggested that there was no influence of IOL haptic angulation on PCO formation. Schmidbauer *et al*[28] implanted Centerflex® IOLs (Rayner) with 0, 5, and 10 degree haptic angulations in rabbit eyes and reported no significant differences in the central PCO, peripheral PCO and Soemmering's ring scores. The author believed that the mechanical stress of the IOL edge may overwhelm the effect of haptic angulation.

In conclusion, RTVue-100 OCT can be applied to objectively analyse and quantify the apposition between an IOL and the posterior capsule and PCO severity (area, thickness, and density). It was suggested that IOL-PC space and PCO area and thickness were positively correlated with axial length. In addition, PCO area and thickness was positively correlated with visual acuity. The cut off level of visual acuity was 0.52 logMAR. when visual acuity was larger than 0.52 logMAR, more items may be needed to describe the visual function impairment. Besides, IOL-PC space and PCO area and thickness were also well related with IOL designs. The 3-piece C haptic, diameter of 12.5 mm, smaller haptic angulation and hydrophobic IOL tended to have smaller IOL-PC space and less severe PCO.

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