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Special Cases in Cataract Surgery

Minghui Deng, Song Chen and Xiaogang Wang

Abstract

During phacoemulsification for cataracts, the surgeon may encounter various challenges and should therefore be trained to handle them. This chapter will share an example of clinical cases encountered by the author in clinical practice, which mainly includes the successful implantation of a trifocal intraocular lens in the capsular bag after posterior capsular tear during posterior polar cataract surgery as well as cataract surgery design after corneal refractive surgery, shrinkage, and treatment of capsular opening in patients with retinitis pigmentosa after cataract surgery to provide a reference for clinicians.

Keywords: posterior polar cataract, retinitis pigmentosa, post-corneal refractive surgery, phacoemulsification surgery for cataract

1. Introduction

With continuous advancements in technology, emergence of new equipment, and introduction of new types of intraocular lens (IOL) for cataract surgery, the latter has entered the era of refractive surgery. Simultaneously, the advent of a variety of functional IOLs [1] can enable patients to achieve functional vision recovery after cataract surgery. The individualized eye conditions of the patient and the unpredictable special conditions that occur during and after surgery should be considered by every cataract surgeon. Based on our clinical experience, the following are a few questions for readers to contemplate: (1) After the occurrence of posterior capsule circular capsulorhexis and posterior capsular rupture, can high-end IOLs be safely implanted? (2) For cataract patients with obvious decentered ablation after laser-assisted in-situ keratomileusis (LASIK), is high-end IOL implantation suitable during phacoemulsification? (3) How can we deal with capsular shrinkage syndrome after cataract surgery in patients with retinitis pigmentosa and high myopia?

In the following chapters, we will specifically report the three aforementioned situations in combination with actual cases, for providing readers with valuable clinical references.

2. A case of successful implantation of a trifocal intraocular lens in the capsular bag after posterior capsule tear in posterior polar cataract surgery

A 25-year-old male patient was admitted to the hospital for a complaint of blurred vision in the right eye since childhood, which had gradually aggravated and was accompanied by photophobia for 2 years. The patient had refractive errors bilaterally and amblyopia in his right eye and had worn glasses for many years.

The eye examination revealed that the right eye had a visual acuity of 0.25, which could not be corrected; the left eye had a visual acuity of 0.1, wherein optometry showed (-2.50 D), and it was corrected to 1.0; the binocular intraocular pressure was normal. The right eye lens was disc-shaped, irregular porcelain, with white opacity seen in the posterior pole, and the left eye lens was transparent (**Figure 1**). The corneal endothelial cell count of the right eye was 2479.9 cells/mm²; No abnormality was evident in the optical coherence tomography (OCT) examination of the macular area. His condition was diagnosed as a posterior polar cataract of the right eye, amblyopia in the right eye, and refractive error in the left eye.

The patient was only 25 years old and had certain requirements for a full range of vision; however, the right eye of the patient had a posterior polar cataract. Based on the results of Pentacam, the posterior capsule was very likely to be severely organized or incomplete, and the patient had amblyopia in the right eye. Therefore, before the operation, the patient was informed about the surgical procedure such that the patient fully understood that the posterior capsule might be organized, opaque, or incomplete during the operation, and it would be necessary to perform posterior capsule continuous circular capsulorhexis. If the capsulorhexis was successful, then a trifocal IOL could be implanted. Otherwise, a prepared three-piece single-focus IOL would be implanted. Even if the trifocal IOL was successfully implanted, the postoperative far, medium, and near visions would not reach the normal level due to amblyopia and would need to be corrected by wearing glasses. With the patient's full understanding, the right eye cataract phacoemulsification and trifocal IOL implantation was performed on March 31, 2020. Before the

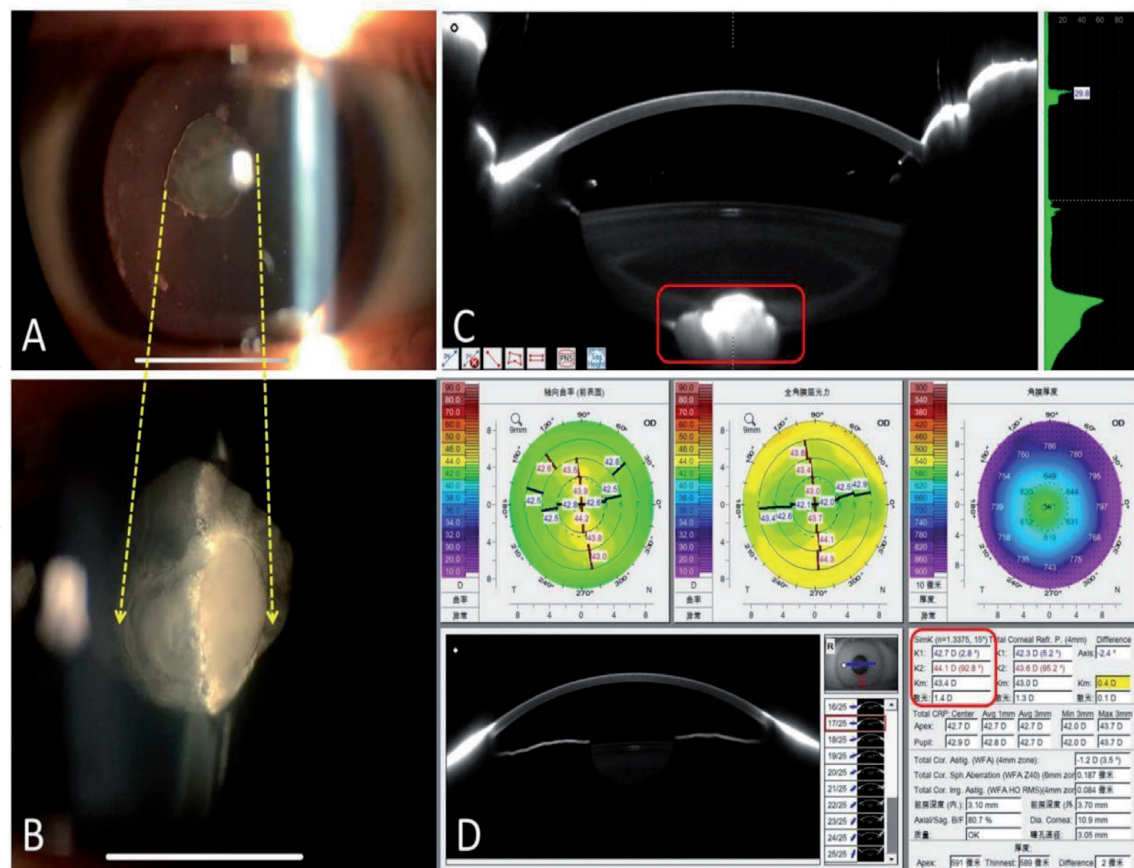


Figure 1. Slit-lamp photography after mydriasis of the surgical eye shows that the posterior capsule is opaque, dense, and organized (A, B). Pentacam examination after mydriasis shows that the posterior capsule is opaque and demonstrates high reflective brightness, with a high brightness value (C red box); there is 1.4 D@93° regular corneal astigmatism at 15° of the center of the anterior surface of the cornea under the measurement of the natural pupil (D red box).

operation, the 0-180° axial position was marked in the surgical eye in the sitting position. After routine disinfection and draping during the operation, the Placido disc marked the meridian position of the steep axis of corneal astigmatism at the 93° and 273° axial positions of the surgical eye; a 3.0-mm skeratome was then used to make a symmetric incision at the corneal limbus of the steep axis of the cornea, and 5.5-mm continuous circular capsulorhexis and hydrodelineation were performed. Phacoemulsification was used to aspirate and remove the nucleus and cortex. The posterior capsule was not found to be incomplete; however, the thick white mass of the opaque, organized tissue attached to the upper center of the posterior capsule could not be polished or aspirated. The viscoelastic agent was injected into the anterior chamber, and a 1-mL syringe needle was used to remove the opaque, organized tissue that adhered to the posterior capsule. Subsequently, a posterior capsule continuous circular capsulorhexis of approximately 4.0 mm was successfully performed, and while a +19.0 D trifocal IOL (AT LISA tri 839mp, Zeiss) was implanted in the capsular bag, during which the IOL was rapidly unfolded. It was found that the posterior capsule annular capsulorhexis opening had partial dehiscence at approximately the 8 o' clock position; however, no vitreous was observed. The IOL was rotated to make its long axis perpendicular to the angle of the posterior capsule dehiscence such that the IOL was centered in the capsular bag, the residual viscoelastic agent in the anterior chamber was aspirated, and the stability and centering of the IOL were verified again. The incision was watertight and the IOL position was observed to ensure that it was centered, and the operation was complete (Figure 2).

