CASE REPORT

Time course of changes in anterior chamber structures after Nd:YAG laser anterior capsulotomy for early-onset postoperative capsular block syndrome evaluated by AS-OCT

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A 69-year-old man underwent uncomplicated 25-gauge pars plana vitrectomy combined with phacoemulsification and intraocular lens (IOL) implantation for treatment of epiretinal membrane. On postoperative day 1, a shallow anterior chamber and an anterior displacement of the IOL with pigment dispersion were observed. Swept-source anterior segment optical coherence tomography (AS-OCT) revealed a capsular hyperexpansion with ciliochoroidal detachment, and the patient was diagnosed with early-onset postoperative capsular block syndrome (CBS). After peripheral anterior capsulotomy by Nd:YAG laser on postoperative day 1, the IOL displacement was resolved immediately, and a transient reverse pupillary block was detected by AS-OCT. A resolution of the reverse pupillary block and ciliochoroidal detachment was confirmed by AS-OCT on postoperative day 3. To our knowledge, this is the first case that describes the postoperative time course and a transient reverse pupillary block after Nd:YAG anterior capsulotomy for early postoperative CBS using swept-source AS-OCT images.

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Capsular block syndrome (CBS) is an uncommon complication that develops during or after cataract surgery with continuous circular capsulorhexis (CCC) and posterior chamber intraocular lens (IOL) implantation. An earlier study proposed that CBS be classified into 3 types according to the time of onset as intraoperative, early-onset postoperative, and late-onset postoperative. A postoperative CBS is known as a capsular bag distension syndrome. One common feature of a CBS is an excessive accumulation of liquid substance within a closed capsular bag and a sealing of the CCC edges by the IOL optics.

The typical early-onset postoperative CBS usually develops within 1 day to 2 weeks after uneventful cataract surgery and is characterized by a hyperexpansion of the capsular bag filled with transparent liquid material, an anterior displacement of the IOL, and a shallow anterior chamber. The etiology of early-onset CBS has not been fully determined. An earlier study reported aspirating the transparent liquid within the capsular bag and analyzing it by high-performance liquid chromatography. The authors indicated that the main ingredient of the transparent liquid was sodium hyaluronate, and they hypothesized that some of the ophthalmic viscosurgical device (OVD) used intraoperatively was trapped and retained in the closed capsular bag. This then created an osmotic gradient across the capsule and drew aqueous humor into the bag. On the other hand, another study performed electrophoresis of the liquid material within the capsular bag in eyes with late-onset postoperative CBS, and the authors found a large amount of alpha-crystallin. The authors suggested that the fluid was derived from the residual epithelial cells.

To treat postoperative CBS, application of Nd:YAG laser to the anterior or posterior capsule has been performed to drain the intracapsular accumulated fluid into the anterior chamber or the vitreous cavity. Evaluations of the postoperative anterior chamber morphology can be performed noninvasively by anterior segment optical coherence tomography (AS-OCT). Several earlier studies showed morphological changes of the anterior chamber in the images obtained by AS-OCT before and after Nd:YAG laser posterior capsulotomy for late-onset postoperative CBS.

However, to our knowledge, there has not been a study published that showed AS-OCT images before and after laser anterior capsulotomy for early-onset postoperative CBS.

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Thus, the purpose of this study was to determine the time course of the changes in the anterior segment morphology before and after anterior capsulotomy by Nd:YAG laser for early-onset postoperative CBS. To accomplish this, we recorded images of the anterior segment of the eye by swept-source AS-OCT.

CASE REPORT

The medical chart of a 69-year-old man who complained of blurred vision and metamorphopsia in his left eye was reviewed. He was diagnosed with epiretinal membrane accompanied by mild senile cataract in his left eye. At the initial visit, his decimal corrected distance visual acuity determined by a Landolt chart was 0.8 (20/25 Snellen units), and the intraocular pressure (IOP) was 12 mm Hg in his left eye. Both eyes were phakic, and he was emmetropic in the left eye. The axial length of the eye measured by optical biometry (OA-2000, Tomey Corp.) was 24.92 mm. The anterior chamber depth (ACD) measured by swept-source AS-OCT (CASIA2, Tomey Corp.) between the inner boundary of the cornea and the surface of the crystalline lens was 3.161 mm. He was recommended to undergo pars plana vitrectomy (PPV) combined with phacoemulsification and IOL implantation for treatment of epiretinal membrane. The patient was informed on the risks and benefits of the surgery, and his written informed consent was obtained.

