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Late capsular blockage syndrome: Clinical and anterior segment optical coherence tomography characteristics

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Abstract

Background: Late capsular blockage syndrome (CBS) is a rare phenomenon which is found after cataract surgery. The mechanism, anterior segment optical coherence tomography (OCT) presentation, and clinical characteristics are not well studied.

Methods: We studied patients who developed late CBS in Taipei Veterans General Hospital from 2012 to 2019. Age, sex, systemic disease, ocular disease, interval between cataract surgery and CBS, axial length, type of intraocular lens implanted, grading of posterior capsular opacity, refraction, visual acuity, and anterior segment OCT findings were documented. Patients are categorized into two groups according to anterior segment OCT findings. All patients underwent Nd:YAG laser capsulotomy and were prescribed a low-dose topical steroid for 7 days. Postcapsulotomy refraction and visual acuity were recorded. All the clinical data were compared in the two groups.

Results: This study included 18 eyes with late CBS. Patients' median age was 80 (range, 54–92) years. The mean duration between cataract surgery and CBS diagnosis was 80.28 (range 15–136) months. According to anterior segment OCT findings, we subcategorized the patients into two groups: gravel appearance (n = 7) and milky (n = 11) appearance. After laser capsulotomy, mean visual acuity improved 0.18 ± 0.10 on the LogMAR. A significant myopic shift in refraction after laser capsulotomy was noted in the gravel appearance group compared to the milky appearance group (p = 0.027). No patient developed complications or needed further treatment for CBS during the median follow-up of 14.5 months (range 1–84 months).

Conclusion: High-resolution anterior segment OCT is useful for analyzing patients with late CBS. Our study implies that the two types of CBS presentation indicate different causes of late CBS formation, as well as distinct clinical presentation and postlaser capsulotomy refractive outcome. In addition, YAG laser capsulotomy is a safe late CBS treatment modality.

Keywords: Capsular blockage syndrome; Laser capsulotomy; Optical coherence tomography

1. INTRODUCTION

Capsular blockage syndrome (CBS) is a phenomenon in which fluid accumulates between the continuous curvilinear capsulorrhexis margin and posterior capsule. In the literature, it can be categorized into three clinical types according to the timing and mechanism[1]: intraoperative, acute, and late CBS. Intraoperative CBS occurs during the step of hydrodissection in cataract surgery. It is transient and can be resolved by releasing the pressure by spinning or dissecting the crystalline lens. Acute CBS occurs in less than 2 weeks. The mechanism has been proposed as retained viscoelastic material or other inflammatory pathways creating the osmotic gradient, dragging fluids between the intraocular lens (IOL) and posterior capsular bag. In addition, fulminant inflammation can cause ciliary body swelling and the formation of the pupillary membrane, blocking the outflow fluid from the capsular space.[2] Anterior rotation of the lens diaphragm may lead to a myopic shift, shallow anterior chamber, elevated intraocular pressure, and decreased visual acuity. In contrast to acute CBS, late CBS may not result in significant symptoms unless decreased vision is expressed by the patient. According to the literature, late CBS can develop in a patient as young as 7 years old. One such patient developed CBS 4 months after cataract surgery.[2] On the other hand, it can also develop in an 89-year-old patient who was found to have late CBS 20 years after surgery.[3] It is believed to develop due to lens epithelial proliferation or latent infection (such as Propionibacterium acnes).[4,5] Clinicians can find whitish turbulent fluid trapped in a space between the IOL and posterior capsule.[6,7] Some cases will show crystal-like material in that particular space, which could be an Elschnig pearl, the result of lens epithelial cell proliferation, or others such as alpha crystalline or albumin.[8,9]

Previous reports on late CBS are few, and most are case reports. Here we have conducted a study of CBS in a medical center from 2012 to 2019. The highlight of the study is that this is the first study that comprehensively documents CBS with high-resolution anterior segment optical coherence tomography (OCT). Furthermore, we categorized the findings into two types.

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Clinical presentation, pathophysiology, treatment, and outcomes are documented and discussed in this study.