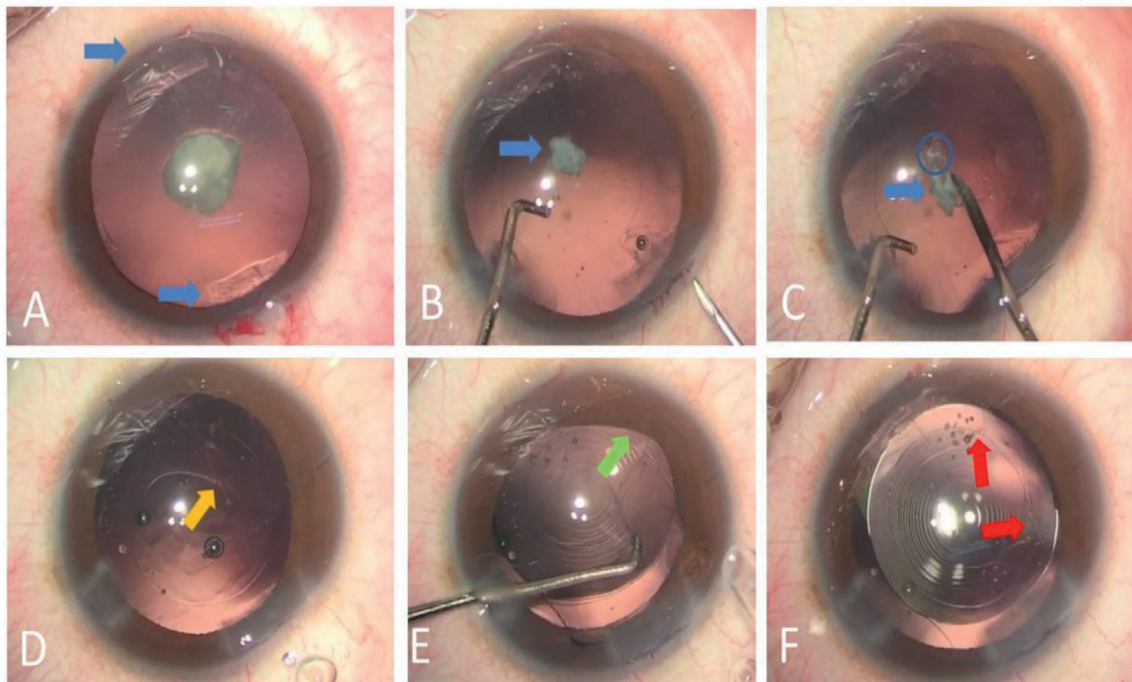


Figure 2.

According to the preoperative corneal astigmatism of the patient, a 3.0-mm-wide symmetric transparent corneal incision was made on the steep axis of the cornea to relieve corneal astigmatism (A, blue arrow). After the nucleus and cortex were aspirated, the thick white mass of opaque and organized tissue attached to the upper center of the posterior capsule could not be polished or aspirated (B, blue arrow). A 1-mL syringe needle was used to remove the opaque and organized tissues that adhered to the posterior capsule (C, blue arrow and the blue circular area). After the completion of the continuous circular capsulorhexis of the posterior capsule, there were manifestations of the irregular capsulorhexis opening at nearly the 8 o'clock position, which was a hidden danger for the subsequent occurrence of posterior capsular rupture at this location (D, yellow arrow); the plate-type trifocal intraocular lens (IOL) was rapidly unfolded during implantation, and pressure was applied to the weak part at nearly the 8 o'clock position of the posterior capsular opening to cause rupture (E, green arrow); finally, the long axis of the IOL was placed in the direction perpendicular to the posterior capsular dehiscence angle, the IOL was stable and centered, and, simultaneously, the dehiscence site of the posterior capsulorhexis opening and the opaque and organized site in Figure D corresponded to each other (F, red arrow).

The uncorrected visual acuity of the right eye was (far vision 0.4, medium vision 0.4 near vision 0.63) at 1 day after operation, (far vision 0.5, medium vision 0.5, near vision 0.63) at 1 week after operation, and (far vision 0.5, medium vision 0.5, near vision 0.63) at 42 days after operation, and (far vision 0.5, medium vision 0.5, near vision 0.63), optometry showing $-0.75DC \times 138^\circ$, which was corrected to $+0.5$ at 7 months after operation. At this time, the IOL position was stable and centered as revealed in reexamination (**Figure 3**). There were no manifestations of anisometropia or complaints of obvious glare, halo, and other adverse visual phenomena in the postoperative reexaminations at various stages.

2.1 Discussion

In this study, a patient with amblyopia and a monocular posterior polar cataract in the right eye was analyzed. The with-the-rule corneal astigmatism (around 1.4D) was partially corrected by using a steep-axis clear corneal symmetric incision during the operation. Considering the potential influence of the densely opaque and organized tissue in the visual axis of posterior capsule, a posterior capsule continuous circular capsulorhexis was successfully performed during the surgery, and a trifocal IOL was implanted in the capsular bag. However, when the trifocal IOL was implanted as the hydrophilic acrylic IOL was unfolded rapidly, it caused pressure

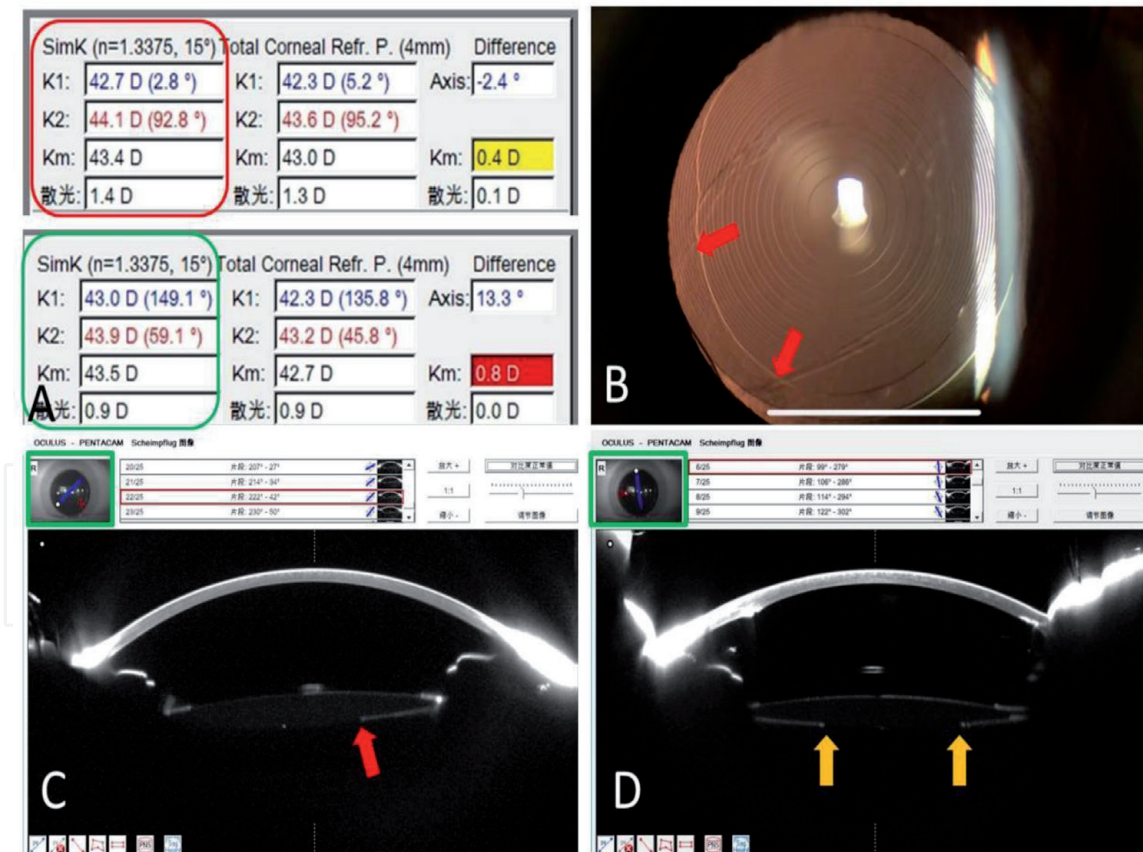


Figure 3.