The patient underwent phacoemulsification after CCC using dispersive OVD of 3% sodium hyaluronate–4% chondroitin sulfate and an acrylic 3-piece IOL (PN6AS, Kowa Co. Ltd.) with polyvinylidene fluoride haptics was inserted into the capsular bag using cohesive OVD of 1.0% sodium hyaluronate. After the implantation, the OVD was aspirated, and 3-port, 25-gauge PPV with internal limiting membrane peeling was performed to remove the epiretinal membrane. Triamcinolone acetonide (MaQaid) and indocyanine green (Diagnogreen) were used to make the internal limiting membrane more visible. During surgery, ciliochoroidal effusion or detachment, which suggested irrigating fluid misleading, was not detected. All ports were closed by 8-0 Vicryl sutures.

One day after surgery, the patient had a shallow anterior chamber with pigment dispersion and an anterior displacement of the IOL. There was no leakage from the surgical wounds, and the IOP in the left eye was 18 mm Hg. Pharmacological mydriasis with topical 0.5% tropicamide and 0.5% phenylephrine (Mydrin P) showed that the CCC had completely covered the optic of the IOL. The posterior capsule was detected very far posteriorly.

Swept-source AS-OCT examinations revealed capsular hyperexpansion and ciliochoroid detachment (Figure 1, A). The patient was diagnosed with early-onset postoperative CBS accompanied by ciliochoroidal detachment. The ACD measured by the AS-OCT was 2.152 mm, and the distance between the surface of the IOL and posterior capsule was 5.543 mm. The values of these parameters were determined semiautomatically by the embedded software. The embedded software also determined the iridotrabecular angle parameters, the angle-opening distance (AOD in mm), angle recess area (ARA in mm²), trabecular–iris space area (TISA in mm²), and trabecular–iris angle (TIA in degrees) at 500 μm and 750 μm from the scleral spur. The horizontal cross-sectional images were used to determine these morphological parameters quantitatively to avoid the influences of upper and lower eyelids (Figure 1, B). The angle parameters at 500 μm from the scleral spur (Figure 1, C to F) are shown in Table 1.

The patient was informed about the early postoperative CBS and the risks and benefits of the Nd:YAG capsulotomy. The patient requested early intervention, and we performed peripheral anterior capsulotomy by Nd:YAG laser in the evening of post-cataract day 1. We performed peripheral anterior capsulotomy because the aiming beam of the Nd:YAG laser could not be focused accurately on the posterior capsule, which was present too far posteriorly. Immediately after the laser peripheral anterior capsulotomy, the anterior chamber deepened, and the capsular expansion gradually decreased. At 1.5 hours after the laser intervention, the ACD increased to 3.294 mm, and the distance between the surface of the IOL and the posterior capsule was 4.151 mm as measured in the AS-OCT images (Figure 2, B). Three hours after the laser intervention, the ACD was 3.467 mm, and the distance between the surface of the IOL and the posterior capsule was 3.793 mm (Figure 2, C). The IOP of the left eye

![Image](https://via.placeholder.com/150)

Figure 1. Swept-source (AS-OCT) images. A: Horizontal cross-sectional AS-OCT image of the entire anterior segment. The posterior capsule (white arrowheads) can be seen located very far posteriorly from the back of IOL (blue arrowheads) indicating a capsular hyperexpansion. The IOL was dislocated anteriorly, and the signal inhomogeneity is due to pigment dispersion in the anterior chamber. A ciliochoroidal detachment (asterisks) is present. B: Quantitative parameters of the central anterior chamber structure in the AS-OCT image. C–F: Quantitative parameters of the iridotrabecular angle. The angle parameters were evaluated at 500 μm from the SS (ACD = anterior chamber depth as the distance from the corneal endothelium to the surface of the IOL; AOD = angle-opening distance; AR = angle recess; ARA = angle recess area; AS-OCT = anterior segment optical coherence tomography; IOL = intraocular lens; SS = scleral spur; TIA = the trabecular–iris angle; TISA = trabecular–iris space area).
was 9 mm Hg. The patient received mydriatic eyedrops (Mydrin P, Santen Pharmaceutical Co., Ltd.) to keep the pupil size larger than the peripheral anterior capsulotomy, which prevented a sealing of the capsulotomy site by a miotic pupil.

In the morning of postoperative day 2, 13 hours after the Nd:YAG laser peripheral anterior capsulotomy, the anterior chamber was much deeper, and the IOP was 13 mm Hg. The pupil was round, and transparent viscous material was observed in the anterior chamber by slitlamp biomicroscopy. The AS-OCT showed that the CCC edges were separated from the surface of the IOL with inhomogeneous signal intensity in the anterior chamber. The ciliary body detachment was still present (Figure 2, D). AS-OCT also showed that the iris was concave in shape with broad contact between the iris and anterior capsule indicating a reverse pupillary block.11 In the evening of postoperative day 2, 24 hours after the Nd:YAG laser peripheral anterior capsulotomy, the reverse pupillary block and ciliochoroidal detachment were still present (Figure 2, E). The IOP was 11 mm Hg.

