

Study of Anterior Capsular Contraction Following Cataract Surgery With Frequently Used Intraocular Lenses

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Abstract

Purpose: Anterior capsular contraction syndrome (ACCS) was compared in this study with cataract patients whose eyes were implanted with one of two types of acrylic lenses frequently used.

Methods: The study included 1305 eyes of 1278 patients. All of them phacoemulsification and intraocular lens (IOL) implantation were successfully performed. Each patient was operated on by the same surgeon. Two types of IOLs were implanted during cataract surgery: Tecnis ZCB00 [Johnson & Johnson Vision] (IOL A), the Akreos AO [Bausch & Lomb] (IOL B). Patients with intraoperative capsular tears and follow-up survey less than 1 month were excluded. In these cases, we recorded the duration of postoperative follow-up, the presence of ACCS, along with the dimensions of the anterior capsule opening. A comparison of ACCS incidence was compared between the two lenses.

Results: Although the ZCB00 group had more patients with ACCS risk factors ($P, 0.009$), the ZCB00 group had a significantly lower incidence of ACCS than the Akreos AO group ($P=0.032$).

Conclusion: Compared with the Akreos AO (IOL B), the ZCB00 (IOL A) showed better anterior capsular stability and a lower incidence of ACCS.

Introduction

Combined with posterior chamber intraocular lens (IOL) implant, the role of cataract surgery has expanded from one of visual restorative to refractive^[1, 2]. Anterior capsular contraction syndrome (ACCS) refers to excessive capsular diameter contraction, which is a complication that cannot be ignored after cataract surgery. It occurs mainly due to the contact of residual lens epithelial cells with the intraocular lens (IOL) near the continuous curvilinear capsulorhexis (CCC)^[3]. The reduction of the equatorial diameter of the lens capsule and the narrowing of the CCC opening in operated eyes post-surgery are the typical manifestations of CCC. The incidence of contraction most generally develops during the first 3 postoperative months, with succeeding decline in development^[4, 5]. This complication can reduce the free optic zone. It may cause decentration of the IOL optic, as well as tilt of the IOL. Furthermore, it can be effective enough to disrupt the visual axis^[6-8]. The IOL composition and design have been shown to contribute to the development of ACCS. For instance, it is well assured that acrylic IOLs caused less capsular shrinkage than the silicone IOLs^[9-11]. Additionally, the risk of ACCS has been associated with many risk factors, including pseudoexfoliation (PXE) syndrome, retinitis pigmentosa, uveitis, diabetes, history of retinal surgery^[12-17].

Some studies only evaluated the material and edge type of the optics the impact on ACCS^[18, 19]. We studied the incidence of ACCS after implantation of two generally used acrylic IOL, the Tecnis ZCB00 (Abbott Medical Optics Inc, Santa Ana, CA, USA) and the Akreos AO (Bausch & Lomb; Rochester, NY, USA). To our knowledge, this is the first study to compare the incidence of ACCS in these two common IOLs. Studying ACCS in these two lenses may illustrate biomechanical factors that influence capsule

phimosis. The study also aimed to determine which lenses, if any, should be considered for use in patients at risk for ACCS by including patients with or without associated risk factors.

Methods

This was a retrospective clinical study of patients included 1305 eyes of 1278 patients from the People's Hospital, Bozhou, China, between July 2018 and March 2021. This study was authorized by the Institutional Review Board of Bozhou People's Hospital and complies with the purposes of the Declaration of Helsinki. The patient's informed consent was waived because it was a retrospective study. All data collected was excluded prior to analysis to meet the requirements of the People's Hospital, Bozhou Institutional Board's Institutional Review Committee. In all cases, the same surgeon performed standardized phacoemulsification from July 2018 and March 2021 using a 3.0 mm clear corneal incision, a 5 mm CCC, followed by phacoemulsification, cataract extraction, and IOL implantation. Two types of IOLs were implantation during cataract surgery: the ZCB00 (IOL A), the Akreos AO (IOL B). The CCC was measured and recorded during each procedure.

Inclusion criteria: successful establishment of CCC and intracapsular fixation of IOL.