Pentacam examination performed again at 7 months after surgery shows that the anterior surface corneal astigmatism changed from 1.4 D@93° before surgery to 0.9 D@59° (A, red frame and green frame); Slit-lamp retroillumination imaging showing that the intraocular lens was centered and stable, the dehiscence of the posterior capsular opening at the 8 o'clock position did not change significantly compared to the intraoperative status (B, red arrow); Pentacam tomography showing that the posterior capsule signal at the 8 o'clock position is discontinuous and no contralateral signal is observed, indicating the direction of posterior capsule dehiscence (C, green box and red arrow); Pentacam tomography scan showing that the posterior capsule is incomplete in the direction of nearly the 6 o'clock position; however, the signal of the margin of the posterior capsule is visible and symmetrical (D, green box and yellow arrow).

on the weak posterior capsule circular capsulorhexis opening, and the dehiscence of posterior capsulorhexis opening occurred. As the posterior capsule and anterior hyaloid membrane were separated with a viscoelastic agent in advance, there was no vitreous overflow. By rotating the position of the IOL, the long axis of the IOL was perpendicular to the direction of the dehiscence of posterior capsulorhexis opening and the four corner loops of the plate-type IOL provided support in the capsular bag, thus ensuring its centering and stability. Although the patient had amblyopia and large astigmatism in the surgical eye, he received full explanation before the operation to ensure his recognition and understanding. The postoperative corneal astigmatism was controlled within 1.0 D, and the far, medium, and near visions were greatly improved compared to those before the operation; the postoperative patient satisfaction was quite high. In 2018, Srinivasaraghavan et al. reported a case of successful implantation of a functional IOL in the capsular bag after a posterior capsule rupture in a traumatic cataract patient, which provided a certain reference basis for this study [2].

The choice of the trifocal IOL for this case is mainly based on the following considerations: (1) Young patients have a high demand for a full range of vision; (2) Although the patient's cornea had 1.4 D with-the-rule astigmatism, studies have shown that after the production of a symmetric transparent corneal incision on the steep axis of the cornea, a 2.8–3.5 mm clear corneal incision could correct 1.00–2.06 D of astigmatism [3–5]. Based on the surgeon's previous surgical experience, it was considered that astigmatism could be reduced to less than 1.0 D through the symmetric incision on the steep axis of the cornea. Simultaneously, according to the correction analysis of the astigmatism IOL using the Baylor nomogram, it was not necessary to correct with-the-rule astigmatism of less than 1.69 D, which also provided the basis for the implantation of the trifocal IOL in this study [6]; (3) Except for the posterior polar cataract, no organic abnormality was evident in the patient's surgical eye examination. However, through a retrospective analysis of the patient's medical history and various examinations, he was diagnosed as amblyopia, and it was expected that although the postoperative visual acuity could not reach normal, it would be greatly improved compared with the preoperative visual acuity, and the full range of visual acuity could be achieved; therefore, the final choice was to implant a trifocal IOL.

Posterior polar cataract surgery is highly challenging and unpredictable, because the specific conditions of the posterior capsule must always be considered during the operation; only hydrodelineation, without hydrodissection, is performed during the operation, and the anterior chamber must be maintained stable at all times to avoid causing excessive tension on the posterior capsule and thus resulting in posterior capsule rupture [7–9]. Although the posterior capsule of this patient was intact during the operation, its opacity was located in the visual axis, which seriously affected the visual quality after IOL implantation. Therefore, the posterior capsule was subjected to continuous circular capsulorhexis during the operation [9]. When a trifocal IOL was implanted, it was unfolded quickly and caused great tension on the posterior capsulorhexis opening, leading to dehiscence of the posterior capsulorhexis opening. The location of the dehiscence of the posterior capsular was the same as the site where the capsulorhexis crossed over the opacity of the posterior capsule. Considering that the tension resistance of the capsule here was weaker than that of the normal posterior capsule, dehiscence occurred under the state of uneven tension when the IOL was unfolded after implantation. This also suggests that we should try to tear off the opacity part as far as possible during the posterior capsule capsulorhexis to ensure even and consistent tension resistance of the capsular opening.

After the intraoperative implantation of a trifocal IOL, the dehiscence of posterior capsulorhexis opening occurred beyond our expectation. We must weigh

the pros and cons according to the specific situation. If the trifocal IOL could not be stably implanted in the capsular bag or if there was a large amount of vitreous overflow, then we would choose to implant a single focal three-piece IOL in the ciliary sulcus, and the optical part was captured in the anterior capsulorhexis opening of less than 6 mm, which could prevent the eccentricity and tilt of the IOL that might occur after surgery and keep its stability [10]. The surgeon assessed that although the posterior capsular capsulorhexis dehiscence occurred during the intraoperative trifocal IOL implantation in this patient, the anterior vitreous membrane was well protected in the early stage and there was no vitreous overflow; therefore, the long axis of trifocal IOL was rotated to the direction perpendicular to the direction of dehiscence, which reduced further pulling of the IOL on the capsulorhexis opening of dehiscence and allowed it to be stable and centered in the capsular bag.

Although this study did not involve a follow-up for 1 year or longer after surgery, the long-term stability of the trifocal IOL remained to be observed; however, this study emphasizes that for posterior capsular continuous circular capsulorhexis in posterior polar cataract surgery or a small range of posterior capsular rupture in common cataract surgery followed by posterior capsular continuous circular capsulorhexis, in circumstances where there is no vitreous overflow, the surgeon can evaluate whether it is feasible to implant the trifocal IOL in the capsular bag according to the actual intraoperative situation and expand the relative indications for trifocal IOL surgery.

3. A case of trifocal intraocular lens implantation for high myopia complicated with cataract after LASIK operation

A 51-year-old male patient underwent LASIK surgery 23 years ago due to high myopia in both eyes. According to the patient's recollection, the best postoperative visual acuity in his eyes was 0.5 in the right eye and 0.6 in the left eye. On May 20, 2019, the patient presented with high myopia and cataract in both eyes, binocular visions: right eye 0.08, left eye 0.12; optometry: right eye $-14.50\text{DS} = 0.3$, left eye $-13.50\text{DS}/-0.75\text{DC}\times 50^\circ = 0.3$. The fundus photos and OCT scanning of both eyes showed high myopic retinal changes (**Figure 4**).

The corneal topography examination showed obvious decentered ablation (**Figure 5**), and the right eye's total corneal astigmatism was 1.3 D, total corneal spherical aberration (SA) was $0.532\ \mu\text{m}$, total corneal irregular astigmatism was $1.615\ \mu\text{m}$, and angle kappa was $0.79\ \text{mm}$. The left eye's total corneal astigmatism was 2.4 D, total corneal SA was $1.259\ \mu\text{m}$, and total corneal irregular astigmatism was $1.373\ \mu\text{m}$. The above indicators were significantly beyond the scope of application of the trifocal IOL recommended by the Expert Consensus on The Clinical Application of Multifocal IOLs in China (2019): estimated postoperative total corneal astigmatism $\leq 0.75\ \text{D}$, preoperative total corneal spherical aberration (SA) $\leq 0.3\ \mu\text{m}$, total corneal irregular astigmatism ≤ 0.3 to $0.5\ \mu\text{m}$, angle kappa $\leq 0.5\ \text{mm}$, or less than half of the diameter of the central refractive optical zone of the IOL.