In the evening of postoperative day 3, 48 hours after the Nd:YAG laser treatment, the iris became flat, indicating a resolution of the reverse pupillary block. The ACD was 4.400 mm, and the AS-OCT signal intensity in the anterior chamber became homogeneous. The anterior and posterior capsules were both in contact with the IOL, but a small ciliochoroidal detachment was still present (Figure 2, F). The IOP was 12 mm Hg. The pupil was round. In the morning of postoperative day 5, 87 hours after the Nd:YAG laser, the iris was still flat, and the capsule contacted the IOL. AS-OCT confirmed a complete resolution of the ciliochoroidal detachment. The anterior chamber and angle parameters at each time point are shown in Table 1. We did not measure the objective refractive errors at each time point. One month after surgery, the decimal corrected distance visual acuity was 1.0 (20/20), the IOP was 15 mm Hg, and the ACD was 4.252 mm. The corneal endothelial cell count in the left eye preoperatively was 3086 cells/mm², and at 1 month postoperatively, it was 2985 cells/mm².

### DISCUSSION

We report our findings in a case that underwent Nd:YAG laser peripheral anterior capsulotomy for early-onset postoperative CBS. The findings were made by analyzing the swept-source AS-OCT images. The AS-OCT images were of the entire anterior segment from the cornea to the posterior lens capsule with less signal attenuation along the x-axis (Figure 1). This noninvasive imaging technique allowed us to obtain quantitative follow-up values of the parameters of the anterior segment in the early postoperative times (Figure 2 and Table 1). Several earlier studies showed the AS-OCT images before and after laser capsulotomy for late-onset postoperative CBS.7–9 To our knowledge, this is the first study showing AS-OCT images before and after laser anterior capsulotomy for early-onset postoperative CBS.

Earlier studies reported on the effects of Nd:YAG laser anterior or posterior capsulotomy on postoperative CBS, and we selected Nd:YAG laser peripheral anterior capsulotomy in this case.1 This was because the aiming beam of the Nd:YAG laser could not be focused accurately on the posterior capsule, which was present too far posteriorly. After the laser intervention, there was an immediate deepening of the anterior chamber and a deflation of the capsule. One day after the anterior capsulotomy, the CCC edges were separated from the IOL surface, and a reverse pupillary block was observed. During this time course, transparent viscous material was observed in the anterior chamber, and the AS-OCT signal intensity in the anterior chamber became inhomogeneous (Figure 2, B to E).

The etiology of the early-onset postoperative CBS was believed to be an entrapment and retention of the OVDs, which then drew aqueous humor into the closed capsular bag by osmosis.1,3,6 The AS-OCT findings suggested that diluted high osmotic OVDs were drained from the intracapsular space into the anterior chamber after the Nd:YAG anterior capsulotomy. Fortunately, a postoperative IOP elevation was not observed in this case. However, our findings indicated that surgeons need to pay attention to the possibility of a postoperative IOP elevation after Nd:

### Table 1. Quantitative parameters of the swept-source AS-OCT at each time point before and after Nd:YAG laser peripheral anterior capsulotomy for early-onset postoperative capsular block syndrome (CBS).

| Position | Parameter | Before Capsulotomy | Hours After Anterior Capsulotomy |
|----------|-----------|---------------------|---------------------------------|
|          |           | 1.5                | 3     | 13    | 24    | 48    | 87    |
| Nasal angle | ACD 500 (mm) | 0.263              | 0.880 | 0.988 | 2.034 | 2.037 | 0.777 | 0.671 |
|          | ARA 500 (mm²) | 0.133              | 0.342 | 0.375 | 0.662 | 0.678 | 0.289 | 0.245 |
|          | TISA 500 (mm²) | 0.119              | 0.298 | 0.334 | 0.640 | 0.646 | 0.247 | 0.213 |
|          | TIA 500 (degrees) | 22.6               | 58.9  | 65.1  | 82.3  | 79.2  | 51.7  | 48.8  |
| Center   | ACD (mm) | 2.335              | 3.294 | 3.467 | 4.510 | 4.462 | 4.400 | 4.381 |
|          | Distance from IOL surface to posterior capsule (mm) | 5.610 | 4.151 | 3.793 | 2.028 | 1.642 | 0.872 | 0.874 |
| Temporal angle | ACD 500 (mm) | 0.240              | 1.019 | 1.207 | 1.810 | 1.781 | 0.819 | 0.753 |
|          | ARA 500 (mm²) | 0.109              | 0.368 | 0.438 | 0.604 | 0.575 | 0.345 | 0.311 |
|          | TISA 500 (mm²) | 0.099              | 0.335 | 0.400 | 0.576 | 0.547 | 0.304 | 0.282 |
|          | TIA 500 (degrees) | 19.9               | 62.1  | 69.9  | 82.0  | 77.9  | 55.5  | 54.7  |

ACD = anterior chamber depth as the distance from the corneal endothelium to the surface of the IOL; AOD = angle-opening distance; ARA = angle recess area; IOL = intraocular lens; TIA = the trabecular–iris angle; TISA = the trabecular–iris space area.

