·Clinical Research·

Effect of four different intraocular lenses on posterior capsule opacification

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Abstract

• AIM: To evaluate the impact of 4 different intraocular lenses (IOLs) on posterior capsule opacification (PCO) by comparing the neodymium: yttrium –aluminum –garnet (Nd:YAG) laser capsulotomy rates.

• METHODS: This retrospective study included 4970 eyes of 4013 cataract patients who underwent phacoemulsification and IOL implantation between January 2000 and January 2008 by the same surgeon at one clinic. Four different IOLs were assessed. The outcome parameter was the incidence of Nd:YAG laser posterior capsulotomies.

• RESULTS: An Nd:YAG laser posterior capsulotomy was performed in 153 (3.07%) of the 4970 eyes. The mean follow–up time was 84mo for all of the IOL groups. The percentage of eyes developing PCO was significantly greater for the acrylic hydrophilic IOLs than for the hydrophobic IOLs, although eyes with acrylic hydrophilic IOLs did not require Nd:YAG laser capsulotomy as soon as eyes with acrylic hydrophobic IOLs. There was no difference between the long–term PCO rates when 1– and 3–piece acrylic hydrophobic IOLs were compared or when IOLs made of the same material but with different haptic angles were compared.

• CONCLUSION: In this study, eyes with acrylic hydrophilic IOLs were more likely to develop PCO than those with acrylic hydrophobic IOLs. The lens design (1–piece versus 3–piece and varying haptic angles) did not affect the PCO rate.

• KEYWORDS: posterior capsule opacification; neodymium: yttrium-aluminum-garnet capsulotomy; intraocular lens

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INTRODUCTION

Posterior capsule opacification (PCO) is a major long-term complication of successful cataract surgery. PCO results from the proliferation, growth, migration, and transdifferentiation of residual lens epithelial cells in the capsule bag after cataract surgery[1]. PCO develops gradually, usually appearing between three months and five years postoperatively. The pathogenesis of PCO is multifactorial, and thus the reported incidence of PCO varies widely, ranging from 15% to 50%[1].

Many techniques have been advocated to prevent PCO, including the use of specific intraocular lens (IOL) materials and designs, surgical techniques, and therapeutic agents[2-6]. Neodymium:yttrium-aluminum-garnet (Nd:YAG) laser capsulotomy is the most common and effective treatment for clinically significant PCO.

The aim of the current study was to compare the impact of 4 foldable sharp-edged IOLs on PCO in a large patient cohort with a long follow-up time.

SUBJECTS AND METHODS

Subjects Data was collected retrospectively for 4970 consecutive eyes of 4013 patients with senile cataract who underwent uncomplicated phacoemulsification surgery and IOL implantation performed by one surgeon (Karel F) at the Ankara University Faculty of Medicine, Department of Ophthalmology between January 2000 and January 2008.

The eyes that had a history of intraocular surgery, concomitant ocular pathologies [uveitis or history of uveitis or high myopia (≥6 spherical equivalent), combined surgery or previous trauma] or had suffered any intraoperative complication (capsulorhexis rim tear, zonular rupture, posterior capsule rupture with or without vitreous loss or the usage of the capsule tension ring) were excluded.

All of the available patient data were recorded including the patient's sex and age at the time of cataract surgery and sex, the operated eye, date of the cataract surgery, lens type, time elapsed between surgery and Nd:YAG laser capsulotomy, date of the capsulotomy, pre and post operative visual acuity

and any associated disorders. Visual acuity was measured standard early treatment diabetic retinopathy study (ETDRS) protocol.

The eyes were evaluated in 4 groups based on the implanted IOL type. In group 1, an AcrySof SN60AT (Alcon Laboratories, Inc., Fort Worth, TX, USA), a 1-piece acrylic hydrophobic IOL with a 6.0 mm optic diameter, a 13.0 mm overall diameter and acrylic haptics angled at 0° , was implanted in 1399 eyes of 1014 patients. In group 2, an AcrySof MA30BA (Alcon Laboratories, Inc., Fort Worth, TX, USA), a 3-piece acrylic hydrophobic IOL with a 5.5 mm optic diameter, a 12.5 mm overall diameter and poly methyl metahacrylate (PMMA) haptics angled at 5°, was implanted in 1509 eyes of 1242 patients. In group 3, an AcrySof MA60BM (Alcon Laboratories, Inc., Fort Worth, TX, USA), a 3-piece acrylic hydrophobic IOL with a 6.0 mm optic diameter, a 13.0 mm overall diameter and PMMA haptics angled at 10°, was implanted in 1501 eyes of 1324 patients. In group 4, an Aqua-Sense™ III (Aaren Scientific Inc., Ontario, USA) a 3-piece acrylic hydrophilic IOL with a 6.0 mm optic diameter, a 12.5 mm overall diameter and acrylic haptics angled at 5° , was implanted in 561 eyes of 433 patients. All of the implanted IOLs were foldable with a square-edged optic.