Given the actual situation of the patient, we conducted in-depth communication with the patient and recommended that the patient should receive an implant of a single-focus IOL to avoid evident symptoms of visual discomfort after the operation. However, the patient had a strong willing of not wearing eyeglasses after surgery; therefore, he still wanted to apply trifocal IOL to achieve full range of vision after surgery. Even in the event of maladaptation, he was willing to replace the IOL with another operation.

Finally, it was decided to perform phacoemulsification combined with trifocal IOL implantation on the right eye, which had relatively good corneal conditions.

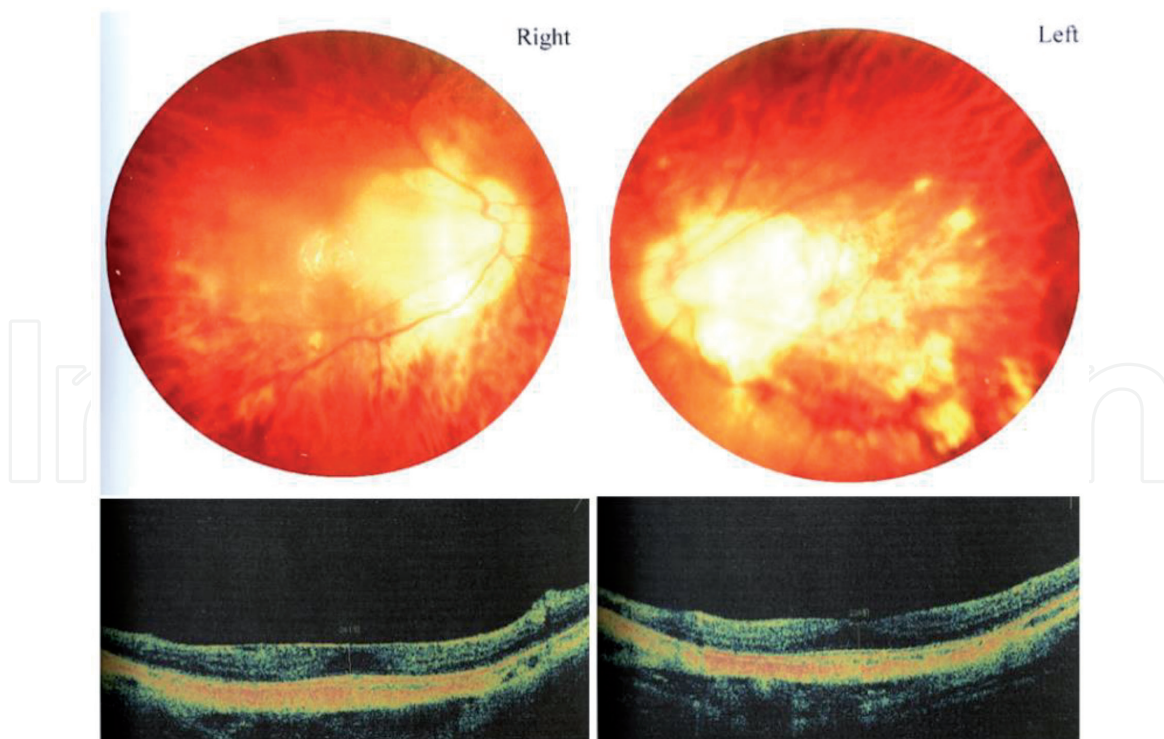


Figure 4.
Fundus photography and OCT examination showing high myopic changes in the fundus of both eyes.

In this case, a multi-formula average method from the American Society of Cataract and Refractive Surgery (ASCRS) website was used for IOL power calculation to improve the accuracy. Because the patient's right eye corneal astigmatism was 1.3D, we used a 3.0-mm symmetrical and clear corneal incision on the 101.9° meridian of the steep axis of the cornea to partially correct the corneal astigmatism. Subsequently, continuous circular capsulorhexis with a diameter of approximately 5.5 mm was performed during the operation, and the phacoemulsification was completed using the Stellaris (Bausch +Lomb Laboratories, USA) system. After aspirating cortex, the anterior and posterior capsules were thoroughly polished, and +10.0 D (IOL degrees of both eyes are selected according to the ASCRS IOL Calculator for Eyes with Prior Myopic LASIK/PRK online calculation formula) Zeiss trifocal IOL (AT LISA tri839MP) was implanted; no complications occurred during the operation.

Visual acuity on the second day of right eye was as follows: far vision 0.4, medium vision 0.63, near vision 0.63; optometry showed that the far vision was $-0.5 \text{ DS}/-0.75 \text{ DC} \times 105^\circ = 0.5$ and intraocular pressure was 15 mmHg; slit-lamp examination showed that the cornea was transparent and clear, and the clear corneal incision was well closed; the pupil was sensitive to light, and the IOL was well-centered (**Figure 6**). The Pentacam examination of the right eye showed that the corneal incision was well closed, and the patient was highly satisfied and did not complain of any visual disturbance or discomfort.

Given the more obvious decentered ablation of the left cornea, greater corneal astigmatism, and greater total corneal SA and total corneal irregular astigmatism (**Figure 5**), we communicated with the patient repeatedly to inform about the possible obvious visual disturbance and discomfort after surgery. After the patient's approval to use the ZEISS trifocal IOL, we used the same method to perform left eye phacoemulsification combined with +9.5 D Zeiss trifocal IOL implantation for the patient on May 28, 2019. There were no complications during the operation.

On May 29, 2019, a re-examination showed that the right eye had a far vision of 0.5, medium vision of 0.63, and near vision of 0.63, and the left eye had a far vision of 0.5, medium vision of 0.5, and near vision of 0.5. Optometry showed that the