1. Angle parameters measured at 500 μm from the scleral spur semiautomatically by the embedded software.
YAG anterior capsulotomy in eyes with an early-onset postoperative CBS.

The etiology of the transient reverse pupillary block observed was not definitively determined; however, the transparent viscous material, most likely diluted OVDs, in the anterior chamber was probably related to the development of the reverse pupillary block. This was because the reverse pupillary block was resolved spontaneously 2 days after the laser intervention accompanied by the disappearance of the presumed OVDs from the anterior chamber (Figure 2, F). The reverse pupillary block may also be related to the vitrectomy. Several earlier studies have shown that intraoperative reverse pupillary block can develop during phacoemulsification and is known as the lens–iris diaphragm retropulsion syndrome.

To determine the relationship between the vitrectomy and the transient reverse pupillary block after anterior capsulotomy for postoperative CBS, future comparative studies of vitrectomized and nonvitrectomized eyes are needed.

The eye of our patient also had a ciliochoroidal detachment. The ciliochoroidal detachment was accompanied by a transient reverse pupillary block, and any relationship might be suspected between these 2 postoperative complications in this case. However, the exact etiology was not determined conclusively in this study. As described, the diluted OVDs, which were drained from the intracapsular space into the anterior chamber after the Nd:YAG anterior capsulotomy, would be related to the reverse pupillary block in this case. On the other hand, the ciliochoroidal detachment was observed on postoperative day 1 before the Nd:YAG anterior capsulotomy (Figures 1 and 2, A) and did not worsen after the laser treatment. These findings indicate that the drained OVD in the anterior chamber was most likely not related to the ciliochoroidal detachment in this case.

Another possible cause for the ciliochoroidal detachment was traction from the capsular hyperexpansion. An earlier case report showed a ciliary body detachment accompanied by capsule contraction determined by ultrasound biomicroscopy (UBM). The authors reported that the zonular fibers could be detected in the UBM scan images, and they were stretched. Unfortunately, UBM examination was not performed on our patient, and the zonular fibers could not be detected by swept-source AS-OCT.

The major limitation of this study was that this patient had undergone cataract surgery combined with 25-gauge PPV. The possible influence of internal limiting membrane peeling and indocyanine green staining needs to be considered. To determine whether the findings in our case are
common for nonvitrectomized eyes, future studies of a greater number of cases are needed.

Another limitation of this study was the lack of information about the objective refractive status just before and after the YAG anterior capsulotomy. One of the features of early-onset postoperative CBS is a myopic shift of the refractive status attributable to the IOL anterior displacement. This myopic shift is expected to be resolved in parallel with the resolution of the IOL anterior displacement just after the YAG anterior capsulotomy. Unfortunately, we did not measure the objective refractive status just before and after the laser intervention. Thus, we could not evaluate the changes of the refractive status to determine whether its time course was attributable to the change of the IOL position.

In summary, we have presented our findings in a case in which we were able to follow the changes of the anterior chamber morphology by swept-source AS-OCT after Nd:YAG laser peripheral anterior capsulotomy for early-onset postoperative CBS after uneventful cataract surgery combined with 25-gauge PPV. The CBS was resolved 2 days after the Nd:YAG anterior capsulotomy. During the time course, a transient reverse pupillary block was observed. We suggest that the transient reverse pupillary block was due to diluted retained OVDs drained from the intracapsular space into the anterior chamber.

WHAT WAS KNOWN

• To treat postoperative capsular block syndrome (CBS), Nd:YAG laser anterior or posterior capsulotomy has been performed. Several earlier studies showed anterior segment optical coherence tomography (AS-OCT) images before and after Nd:YAG laser posterior capsulotomy for late-onset postoperative CBS. There has not been a study published that showed AS-OCT images before and after laser anterior capsulotomy for early-onset postoperative CBS.

WHAT THIS PAPER ADDS

• To our knowledge, this is the first study that describes the postoperative course in anterior chamber structures quantitatively and transient reverse pupillary block after Nd:YAG anterior capsulotomy for early postoperative CBS using AS-OCT images.

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