—Report on Experiments and Clinical Cases—

Quantitative Analysis of Posterior Capsule Opacification of Hydrophobic Acrylic Intraocular Lenses

Hideaki Oharazawa[1], Hisaharu Suzuki[1], Keiko Shibata[1], Yumi Yamada[1], Hironori Matsui[1], Toshihiko Shiwa[1], Hiroshi Takahashi[1] and Kunitoshi Ohara[2]

[1]Department of Ophthalmology, Nippon Medical School
[2]Kichijoji Minamicho Eye Clinic, Tokyo

Abstract

Posterior capsule opacification (PCO) remains a common complication of modern cataract surgery, although both modification of materials used and changes in the intraocular lens (IOL) optic edge design have helped to decrease its incidence slightly. Recently, various kinds of quantitative methods have been developed for measuring PCO. The purpose of this study was to compare the quantitative analysis of PCO between different types of IOL designs. Patients enrolled in the study had age-related cataract and underwent uneventful cataract surgery and implantation of either the AcrySof®MA30BA (Alcon) or the Sensor®AR40e (AMO), which are differently designed hydrophobic acrylic IOLs with a sharp-edged optic design. Postoperative examination was performed at 6 months. Retroillumination photographs of each eye were obtained, and the degree of PCO was assessed using the Evaluation of Posterior Capsule Opacification (EPCO) system. Grade 1 PCO was noted in both the MA30BA and the AR40e groups. There was no significant difference in the mean PCO score between the MA30BA and AR40e groups. Although the sharp-edged optic designs of both IOLs might similarly inhibit PCO at 6 months, a long-term follow-up period is needed to determine if any PCO differences occur between these 2 hydrophobic acrylic IOLs.
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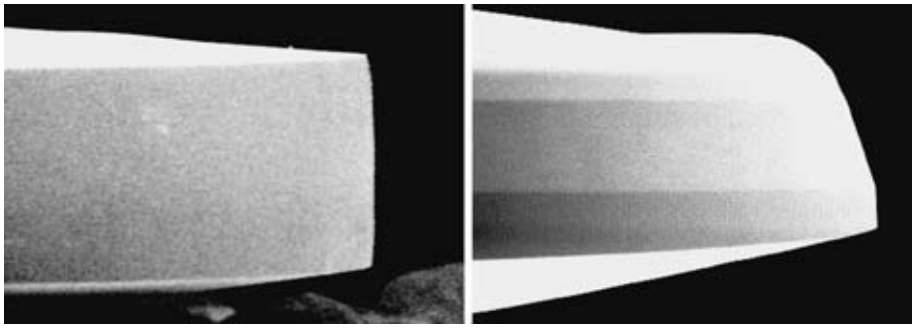
Key words: posterior capsule opacification, Evaluation of Posterior Capsule Opacification system, sharp-edged optic design, hydrophobic acrylic intraocular lens

Introduction

The most common complication of cataract surgery is posterior capsule opacification (PCO)[1]. This complication is caused by the migration and proliferation of lens epithelial cells in the capsular bag after cataract surgery. The development of PCO decreases visual function when it affects the central region of the visual axis. The standard treatment for PCO is neodymium: YAG laser capsulotomy, although this procedure can lead to other complications, including an increase in intraocular pressure, ocular inflammation, cystoid macular edema and retinal detachment. The incidence of PCO has decreased slightly as a result of improved

Correspondence to Hideaki Oharazawa, MD, PhD, Department of Ophthalmology, Nippon Medical School Musashi Kosugi Hospital, 1–396 Kosugi-cho, Nakahara-ku, Kawasaki, Kanagawa 211–8533, Japan
E-mail: hideaki@nms.ac.jp
Journal Website (http://www.nms.ac.jp/jnms/)



MA30BA AR40e

Fig. 1 Scanning electron micrographs of the edge profile of the MA30BA (left) and the AR40e (right).