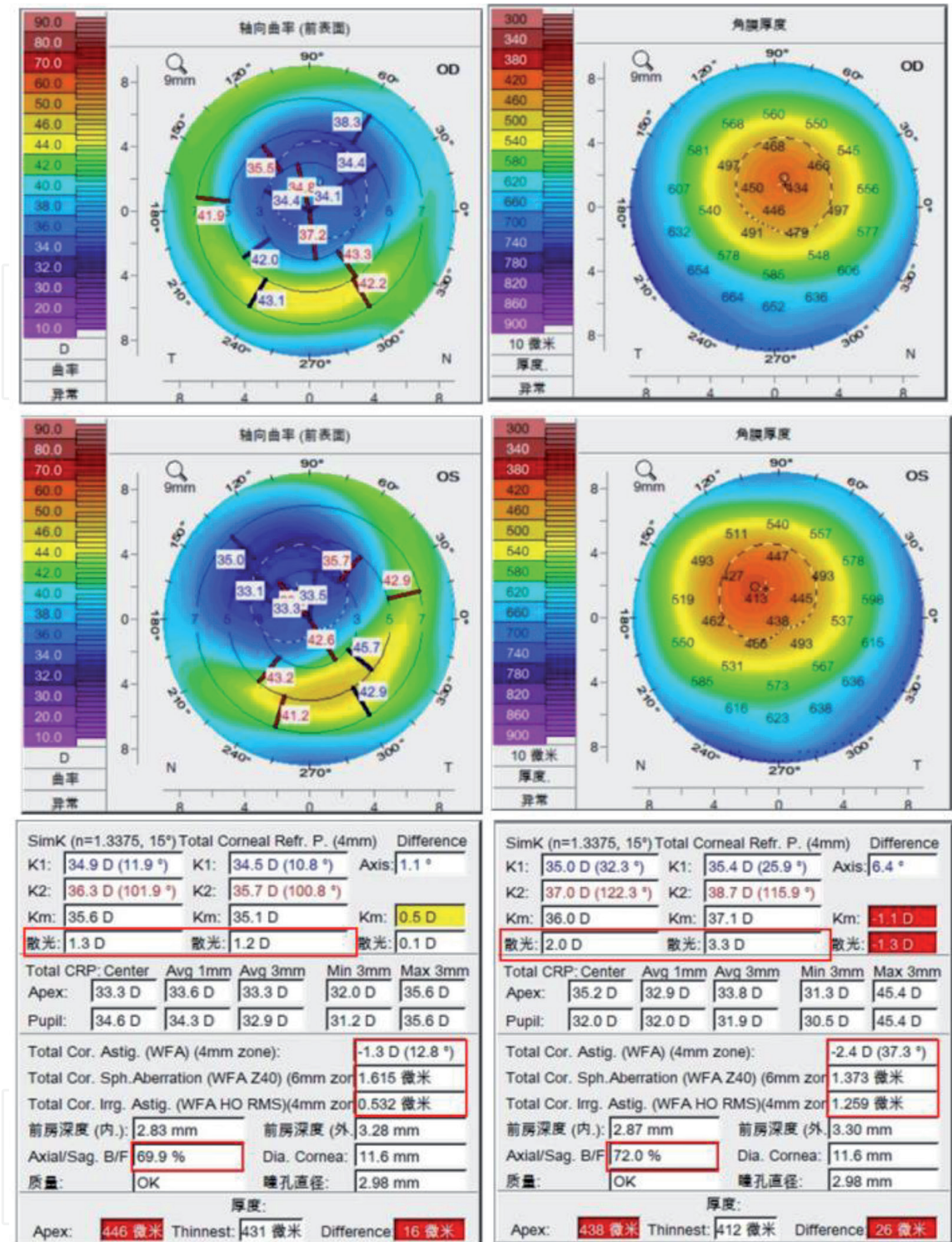


Figure 5. Binocular Pentacam examination showing decentered ablation in both eyes.

right eye had $-0.75 \text{ DC} \times 107^\circ = 0.5$ and the left eye had $-0.25 \text{ DS} / -0.5 \text{ DC} \times 135^\circ = 0.5$. The intraocular pressure was 14 mmHg in the right eye and 16 mmHg in the left eye. Slit-lamp examination showed that the cornea of both eyes was transparent and clear, the clear corneal incision was well closed, the pupils were sensitive to light, and the IOL was well-centered (Figure 7). On June 05, 2019, the results of Pentacam examination performed again on both eyes showed that the corneal incision was well closed, the corneal astigmatism in both eyes was reduced compared with that before the operation, and the total corneal SA and total corneal irregular astigmatism were both reduced compared with those before the operation. The patient was highly satisfied, which was a completely unexpected outcome (Figure 8).

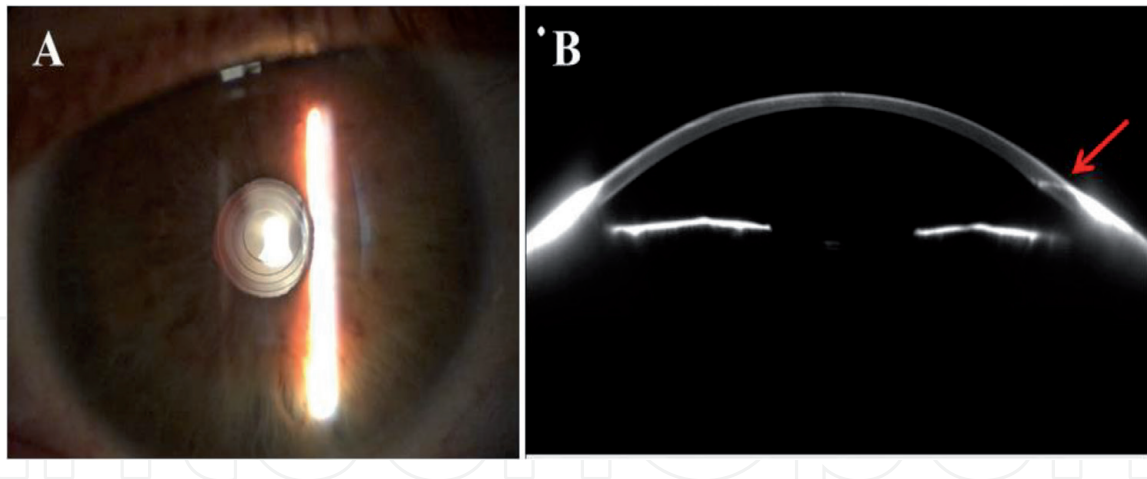


Figure 6.
A right-eye slit-lamp photograph taken on May 24, 2019, showing the trifocal intraocular lens (IOL) is well centered, and the center of the diffraction ring is quite close to the center of the pupil (Panel A). Simultaneously, Pentacam in the right eye shows that the corneal incision is well closed (red arrow in Panel B).

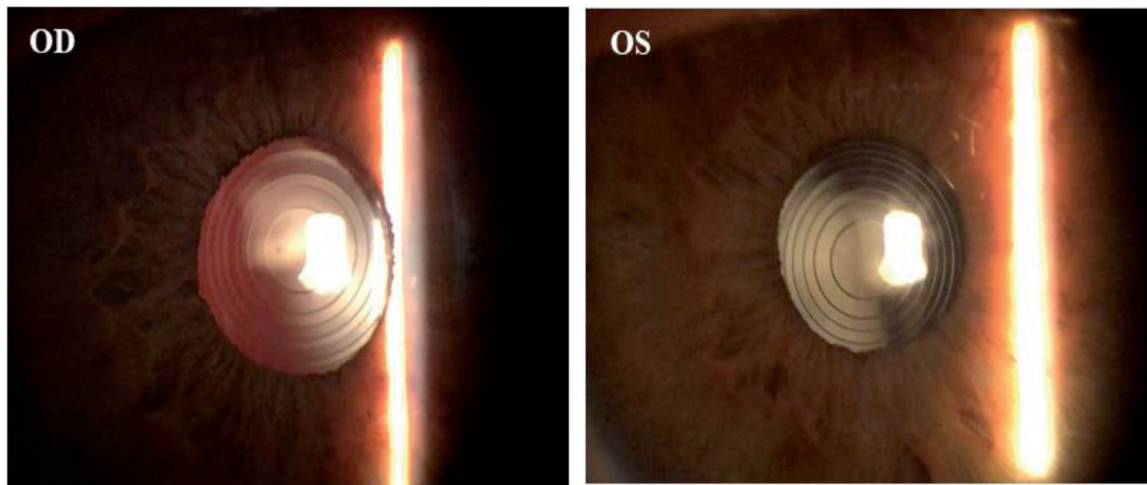


Figure 7.
A binocular slit-lamp photograph taken on May 29, 2019, showing that the trifocal intraocular lens (IOL) is well centered, and the center of the diffraction ring is quite close to the center of the pupil.

3.1 Discussion

Since 1990s, corneal refractive surgery has been widely performed for refractive correction in millions of younger patients. As they grew older for cataract surgery, they are still willing to acquire better visual quality and freedom from glasses [11]. Some of previous studies have demonstrated that multifocal IOL implantation could be a safe and efficient way for patients with previous corneal refractive surgery [12–15]. However, due to the uncertainty in IOL power calculation and the potential side effects such as glare, halo or other visual acuity problems, premium IOL surgical plans for patients post-corneal refractive surgery are still facing many challenges.

AT LISA tri839MP used in this study, as a monolithic diffractive trifocal IOL, is able to split the incoming light at near, intermediate, and distant focus, respectively. It has been shown to provide good outcomes of visual acuity at a near, intermediate, and far distance and a high postoperative satisfaction [16, 17]. Moreover, two previous studies also demonstrated that it can provide a good visual outcome at both near and distance vision for post-myopic LASIK cases [18, 19].