2. METHODS

We collected patients who developed late CBS from 2012 to 2019 in Taipei Veterans General Hospital. Basic data including age, sex, best-corrected visual acuity before and after laser capsulotomy, refraction before and after laser capsulotomy, axial length, type of IOL implanted, grading of posterior capsular opacity (PCO), duration between cataract surgery and detection of late CBS, systemic disease, and ocular disease were recorded. The value of best-corrected visual acuity was calculated by logMAR. The measurements of visual acuities beyond the limits of the Snellen chart, namely based on counting fingers, hand movement, light perception, and no-light perception, were 1.9, 2.3, 2.7, and 3, respectively, in logMAR numbers.[10,11] Patients' eyes were photographed using a slit lamp. Grading of PCO was performed by two experienced ophthalmologists according to slit-lamp images subjectively and independently. There were four classifications of PCO: minimal, mild, moderate, and severe.[12] Then, we chose anterior segment OCT (Optovue, USA) as a supplementary tool to evaluate the fluid trapped in the capsular space. The volume and density of fluid were evaluated with anterior segment OCT. If the fluid showed nonhomogenous signals, it is defined as a gravel appearance group (Fig. 1). On the other hand, a uniform fluid signal in the capsular space is defined as a milky appearance group (Fig. 2).

All the patients were treated with neodymium-doped yttrium aluminum garnet (Nd:YAG) laser capsulotomy. Before treatment, the patients received 1% tropicamide and 0.5% Proparacaine hydrochloride two times at a 15-minute interval. A capsulotomy lens (Volk capsulotomy lens, USA) was applied to the eye with hydroxypropyl methylcellulose as a lubricating gel. Capsulotomy was performed with the cross-pattern method to create an opening of at least half of the dilated pupil size. Pulses of 1.0–1.2 mJ were applied. Total energy ranged from 23 mJ to 49 mJ. A fluorometholone 0.02% eye drop was given four times daily for 7 days after laser treatment. Patients were followed up for 45 minutes, then in 1 week, and 1 month after laser treatment. Follow-up standard exam included best-corrected visual acuity, intraocular pressure, and slit-lamp exam. The advanced exam may be applied if visual acuity or clinical findings supported the necessity of further studies. An extended followed up period may be proceeded according to clinicians' judgment.

All statistical analyses were performed using SPSS Statistics (Statistical Product and Service Solutions, version 22, International Business Machines Corporation). Mann-Whitney test and Fisher's exact test were used for analyzing nonparametric data. Significance was considered if the p value was less than 0.05.

3. RESULTS

In total, we collected 18 cases of late CBS. We categorized them into two groups: gravel appearance (n = 7, 38.9%) and milky appearance (n = 11, 61.1%) according to the anterior segment OCT findings. The clinical findings of the two groups are shown in Table 1. All these patients received phacoemulsification and posterior IOL implantation through a temporal clear corneal wound. None of them received combined surgeries or additional surgeries before laser capsulotomy. The mean age was 79.6 years old, ranging from 54 to 92 years. Half of the patients were male. The mean interval between CBS and cataract surgery was 80.3 months, ranging from 15 to 136. The mean axial length was 23.69 ± 1.35 mm. Most patients had a hydrophobic lens (94.4%) with two haptics while only one patient had a hydrophilic lens with two plate loop haptics. All the IOL implanted were sharp-edge designs and 6 mm diameters in optical size. Visual acuity before treatment was 0.29 at logMAR in average. Systemic disease in the two groups included diabetes (38.9%), hypertension (44.4%), hyperlipidemia (5.6%), and cardiovascular disease (16.7%). Other ocular disease in the study group consisted of glaucoma (5.6%) and nonproliferative diabetic retinopathy (5.6%). There was no significant difference in age, sex, systemic disease, ocular disease, interval between CBS and cataract surgery, axial length, type of IOL, PCO grading, and presenting visual acuity between the two groups. After YAG laser capsulotomy, visual acuity, and refraction change in the two groups are shown in Table 2. All the patients showed improvement in visual acuity after laser treatment. A mean myopic refraction shift of 0.22 ± 0.39 diopters in average was noted postlaser treatment. All the patients received Nd:YAG laser capsulotomy smoothly with the energy range 1.0–1.2 mj.

Mean refraction change after laser capsulotomy in the gravel appearance group was –0.5 ± 0.44 diopters, significantly greater than that in the milky appearance group (–0.03 ± 0.21) (p = 0.027).

During the follow-up examination, there were no laser-related complications such as IOLs breaks by laser, lens dislocation, elevated intraocular pressure, recurrence of CBS, or endophthalmitis noted. The median follow-up period after laser treatment in this study was 14.5 months (ranged from 1 to 84 months).