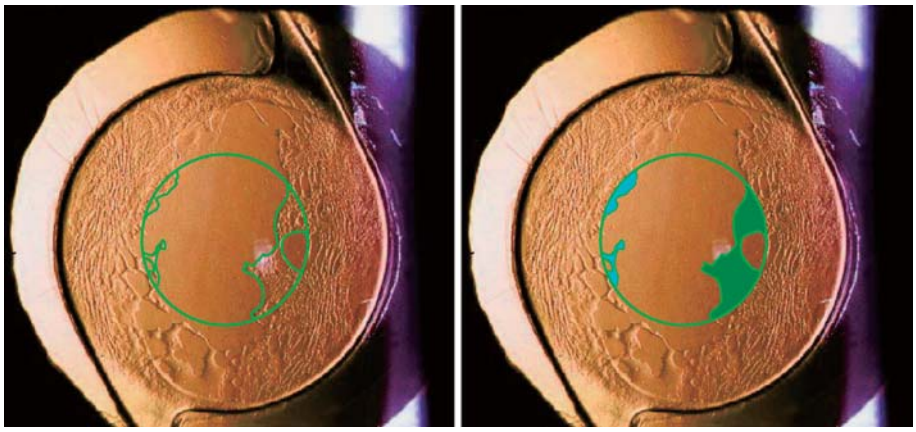


Fig. 2 **A** Example of a retroillumination photograph, which is loaded into the EPCO system. The light green circle indicates the central 3.0-mm area of the posterior capsule. The different opacification areas have also been interactively marked (light green borders). **B** The different opacification areas are color-coded according to their density (0 to 4), with a ratio of 0.029 for the grade 1 area (light blue area) and 0.13 for the grade 2 area (dark green area). The PCO score in this particular case was 0.29: $0.029 \times 1 + 0.13 \times 2 + 0 \times 3 + 0 \times 4$.

surgical techniques and the introduction of new intraocular lens (IOL) materials and optic edge designs. Also, it has recently been shown that hydrophobic acrylic IOLs and the sharp-edged optic design of the IOL prevents PCO[2]. Therefore, a standardized method of measurement is needed to evaluate and quantify differences in PCO between different types of IOL. Recently, various quantitative methods for PCO have been developed, including the Posterior Capsule Opacity (POCO) system, the Evaluation of Posterior Capsule Opacification (EPCO) system, the Posterior Capsule Opacity Manual (POCOMAN) system, and the Automated Quantification of After-Cataract (AQUA) system. These methods use retroillumination photographs, which are then used to measure the area of PCO and determine a severity grade[3].

In this study, we used the EPCO system to evaluate patients who underwent uneventful cataract surgeries and implantation of 2 different types of hydrophobic acrylic IOL that have a sharp-edged optic design: the AcrySof®MA30BA (Alcon) or the Sensor®AR40e (AMO)[4,5].

Patients and Methods

All patients who had age-related cataract underwent cataract surgery at the Nippon Medical School Main Hospital. Phacoemulsification and IOL implantation were performed in all patients without

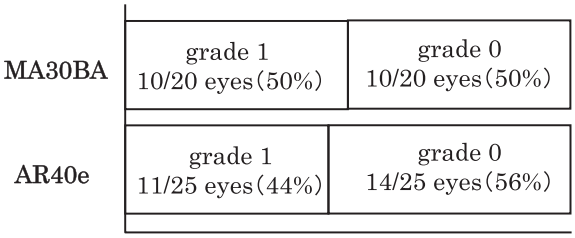


Fig. 3 Severity of PCO in all patients.

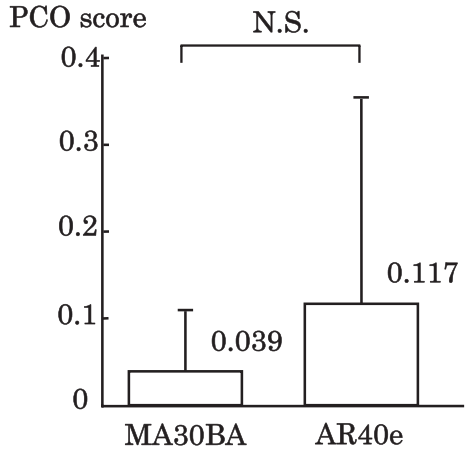


Fig. 4 Mean PCO score in all patients.

complications. Each patient received a sharp-edged optic design hydrophobic acrylic IOL. Twenty eyes of 13 patients received a MA30BA IOL, and 25 eyes of 18 patients received an AR40e IOL **(Fig. 1)**. The mean ages in the MA30BA and AR40e groups were 72.8 and 70.0 years, respectively.

Examinations were performed 6 months after surgery. Retroillumination photographs of the posterior capsule were obtained at maximum pupil dilation using a charge coupled device camera mounted on a slitlamp microscope, with all photographs stored on a personal computer for later evaluation.

The EPCO system was used to score the severity of PCO. Use of the EPCO program allows the examiner to trace all regions of the PCO that are seen on the retroillumination photograph. Afterwards, individual PCO scores can then be calculated by multiplying the PCO grade by the fraction of the capsule area behind the IOL optic that is involved. The severity of the opacification was graded as follows: 0=none; 1=minimal; 2=mild; 3=moderate; and 4=severe. In this study, the

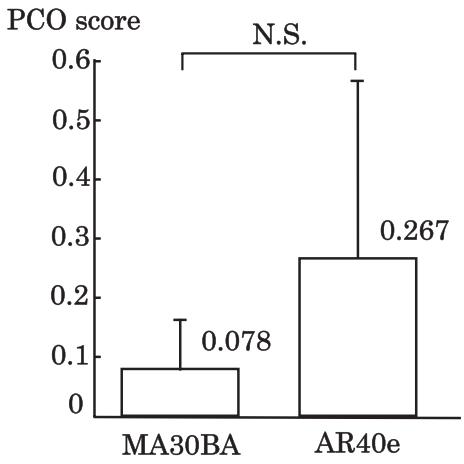


Fig. 5 Mean PCO score without grade 0.

individual PCO scores for the central 3.0-mm area of the posterior capsule under the IOL optic were calculated **(Fig. 2A and 2B)**[6].