Although the patient's corneal astigmatism, irregular astigmatism, and SA in both eyes exceeded the scope of application of the Zeiss trifocal IOL, the patient had a strong willingness of not wearing eyeglasses after the operation. Therefore,

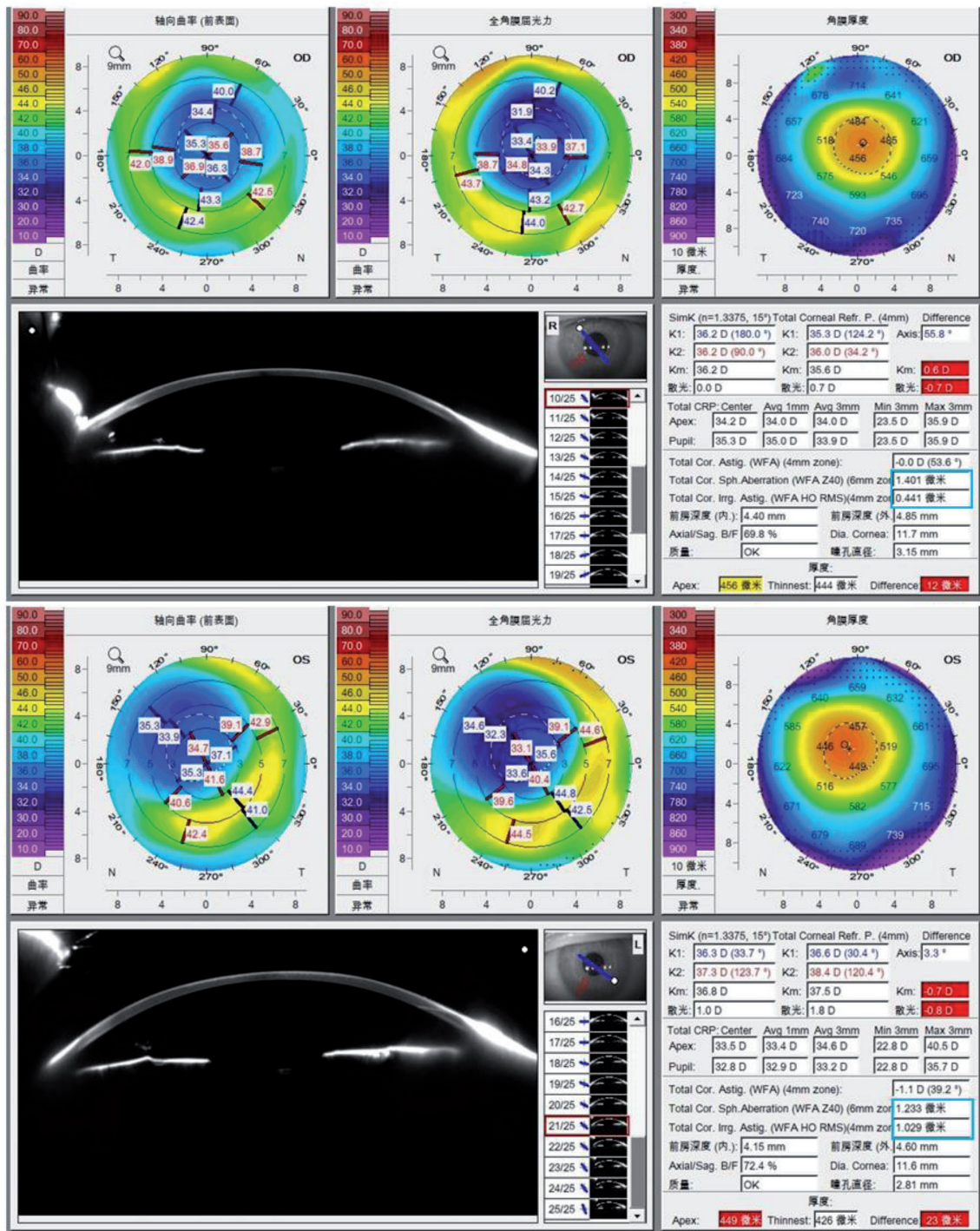


Figure 8. A binocular Pentacam image taken on June 05, 2019, showing that corneal astigmatism, total corneal spherical aberration (SA), and total corneal irregular astigmatism are all reduced compared with those before surgery.

after a comprehensive preoperative evaluation, a symmetric clear corneal incision on a steep axis was used to correct corneal astigmatism. Pentacam examination after surgery showed that corneal astigmatism was corrected to a certain extent, and corneal irregular astigmatism and SA were reduced. This played a certain role in improving the visual quality of patients after surgery. The absence of evident symptoms of visual disturbance and discomfort after surgery in the patient may be related to the neurological adaptability of the brain for many years. Therefore, when the phacoemulsification cataract surgery removed the effects of cataract-induced refractive interstitial opacity and myopia and reduced astigmatism, irregularities, and SA, the patient had improved vision without the occurrence of any additional symptoms of visual disturbance and discomfort. For the calculation of IOL power,

we used the formula for the calculation of IOL after myopic refractive surgery on the ASCRS website, took the average power as the final IOL power, and obtained a relatively accurate target refraction after the operation.

Through the analysis of this case, we can provide certain experience references for more patients who had undergone early myopia refractive surgery, particularly for some patients who desired to receive an implant of trifocal IOL but had decentered ablation, irregular corneal astigmatism, and large SA caused by early refractive surgery.

4. A case of early capsular shrinkage syndrome after cataract surgery for retinitis pigmentosa and high myopia eyes

On March 5, 2018, a patient with binocular retinitis pigmentosa and high myopia complicated with cataract was admitted to hospital. The visual acuity was hand motion in both eyes; intraocular pressure was 15 mmHg in the right eye and 20 mmHg in the left eye; there was alternating exotropia and nystagmus in both eyes. The lens cortex of the right eye had localized opacity, and the nucleus was opaque and dark brown; the left lens nucleus was opaque and brown-yellow, and there was obvious posterior subcapsular opacity (**Figure 9**).

The patient underwent small incision cataract extraction in the right eye and phacoemulsification cataract surgery in the left eye on March 8, 2018, and April 3, 2018, respectively. The author knew that both retinitis pigmentosa and high myopia are risk factors for capsular contraction syndrome (CCS), small incision cataract extraction in the right eye was performed gently and the continuous curvilinear capsulorhexis (CCC) diameter was larger than 6 mm; the patient's lens suspensory



Figure 9.
The state of binocular lens opacity (the upper row is the right eye, and the lower row is the left eye).

ligament was found to loosen during capsulorhexis. When the residual cortex was aspirated, starfish-like cortical debris was found attached to the posterior capsule, which was polished using a viscoelastic needle. As the pupil could not be fully dilated, the IOL positioning hook assisted in the dilation of the pupil, the equatorial cortex was aspirated as far as possible, the posterior capsule was carefully polished, and finally, a one-piece hydrophilic acrylic IOL was implanted. Postoperative vision in the right eye was 0.2, intraocular pressure was 17 mmHg, the cornea was clear, pupils were round, light reflection was good, aqueous flare was ++, the IOL position was good, and retinitis pigmentosa and high myopic changes were observed in the fundus. The patient received prednisolone acetate eye drops 8 times a day and levofloxacin, pranoprofen, and 3% sodium hyaluronate eye drops four times a day. At the re-examination 1 week after the operation, the anterior chamber inflammation was significantly relieved, the IOL position was stable, the rest were similar to that at 1 day after surgery. The patient came to the hospital for scheduled cataract surgery for the left eye, 20 days after the operation. Re-examination showed right eye visual acuity as 0.25 and the intraocular pressure as 18 mmHg; the cornea was clear as revealed by the slit lamp examination, the aqueous flare was -, the pupils were round, and light reflection was good. Mydriatic examination showed that the anterior capsular opening was shrunk to less than 4 mm with obvious CCS (**Figure 10**).