4. DISCUSSION

CBS is a rare complication of cataract surgery.[13] Previous studies looked at CBS with slit-lamp photography and some with ultrasound biomicroscopy. This study is the first to comprehensively

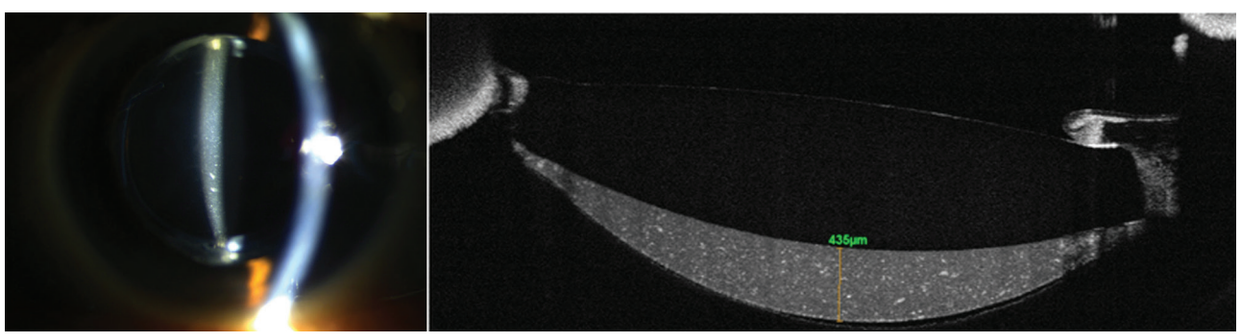

Fig. 1 Gravel appearance type of late CBS. (Left) Slit lamp shows a fluid space between IOL and posterior capsular space. (Right) Anterior segment OCT revealed uneven reflectivity of the fluid. CBS = capsular blockage syndrome; IOL = intraocular lens; OCT = optical coherence tomography.

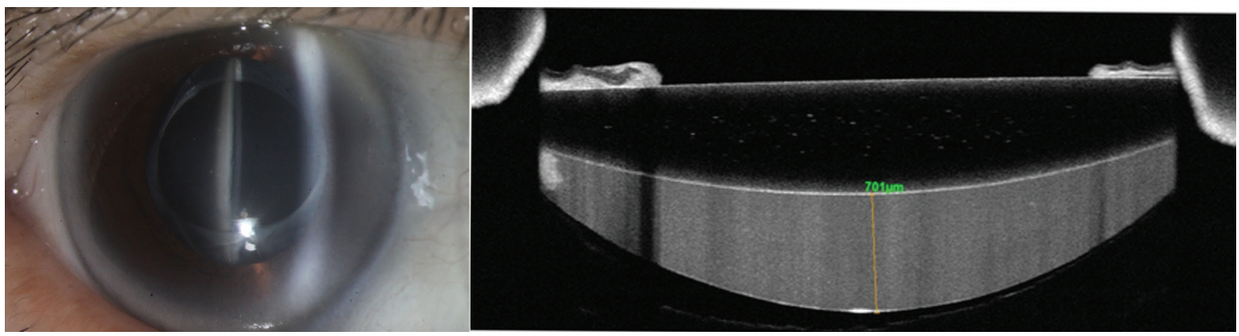

Fig. 2 Milky appearance type of late CBS. (Left) Slit lamp shows turbid fluid in the space between the intraocular lens and posterior capsule. (Right) Anterior segment OCT demonstrate homogenous moderate reflectivity in the capsular space. CBS = capsular blockage syndrome; OCT = optical coherence tomography.

record and categorize CBS with anterior segment OCT. The cross-sectional image compiling multiple interference patterns from light reflected on the intraocular layers can better display the anterior segment image.[14] It can also be used to identify the slope and deflection of the IOL optical region relative to the pupil plane[15] and the sizing of the implantable collamer lens, indicating its accuracy and convenience.[16]Besides slit-lamp examination, anterior segment OCT can help differentiate the substance lying between the IOL and posterior capsule more clearly, compared with ultrasound biomicroscopy.