Surgical Technique The same surgeon (Karel F) performed all the operations. After administration of topical anesthesia, a 3.0 mm temporal clear corneal incision was created. The anterior chamber was filled with an ophthalmic viscosurgical device, and an anterior continuous curvilinear capsulorhexis with an intended 0.25 to 0.40 mm 360-degree optic overlap was created. Phacoemulsification of the nucleus was achieved through hydrodissection. The nuclear segments were aspirated with phacoemulsification-assisted removal using a divide and conquer technique and an Alcon Legacy® 20 000® phacoemulsification machine (Alcon Laboratories, Inc., Fort Worth, TX, USA). The cortex was aspirated with a 0.3 mm irrigation/aspiration (I/A) tip (surgeon control of aspiration; maximum vacuum setting, 500 mm Hg; maximum aspiration flow rate, 50 cc/min). An Alcon Surgical silicone I/A tip was used for both the cortex removal and capsule vacuuming. The wound was not enlarged for IOL implantation, which was achieved using a Monarch II cartridge-based injector system (Alcon Laboratories, Inc., Fort Worth, TX, USA). Postoperatively, all of the patients received a similar regime medication comprised of topical dexamethasone 0.1% and ciprofloxacin 5 times daily for 1mo.

An Nd:YAG laser posterior capsulotomy was performed to remove a clinically significant posterior capsule opacity in patients who presented with appropriate complaints or a decrease in visual acuity. An L Pulsa Syl 9000 (Lightmed, Taipei, Taiwan, China) was used for all of the capsulotomies.

Statistical Analysis The rate and time of PCO development and IOL properties that may affect PCO development associated with each IOL were compared. SPSS 13.0 software SPSS Inc., Chicago, USA) was used for the statistical analysis. The differences between groups were compared using a Z test, and the statistical significance of differences in frequencies was assessed using the Chi-square test. A P value less than 0.05 was considered statistically significant.

RESULTS

The mean age of patients at the time of cataract surgery was 67.90±9.55 in group 1, 66.90±10.73 in group 2, 69.33±8.44 in group 3, and 70.03 ±9.56 in group 4. There was no difference in age, gender distribution, or follow-up time from surgery to examination among the groups.

PCO requiring Nd:YAG laser capsulotomy was detected in 41 eyes (2.93%) in group 1, 41 eyes (2.72%) in group 2, 45 eyes (3.00%) in group 3, and 26 eyes (4.63%) in group 4. The number of eyes that developed PCO requiring Nd:YAG laser capsulotomy and mean time from surgery to capsulotomy for each IOL group are shown in Table 1. The rate of PCO development in group 4 (3-piece acrylic hydrophilic IOL) was statistically different from that detected in the other hydrophobic lens groups (P=0.015). There was no difference in the rate of PCO development in group 1 (1-piece acrylic hydrophobic IOL) compared with group 2 (3-piece acrylic hydrophobic IOL with PMMA haptics angled at 5°) or group 3 (3-piece acrylic hydrophobic IOL with PMMA haptics angled at 10° ; P=0.74 and P=0.71, respectively). There was no significant difference in the percentage of eyes that developed PCO with IOLs made of the same material but with different haptic angles [0° (group 1), 5° (group 2), or 10° (group 3); P>0.05 for all], indicating that the hepatic angle does not affect PCO development.

The mean time of PCO development was 13.21 ±10.02mo (range, 3-38) post-operative for group 1, 33.11 ±25.06mo (range, 3-78) for group 2, 22.25±16.02mo (range, 3-56) for group 3, and 39.91 ±15.52mo (range, 13-62) for group 4 (Table 1). The mean time of PCO development in group 1 was statistically shorter than in the other groups (P<0.001). The mean time of PCO development in group 4 was statistically longer than in the other groups (P<0.001). The Nd:YAG laser application time according to groups is shown in Table 1.

We calculate the percentage changes in the mean best-corrected visual acuity (BCVA) before and after Nd: YAG laser application in all IOL groups by one-way analysis of variance. There was no difference in postoperative improvement in BCVA between all of the groups (P=0.947; Table 2).