CCS was quite obvious soon after cataract surgery, and timely detection and treatment were necessary to prevent serious complications. Therefore, after communicating with the patient, YAG laser anterior capsular opening lysis was performed for the right eye of the patient. First, the site of the anterior capsule with less tension was selected; then the anterior capsule was opened using laser, and the laser was used continuously at the contralateral site to loosen the shrunk anterior capsule, and the rest was performed in a manner similar to that followed to loosen the anterior capsule around the entire circumference. It was forbidden to directly select the edge of the capsular opening for laser lysis, as asymmetrical dehiscence of the capsular membrane might occur due to excessive tension (**Figure 11**).

After YAG laser surgery, slit-lamp examination showed that the patient had more floating white crystalline cortical debris in the anterior chamber of the right eye. The intraocular pressure was 30 mmHg. He received prednisolone acetate eye drops four times a day; timolol eye drops two times/day; levofloxacin, pranoprofen,

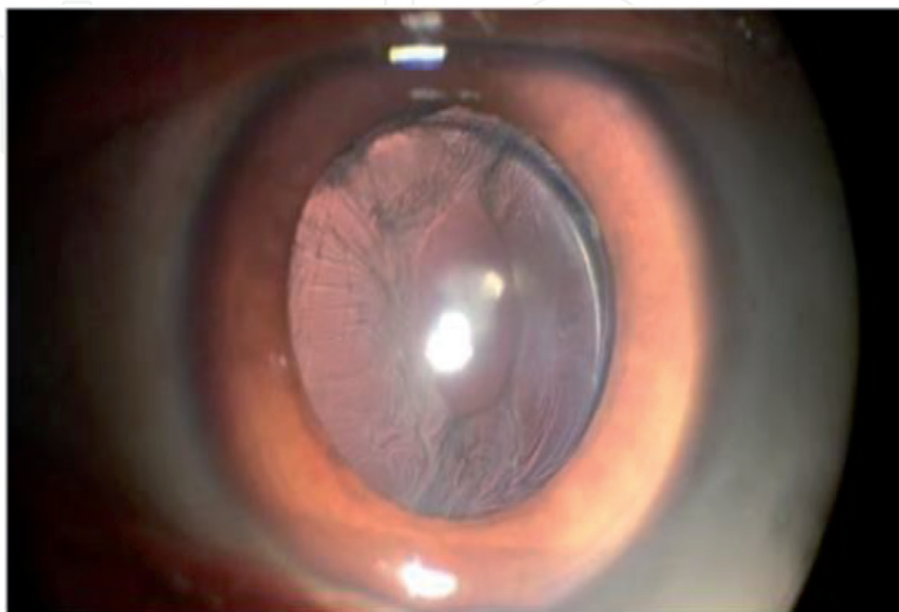


Figure 10.
Anterior capsular opening of the right eye is shrunk.

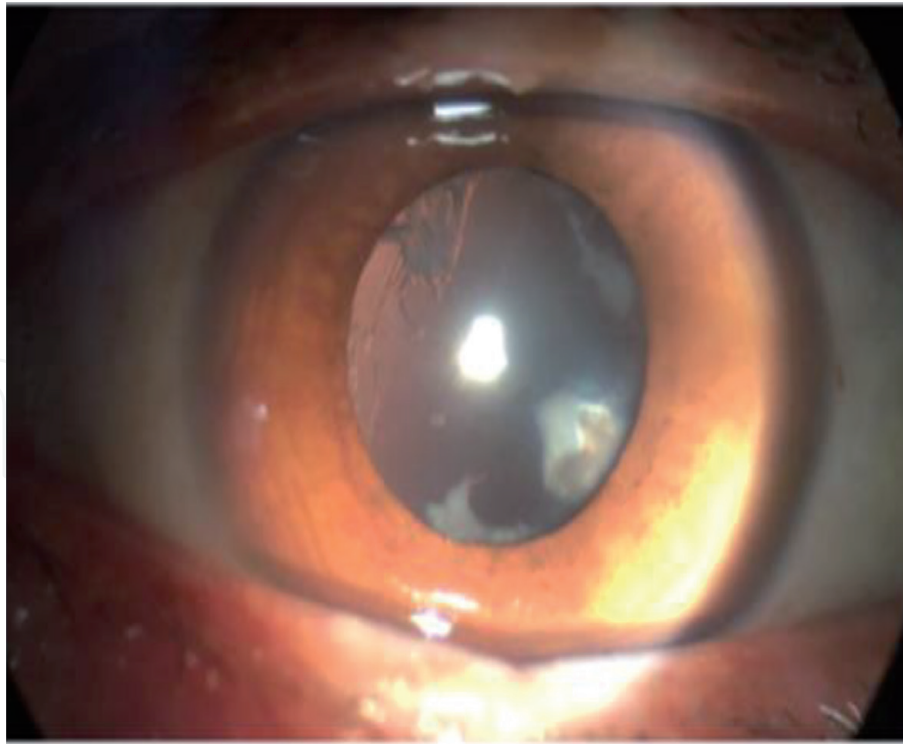


Figure 11.

The shrinkage of the anterior capsular opening is significantly reduced after laser lysis in the right eye.

and 3% sodium hyaluronate eye drops four times/day, and the patient was asked to visit for re-examination the next day. The re-examination showed that the visual acuity of the right eye was 0.25 and the intraocular pressure was 22 mmHg. The slit-lamp examination showed that the cortical debris floating in the anterior chamber of the right eye was significantly reduced, and the IOL position was stable. The patient was instructed to continue the medication and to visit for re-examination after 3 days. The re-examination showed the visual acuity of the right eye was 0.25, and the intraocular pressure was 17 mmHg. The slit-lamp examination showed only a small amount of floating cortical debris in the anterior chamber of the right eye, and the IOL position was stable; the patient was instructed to continue the previous medication. Because the degree of cataract in the left eye of the patient was lighter than that of the right eye and the nuclear hardness grade was lower than that of the right eye, phacoemulsification cataract aspiration in the left eye was scheduled on April 3, 2018. Owing to the experience in the right eye, special attention was paid to the prevention of CCS during the perioperative period of the left eye. First, preoperatively, non-steroidal anti-inflammatory drug pranoprofen eye drops were administered four times a day to reduce the intraoperative inflammation and maintain the dilated state of the pupil during the operation. Second, operations were performed as gently as possible during the surgery to reduce mechanical irritation to the iris to reduce the release of inflammatory mediators. During capsulorhexis, the suspensory ligament of the lens was loosened, and the diameter of the capsulorhexis opening was larger than 6 mm. Sufficient hydrodissection was performed to reduce the pulling effect of the intraoperative operation on the ligament, during the phacoemulsification process, the nucleus was split into smaller nuclei as far as possible before performing emulsification to reduce the release of ultrasound energy. When the emulsification was completed and the residual cortex was aspirated, the central part of the posterior capsule showed starfish-like attached cortical debris, which was tightly attached to the posterior capsule. It was mechanically polished using a viscoelastic needle, and the anterior subcapsular region was polished using a polisher around the whole circumference to reduce postoperative

proliferation. A one-piece hydrophilic acrylate IOL of the same model was implanted. On the second day after surgery, re-examination showed that the left eye visual acuity was 0.3, and the intraocular pressure was 16 mmHg; the slit-lamp examination showed clear cornea, round pupils, good light reflection, aqueous flare was ++, and normal IOL position. The patient received prednisolone acetate eye drops eight times a day and levofloxacin, pranopfen, and 3% sodium hyaluronate eye drops four times a day. The left eye was re-examined 20 days after surgery, the visual acuity was 0.3, the intraocular pressure was 18 mmHg, the cornea was clear, the aqueous flare was -, the pupil was round, and the light reflection was good. Mydriatic examination showed that the anterior capsular opening was shrunk, less than 4 mm, and CCS was evident. A YAG laser anterior capsule lysis was performed for the patient's left eye, and good postoperative results were achieved (**Figure 12**).