The PCO scores for the MA30BA and the AR40e groups were calculated, after which differences between the groups were examined. The level of statistical significance was calculated using the Mann-Whitney test. Differences with a *P* value less than 0.05 were considered significant.

Results

Ten (50%) of 20 eyes in the MA30BA group and 11 (44%) of 25 eyes in the AR40e group had PCO in the central 3.0 mm of the posterior capsule region. Grade 1 PCO was noted for both the MA30BA and the AR40e groups. The characteristics of grade 1 include the presence of sheets of lens epithelial cells that are not as severe as that normally seen in patients with fibrotic and Elschnig's pearls-like PCO. The mean PCO scores for the MA30BA and AR40e groups were 0.039 ± 0.069 and 0.117 ± 0.237, respectively. However, the differences between the scores for the 2 groups were not statistically significant **(Fig. 4)**. The mean PCO score without the inclusion of grade 0 was 0.078 ± 0.082 in the MA30BA group and 0.267 ± 0.301 in the AR40e group, and these scores were also not differ significantly **(Fig. 5)**.

Discussion

In this study, we compared the PCO quantification

between 2 types of hydrophobic acrylic IOLs with sharp-edged optic designs, the MA30BA and the AR40e. A recently published survey has indicated that hydrophobic acrylic IOLs are the preferred material for small-incision cataract surgeries[2].

Many efforts have been made to prevent PCO formation, including using new surgical techniques and making modifying both the materials used and the design of the IOLs. PCO is a multifactorial process that differs significantly between the various hydrophobic acrylic IOLs and poly (methyl methacrylate) (PMMA) or silicone lenses[7]. Since a reduction of PCO has been noted with hydrophobic acrylic IOLs, they are felt to be superior to other lenses now used. Thus, it has become clear that both the materials used for the IOL and the IOL design play important roles in preventing PCO. Since the introduction of the MA30BA IOL in 1994, several studies have documented that PCO development is significantly less with the MA30BA than with other IOLs[4,8–11].

Two main theories have been proposed for the prevention of PCO: the sandwich theory (Linnola et al.[12,13]) and the discontinuous barrier theory (Nishi et al.[14,15]). As a result of these findings, several new hydrophobic acrylic IOLs, which employ a sharp-edged optic design, have been introduced over the past few years. One of these is the AR40e, which was modified from the AR40 IOL and is a hydrophobic acrylic IOL with a round-edged optic design.

Casprini et al. have used the EPCO system to compare the incidence of PCO between the MA30BA and the AR40 IOL. By evaluating the optic edge designs of the MA30BA and the AR40, which have a sharp and a round edge, respectively, they found that the PCO of incidence at 2 years was lower with the MA30BA than with the AR40. However, there was no significant difference seen at 1 year, and for both of IOLs, the rates of PCO were low[16]. Buehl et al. have used the AQUA system to compare the PCO-inhibitory effects of the sharp-edged optic design of the AR40e and the round-edged design of the AR40. They found that the rate of PCO was significantly higher in the AR40 group than in to the AR40e group starting at 6 months point and, therefore, concluded that the sharp-edged optic design was responsible for the significantly lower rate of PCO[17].

On the basis of studies performed to date, the AR40e IOL is believed to lead to less PCO than the MA30BA IOL, even at 6 months. In our study, we found that the MA30BA tended to have less PCO than did the AR40e. However, the differences between the groups were not significant, with both groups exhibiting a low PCO rate. These results suggest that the acrylic materials and the sharp-edged optic designs enable strong adherence of the optic to the posterior capsule, thereby creating a discontinuous capsular bend, which reduces of lens epithelial cell migration via a barrier effect.

By using the EPCO system in our study, we were able to examine the severity of PCO found in the central 3.0-mm area of the posterior capsule that was under the IOL optic. This system can measure an area up to 5.0 mm in diameter within the central IOL optic. When examining IOL characteristics, it is important to evaluate the central area of the posterior capsule, which can influence visual functions related to visual acuity, glare, contrast sensitivity, and optical aberration. To determine these parameters, the EPCO system is an easy, applicable, and objective method that is commercially available[6].

In conclusion, this study found no significant differences between the MA30BA and the AR40e IOLs with regard to the severity of PCO at the 6 months. However, with a longer follow-up period, a difference might be observed. Whether such changes are because of a delayed development of or a permanent reduction in PCO, this difference should become more evident with a longer follow-up period. Therefore, further studies that compare the development of PCO with longer follow-up periods should be performed.

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