CBS can be categorized into three groups according to its onset after cataract surgery and proposed mechanism: intraoperative, acute, and late CBS. According to the timing and clinical presentation mentioned previously, our study group belongs to late CBS. Another classification of CBS was proposed by Kim et al.[17] They classified CBS into three groups according to their distinct clinical characteristics: noncellular, inflammatory, and fibrotic CBS. Noncellular CBS includes translucent fluid trapped in the posterior capsular bag. It is thought to be caused by retained viscoelastic materials and developed in the very early postoperative period. Inflammatory CBS is presented with prominent anterior chamber reaction in the early postoperative period and can be treated with anti-inflammatory medication. Fibrotic CBS is assumed to be caused by lens epithelial cell proliferation and pseudometaplasia. It is usually formed months to years after surgery. By definition, noncellular and inflammatory CBS belong to acute CBS, and fibrotic CBS belongs to late CBS. In our study, we assumed that there are two different types of late CBS according to anterior segment OCT findings—gravel appearance and milky appearance—which indicates that the mechanism behind late CBS might vary. It is possible that the substances between the IOL and posterior capsular bag are different in the two groups and thus cause a distinct optical and refraction effect. The distended bag behind the IOL forms a convex contour. The overall density and evenness of the substance in this convex contour may create a various refractive effect accounting for different refraction changes after Nd:YAG capsulotomy. The substance of the gravel appearance type showed uneven distribution in anterior segment OCT and may build a refractive index lower than vitreous and aqueous. As a result, myopic refraction change was noted after laser capsulotomy. The materials in the milky appearance type showed equal distribution in anterior segment OCT, and they may create a very mild refractive effect possibly due to a similar refractive index. Thus, this type of patient showed a very mild myopic refraction shift after laser treatment. Lin et al[12] also found different

Table 1

Characteristics of patients with CBS

Characteristics	Total *n* = 18	Gravel appearance *n* = 7	Milky appearance *n* = 11	*p*
Median age, years (range)	80 (54–92)	79 (66–92)	80 (54–91)	0.860
Male, n (%)	9 (50.0)	3 (42.9)	6 (54.5)	0.500
Mean interval between CBS and cataract surgery, months (range)	80.28 (15–136)	84.43 (44–120)	77.64 (15–136)	0.860
Axial length, mm (SD)	23.69 (1.35)	23.63 (1.09)	23.73 (1.48)	0.659
IOL type (hydrophobic) (%)				0.611
Hydrophobic, n (%)	17 (94.4)	7 (100.0)	10 (90.9)	
Hydrophilic, n (%)	1 (5.6)	0 (0)	1 (9.1)	
PCO grading, n (%)				0.429
Minimal	8 (44.4)	3 (42.9)	5 (45.5)	
Mild	9 (50.0)	3 (42.9)	6 (54.5)	
Moderate	1 (5.6)	1 (14.3)	0 (0)	
Severe	0 (0)	0 (0)	0 (0)	
Mean presenting VA, logMAR(range)	0.29 (0.1–0.7)	0.24 (0.1–0.4)	0.32 (0.15–0.7)	0.375
Diabetes, n (%)	7 (38.9)	4 (57.1)	3 (27.3)	0.220
Hypertension, n (%)	8 (44.4)	3 (42.9)	5 (45.5)	0.648
Hyperlipidemia, n (%)	1 (5.6)	0 (0)	1 (9.1)	0.611
Cardiovascular disease, n (%)	3 (16.7)	1 (14.3)	2 (18.2)	0.674
Glaucoma, n (%)	1 (5.6)	1 (14.3)	0 (0)	0.389
Diabetic retinopathy, n (%)	1 (5.6)	1 (14.3)	0 (0)	0.389

CBS = capsular blockage syndrome; IOL = intraocular lens; PCO = posterior capsular opacity; SD = standard deviation; VA = visual acuity.

Table 2

Vision and refraction change after laser capsulotomy

Characteristics	Total *n* = 18	Gravel appearance *n* = 7	Milky appearance *n* = 11	*p*
Mean refraction shift,diopter (SD)	−0.22 (0.39)	−0.5 (0.44)	−0.03 (0.21)	0.027
Mean VA improve, logMAR(SD)	−0.18 (0.10)	−0.16 (0.11)	−0.20 (0.07)	0.791

SD = standard deviation; VA = visual acuity.

refraction change after the treatment of CBS. However, due to different study design and classification, we cannot compare our research group with that study group. Further studies need to be performed to prove our hypothesis.