Exclusion criteria: 1. Intraoperative capsular tear; 2. Postoperative follow-up less than 1 month; 3. The CCC diameter is less than 5mm. Postoperative follow-up time, type of intraocular lens used and the presence of ACCS were recorded. The capsulorhexis was observed by slit lamp and the diameter along the longitude of 90° and 180° was recorded. The size of the capsule opening was measured. The average of the two diameters is used to calculate the capsular area by the formula $A = \pi r^2$. When the measured diameter of any meridian is less than 3.5 mm and the corresponding opening area is less than 10 mm², it is considered that ACCS exists. There was a note on any PXE syndrome, past uveitis, retinitis pigmentosa, previous retinal surgery, or diabetes retinopathy (Table 1). Patients were also assessed for the presence of mature cataracts that were related to any ACCS.

IBM SPSS Statistics ver. 24.0 (IBM SPSS Statistics for Windows, Version 24.0., Armonk, NY, USA) software was used for statistical analysis. The Fischer's exact test and the chi-squared test were used to explore any difference between ACCS occurrence and to explore any differences in risk factor quantity between the two groups. The difference was statistically significant ($p \leq 0.05$).

Results

One thousand three hundred and five eyes of 1278 patients were included in the study. Six hundred and seventy-four (52.7%) were women and 604 (47.3%) were men, 649 eyes had ZCB00 implants and the remaining 656 eyes had Akreos AO implants. The average age of the patients at surgery was 68.2 ± 8.4 years for the ZCB00 lens and 69.3 ± 9.6 years for the Akreos AO lens. There are no significant differences in either male-to-female ratio ($p = 0.825$) nor ZCB00 lens group to Akreos AO lens group ratio ($p = 0.265$) (Table 2).

ACCS was observed in 1 eye with ZCB00 lens and 7 eye with Akreos AO lens, and the statistically difference was significant ($P=0.032$). At the last follow-up, the mean anterior capsular area of ACCS was $9.6\pm 2.6 \text{ mm}^2$, the median time to discover ACCS was 1.4 months (range 1–19 months), and only two cases of ACCS (AO lens) required Nd:YAG laser capsular incision to improve visual acuity.

At least one risk factor for ACCS occurred in 64/649 (9.86%) eyes with IOL A and 39/656 (5.95%) eyes with IOL B, There was no significant difference ($P=0.442\geq 0.05$). Of the 8 ACCS cases, 3 patients had known ACCS risk factors (Table 1). No cases of ACCS were detected in mature cataract patients.

Discussion

In this study, the incidence of ACCS was decreased in eyes implanted with ZCB00 lenses compared to those implanted with Akreos AO lenses. This is largely due to differences in IOL composition and design^[10, 11, 13] Although the two IOLs in this study have acrylic composition, their design is significantly different (Table 3).

To reduce the incidence of posterior cataracts, both lenses are designed with a a 360° continuous edge, Although square-edged lenses decrease posterior capsule opacification (PCO), they increase anterior capsule shrinkage^[12]. Recently, Miyata et al^[10] concluded that a square edge is not a risk factor for ACCS. Based on this discrepancy, other distinctions were explored.

Choi, M et al^[20] concluded that Anterior capsular stability may be affected by the number and position of haptics within the capsular bag. It is presumed that evenly supporting the zonules contributes to anterior capsular stability. The meta-analysis showed that hydrophobic acrylates reduced the incidence of membrane turbidity compared with hydrophilic acrylates^[21] There may have been differences in the biomechanical properties of these lenses that may have contributed to the higher rate of ACCS in the AO lens in our study. Several studies showed that hydrophobic acrylates reduced the incidence of membrane turbidity compared with hydrophilic acrylates^[22, 23]. The Tecnis IOL significantly reduced anterior capsule retraction and ACO development compared to the Acrysof SA60AT, It has a better performance when it comes to preventing ACCS^[24]. This good performance of Tecnis was also confirmed in our study.