4.1 Discussion

This case study analyzed a case of a complicated cataract patient with binocular retinitis pigmentosa and high myopia who developed severe CCS short-term postoperatively, and both eyes were treated using YAG laser lysis.

Most of the capsular bag shrinkage caused by non-specific stimulation after cataract surgery occurs in the anterior lens capsule [20]. Residual lens epithelial cells (LEC) under the margin of the anterior capsule produce a variety of cytokines under the surgical stimulation and stimulation by different material IOLs. These factors may react against LEC and make it produce collagen and fibers through autocrine or paracrine, leading to shrinkage of the anterior capsular opening [21].

Several studies have shown that silicone gel IOLs have a higher incidence of CCS than other types of IOLs [22, 23]. The study of Tsinopoulos et al. [24] showed that hydrophilic acrylate IOL has a higher incidence of CCS than hydrophobic acrylate IOL. Although hydrophilic acrylic material has better uveal biocompatibility, lower adhesion of bacteria and silicone oil, and less incidence of glare, its weak adhesion to type IV collagen leads to an increased incidence of fibrosis, which is more likely to lead to the occurrence of CCS [25–27]. The hydrophobic acrylate IOL can inhibit the migration of LEC to the optical zone and loops, thereby reducing the occurrence of CCS [22, 28, 29]. In this case, both eyes of the patient used hydrophilic acrylic IOL, which may also be one of the risk factors for the rapid occurrence of CCS. Studies have shown that one-piece acrylate and three-piece acrylate IOL have similar incidences of CCS [30]. Another study showed that four-loop IOL is more effective in preventing postoperative IOL eccentricity and CCS [31].

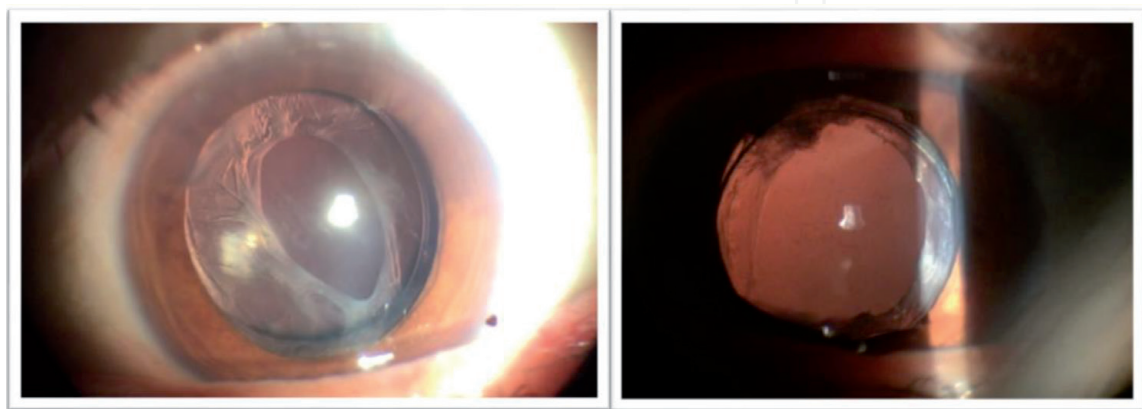


Figure 12.

Image of the capsular opening that was shrunk after the operation of the left eye. Image of the capsular opening that is in good condition after YAG laser anterior capsule lysis.

Studies have shown that the size of the diameter of capsulorhexis is closely related to CCS. CCC larger than 5.5 mm showed an increasing trend in the change of the size of the capsulorhexis after surgery; conversely, the capsulorhexis opening of CCC smaller than 5 mm showed a gradually shrinking trend after the surgery [32]. Anterior capsule opacity after cataract surgery occurs only in the part where the anterior capsule is in contact with the IOL. Therefore, the smaller the capsulorhexis diameter, the more obvious the anterior capsule opacity and organization will be, thereby aggravating the occurrence of capsular bag shrinkage. To prevent postoperative CCS, the diameter of the capsulorhexis, in this case, was greater than 6 mm; however, it did not have an obvious preventive effect. This may be related to other risk factors that are prone to CCS in the patient.

All diseases that easily affect the normal function of the suspensory ligament and lead to the fragility of the suspensory ligament are risk factors for the occurrence of CCS, including retinitis pigmentosa, high myopia, and advanced age [33]. The shrinkage area of the capsular bag of patients with retinitis pigmentosa was significantly larger than that of the normal control group, which was close to 25%. In total, 9.4% of the retinitis pigmentosa group underwent YAG laser anterior capsulotomy within 12 months after surgery. The anterior capsular opening area of these patients was all less than 10 mm² [34]. Diseases involving abnormal blood–aqueous barrier function, including exfoliation syndrome, uveitis, diabetes, and myotonic dystrophy, were all risk factors for CCS [35, 36]. The stimulation of cataract surgery is more likely to lead to the destruction of the barrier, thus causing the occurrence of CCS. Moreover, patients with diabetic retinopathy are more likely to develop CCS than those without fundus disease [35].

The treatment of CCS includes YAG laser anterior capsulotomy and surgical treatment. YAG laser is a safe and effective method for the treatment of early CCS, which can effectively enlarge the anterior capsule opening and restore visual function [37]. The study by Deokule et al. [37] showed that the success rate of YAG laser treatment of CCS was 78%, while the failure rate of preoperative IOL eccentric cases was high. Some researchers have reported [38, 39] that the early preventive application of YAG laser after cataract surgery for anterior capsulotomy at meridian 0°, 120°, and 240° can effectively prevent the occurrence of CCS in high-risk patients without adverse reactions. In more severe cases of CCS, YAG laser lysis cannot achieve effective treatment, and the proliferating fibrous membrane must be surgically separted under the anterior capsule and the adhesion of IOL edges and loops, to remove the fibrous membrane as far as possible by cutting or tearing it off. Radial cutting or direct continuous circular capsulorhexis was performed on the narrowed anterior capsular opening to remove the fibrous membrane, and there was no recurrence during postoperative follow-up [40]. Yeh et al. [41] proposed to use an anterior vitrectomy to cut the shrunk anterior capsular opening to remove the subcapsular fibrous membrane and residual lens epithelial cells, which can reduce the chance of radial tear of the suspensory ligament and secondary IOL eccentricity. The disadvantage of the surgical method is that it may cause further damage to the suspensory ligament and IOL eccentricity for patients with poor suspensory ligament function.

The prevention of CCS mainly includes the following aspects: (1) The application of preoperative non-steroidal anti-inflammatory drugs can effectively reduce the release of intraoperative inflammatory factors, thereby preventing the progression of anterior capsule shrinkage [42]. (2) Avoid excessive stimulation of the iris tissue and further aggravation of the destruction of the blood–aqueous barrier during whole operation. The diameter of the CCC should be 5.5–6.0 mm. The complete removal of the residual LEC under the anterior capsule helps to prevent the excessive proliferation of the anterior capsular opening, preventing CCS [43].

(3) Adequate anti-inflammatory treatment should be provided after the operation, which should be combined with glucocorticoid and non-steroidal anti-inflammatory eye drops, and the use time of non-steroidal anti-inflammatory drugs should be appropriately extended, which can effectively control the postoperative inflammatory response of operation and plays a role in preventing CCS. (4) In terms of IOL selection, hydrophobic acrylate materials are the first choice. (5) The use of intraoperative capsular tension ring. Studies have shown that the implantation of the capsular bag tension ring can effectively prevent IOL eccentricity, tilt, and significantly prevent capsular bag shrinkage [44, 45].

5. Conclusions

In conclusion, in actual clinical work, surgeons will encounter a variety of special conditions. Based on different conditions, the surgeon should comprehensively evaluate the surgical plan and the specific conditions before and after the operation, and deal with them in a targeted manner, to improve the post-operative visual quality of patients.

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Conflict of interest

The authors declare no conflict of interest.

Notes/thanks/other declarations

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