There were only a few studies documenting the axial length and IOL design in CBS cases. Kim et al[17] believe that patients with longer axial length and an IOL with four haptics are more likely to develop CBS. Three piece,[18] trifocal toric,[19] accommodating,[20] and hydrophylic[7] lenses were also reported. Our study reveals that most CBS patients have an average axial length (23.69 ± 1.35 mm), and they were mostly implanted with foldable one-piece hydrophobic lenses with two haptics. Only one patient had a hydrophilic lens with two plate loop haptics. The IOL dominance in this study might be due to local market preferences. Nevertheless, the study results proved that CBS could happen in both hydrophobic and hydrophilic lenses with two haptics.

While the mechanism of intraoperative and acute CBS is well understood, the mechanism behind late CBS is still a mystery. The substance between the IOL and posterior capsule might be different from that of acute CBS, as it causes only a few refraction changes and no swelling of the ciliary body. Though some studies have posed a possibility of insidious infection, such as Propionibacterium acnes,[4,5] there has been no strong evidence presented to support this hypothesis. Raina et al[21] performed a 25-gauge vitrectomy to get the specimen and culture. Both aerobic and anaerobic cultures yielded negative results for 14 days in three cases of late CBS. Rana et al[6] aspired the milky fluid and the culture yielded no growth of any microbes. In our study, we found no conjunctival congestion, corneal keratic precipitate, anterior chamber cells, plaque-like material coating around the IOL, or flare-up of inflammation after Nd:YAG capsulotomy. Furthermore, we did not prescribe any antibiotics after laser treatment, but rather a low-dose topical steroid. In the event of indolent infection, there would have been infection-associated inflammation after laser treatment, which results from the releasing of toxins and the infection source into the vitreous. Another hypothesis for the mechanism of late CBS is lens epithelial cell proliferation. Though all our study patients had sharp-edge IOL, which is proved to decrease the rate of cell proliferation at the posterior capsule,[22] CBS and PCO still happened in a relatively low rate. It is assumed that retained epithelial cells and lens materials may release fluid by self-degradation or drag turbid fluid inside the posterior capsular space by the osmotic gradient. This might explain why the gravel appearance group showed nonhomogenous reflectivity at the posterior capsular space in anterior segment OCT. However, the grading of PCO in our study showed no significant difference in the two groups, which cannot explain the different clinical appearance. The factors that determine which patients show unevenly distributed particles or consistent reflectivity inside the capsular space are still mysteries.

Surgeons have taken the specimen between the capsular bag and IOL for further analysis. Alpha-crystallin,[7,8,21] beta-crystallin,[5] albumin,[8,23] collagen,[21] calcium,[7] sodium hyaluronate,[24] and globulin fractions[23] were found in the previous literature. Some of the substances were assumed to be released from lens epithelial cells.[21] These various results imply that there are different mechanisms behind CBS formation. The fact that different materials were found in that space also explains why there are different types of presentation in anterior segment OCT.

Treatment of CBS includes anti-inflammatory medication for inflammatory CBS, Nd:YAG capsulotomy, and surgical intervention. Gilhotra et al[18] and Koh et al[25] reported recurrence of CBS 1 week and 10 months after YAG capsulotomy, respectively. Capsular fluid aspiration[5,6,26] and vitrectomy[7,12] can be performed if laser treatment fails[7] for refractory cases, or cases that need specimens for analysis. All our patients, no matter which type in anterior segment OCT, received laser capsulotomy without complications, and mean visual acuity improved by 0.18 ± 0.10 on the LogMAR.

The limitation of this study includes a small study number because this is a rare complication after cataract surgery. Notably, compared to previous studies, the case number is the most for CBS after simple cataract surgery. In addition, some patients were not regularly followed up 1 month after laser treatment. Late complications associated with the laser may be overlooked. However, as a tertiary referral center, it is unlikely that patients with severe complications in our hospital are not referred to us for further management.

In conclusion, this is the first study in English literature that comprehensively documents most cases with late CBS after phacoemulsification and IOL implantation. High-resolution anterior segment OCT is a useful tool for detecting structural changes in CBS. It can help predict refractive outcomes and possible different disease pathologies. The mechanism of late CBS formation is unknown, but, in our study, indolent infection was less likely. Our study implies that these two types of CBS may result from various causes with different optical impacts, and Nd:YAG laser capsulotomy is a safe treatment modality for late CBS.

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