It was shown that using various diameters to represent different sized capsules, the ZCB00 applied a greater force than the Akreos AO. In prior studies, capsule tension imbalances were believed to be responsible for ACCS pathogenesis. An outward force provided by lens haptics is hypothesized to provide increased resistance to the contraction forces of ACCS, which stabilizes the bag and reduces zonular tension. Cochener et al^[15] hypothesized that the silicone lens' increased flexibility contributed to the higher rate of ACCS compared with other lenses. In addition, zonular friability in PXE syndrome was suggested to contribute to ACCS risk^[25].

There was no relation between cohort risk factors and the low incidence of ZCB00 ACCS in our study. It was noted by the surgeon during the course of this study that AO IOLs had a greater risk of ACCS.

Therefore, The surgeon chose the ZCB00 IOL for patients with ACCS risk factors as well. According to the "Results" section, 39/656 (5.95%) eyes with the AO IOL had at least one risk factor, whereas 64/649 (9.86%) eyes with the ZCB00 IOL had at least one risk factor. In the 64 eyes with at least one risk factor that received the ZCB00 lens, only one developed ACCS (1.3%).

In addition, there has been another study that examined ACCS using the ZCB00 lens, and its results are similar to ours. According to Kahraman et al^[23] in a clinical trial, ZCB00 had no capsular phimosis while AcrySof SA60AT had some degree of phimosis in 17% of the patients.

Conclusion

This study demonstrates that using the ZCB00 lens may lead to a lower risk of developing ACCS as compared with the Akreos AO lens, a result partly explained by the ZCB00's increased mechanical rigidity. Tecnis ZCB00 IOL should be considered for patients at risk for capsular contraction after cataract extraction.

Declarations

Ethics approval and consent to participate: This study was authorized by the Institutional Review Board of Bozhou People's Hospital and complies with the purposes of the Declaration of Helsinki. The patient's informed consent was waived because it was a retrospective study. All data collected was excluded prior to analysis to meet the requirements of the People's Hospital, Bozhou Institutional Board's Institutional Review Committee.

Informed consent was obtained from all individual participants included in the study.

Consent for publication: Not applicable.

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Tables

Table 1 Eyes with ACCS risk factors

Risk factors	ACCS (-)		ACCS (+)	
	AO	ZCB00	AO	ZCB00
PXE syndrome	11	4	1	
Uveitis	2	1		
Retinitis pigmentosa				
History of retinal surgery	4	1		1 ^a
Diabetic retinopathy	65	32	1	1 ^a
Total ^b	82 ^c	38	2	1

Notes: (-), absence of ACCS. (+), presence of ACCS. ^aSingle eye with two risk factors.

^bNumber of patients with at least one risk factor:64/649 (ZCB00) and 39/656

(AO). ^cIn all, 16 eyes had two risk factors and two eyes had three risk factors.

Abbreviations: ACCS, anterior capsular contraction syndrome; PXE, pseudoexfoliation.

Table 2 Patient demographics and ACCS incidence

Group	Eyes(n)	Average age (years), mean±SD	Male (n) / Female (n)	Disease course [years]	Average follow-up (months),median statistic	ACCS cases [n]	ACCS incidence [%]
ZCB00 lens	649	68.2±8.4	301/332	8.5±7.3	4.8 (1–33.4)	1	0.15
AO lens	656	69.3±9.6	303/342	9.2±6.6	4.5 (1–33.1)	7	1.07
p-value or χ^2	0.916*	0.991*	0.825*	0.847*	0.564*	0.032	

Abbreviations: ACCS, anterior capsular contraction syndrome.

* One-way anova test.

Table 3 Lens specifications

Characteristic	Tecnis ZCB00 (Abbott Medical Optics Inc)	Akreos AO (Bausch + Lomb Inc)
Material	1-piece hydrophobic acrylic	1-piece hydrophilic acrylic
Overall length (mm)	13	10.5 to 11.0
Optic Diameter (mm)	6	6
Optic design	Biconvex	Biconvex
Optic edge	360° square edge	360° square edge
Haptics design	Modified C	four-loop plate
Haptics Position with	Offset, 3-point	Offset, 4-point
Haptics respect to optic	fixation	fixation