Table 1 Number of Nd:YAG laser capsulotomies and mean PCO development time according to IOL group *n* (%)

Groups	1	2	3	4
n of Nd:YAG laser capsulotomies	41 (2.93)	41 (2.72)	45 (3.00)	26 (4.63)
Mean time of PCO development	13.21±10.02 (3-38)mo	33.11±25.06 (3-78)mo	22.25±16.02 (3-56)mo	39.91±15.52 (13-62)mo

PCO: Posterior capsule opacification.

Table 2 Changes in the mean BCVA before and after Nd:YAG laser application in all IOL groups

Groups	1	2	3	4	5
Before Nd-YAG BCVA	0.30±0.19 (0.1-1.0)	0.41±0.29 (0.1-1.5)	0.35±0.23 (0.1-1.1)	0.32±0.23 (0.2-1.0)	0.42±0.40 (0.1-1.0)
After Nd-YAG BCVA	0.06±0.16 (0.0-0.2)	0.08±0.11 (0.0-0.2)	0.06±0.11 (0.0-0.5)	0.07±0.17 (0.0-0.8)	0.13±0.39 (0.0-1.5)

BCVA: Best-corrected visual acuity.

DISCUSSION

The incidence of PCO is affected by many factors. The development of modern foldable IOLs with square-edged optics has greatly reduced the incidence of PCO following cataract surgery. Despite major improvements, PCO remains the most common long-term complication of cataract surgery and the most common cause of nonrefractive decreased postoperative vision[7,8].

The sharp optic edge, now known to be a major inhibitory factor for PCO development [9,10]. Nishi *et al* [2] reported that PCO-reducing effect is mainly due to sharp-edged optic IOL design and the formation of a capsular bend [3]. Sharp-edged optics have been reported to apply up to 70% more pressure than round optics [11]. The recent Meta-analysis of 66 prospective, randomized, and controlled studies found significantly less PCO associated with sharp-edge IOLs compared with round-edge IOLs of the same material [8]. In our study, all of the IOLs had a square-edged optic, and the rates of PCO development were very low with IOLs of same material.

The clinical introduction of 1-piece acrylic hydrophobic IOLs with some differences in optic and haptic design was expected to be associated with a different rate of PCO development compared with 3-piece acrylic hydrophobic IOLs. The haptics of a 1-piece IOL extend directly from the posterior surface, leaving a potential gap in the 360° sharp-edge optic. The more bulky haptic root of the 1-piece IOL could hinder adhesion of the anterior and posterior lens capsule around the loop such that a discontinuous capsular bend could be formed. Lens epithelial cells could then progress through the broad haptic-optic junction toward the center of the posterior lens capsule[12]. This may be due to the adhesive property of acrylic hydrophobic material that can cause a large optic-capsule adhesion [13]. Mylonas *et al*[14] reported at 1y after surgery, 1-piece acrylic IOLs are associated with slightly more regeneratory PCO than 3-piece acrylic IOLs made from the same material. However, Prinz *et al* [15] reported that the modification of an IOL from a 3-piece to a 1-piece haptic design caused no significant change in the development of PCO. In our study, there was no significant difference in the PCO development rate between 1-piece and 3-piece acrylic hydrophobic IOLs.

Despite their high biocompatibility, hydrophilic acrylic lenses provide a suitable environment for lens epithelial cells migration because of the hydrophilic surface properties. Previous studies have reported that hydrophobic IOLs are associated with lower rates of PCO than hydrophilic IOLs [16-20]. According to our results, eyes with acrylic hydrophilic optic IOLs were more likely to require Nd:YAG laser capsulotomy than eyes with acrylic hydrophobic optic IOLs.

In the current study, the amount of elapsed time after surgery before PCO developed was evaluated for each IOL. Despite the higher total PCO rate associated with acrylic hydrophilic IOLs, most of the Nd:YAG laser capsulotomies performed on eyes with these lenses (group 4) were performed at least 3y after cataract surgery. The development of PCO in the late postoperative period may provide some advantages in terms of decreasing the complication rate of Nd:YAG laser capsulotomy.

In this retrospective study, the effects of 4 IOLs with different properties on PCO were compared during a long-term follow-up of cataract surgery patients. A higher percentage of eyes with hydrophilic acrylic IOLs developed PCO than eyes with acrylic hydrophobic IOLs. There was no significant difference in the long-term PCO rate of a1- or 3-piece haptic lens design. Eyes with acrylic hydrophilic IOLs did not require an Nd:YAG laser capsulotomy as soon as eyes with acrylic hydrophobic IOLs.

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