

Posterior capsule opacification 3 years after implantation of an AcrySof and a MemoryLens in fellow eyes

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ABSTRACT

Purpose: To compare the rates of lens epithelial cell (LEC) migration and posterior capsule opacification (PCO) 1 and 3 years after sutureless small incision phacoemulsification and in-the-bag implantation of 2 acrylic polymer intraocular lenses (IOLs)—the AcrySof® and MemoryLens®—in fellow eyes of patients.

Setting: Eye Clinic, Beyoğlu Education and Research Hospital, İstanbul, Turkey.

Methods: Fifty patients with no systemic or ocular problems that would interfere with postoperative visual acuity were included in this prospective study. Each patient had in-the-bag implantation of an AcrySof® IOL in 1 eye and a MemoryLens® in the fellow eye in a randomized fashion after uneventful phacoemulsification through a sutureless clear corneal incision.

Results: At 1 year (n = 32 patients), there was no significant difference between fellow eyes in postoperative best corrected visual acuity (BCVA) and contrast sensitivity. In the MemoryLens group, 10 eyes (31.3%) had PCO and 9 (28.1%), LEC migration. In the AcrySof group, no eye had PCO and 2 eyes (6.3%) had LEC migration (P < .001). At 3 years (n = 21 patients), 1 eye (4.7%) in the AcrySof group had PCO and 3 eyes (14.4%) had LEC migration without PCO. In the MemoryLens group, 1 eye (4.7%) had a clear posterior capsule, 11 eyes (52.4%) had LEC migration, and 9 eyes (42.9%) had PCO (P < .001). A neodymium:YAG capsulotomy was required in 4 eyes (19.0%) in the MemoryLens group but no eye in the AcrySof group. At 3 years, BCVA was lower in the MemoryLens group than in the AcrySof group (P < .05).

Conclusion: The 3 year clinical data of fellow eyes indicate that the AcrySof IOL causes less PCO than the MemoryLens. *J Cataract Refract Surg* 2000; 26:1176-1182 © 2000 ASCRS and ESCRS

Posterior capsule opacification (PCO) is the major remaining complication of modern cataract surgery, even with the development of high-technology phaco units and sutureless small incision techniques. Its inci-

dence is reported to be between 10% and 50%.¹⁻⁴ A meta-analysis showed that the rate of PCO was more than 25% during a 5 year postoperative period.⁵

A refined surgical technique involving complete cortical cleanup and in-the-bag intraocular lens (IOL) implantation is the most important line of defense against Soemmering's ring and PCO formation.^{6,7} Material biocompatibility⁸⁻¹⁶ and optic geometry of the IOL¹⁷⁻²¹ are also important factors in reducing PCO.

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Polyacrylic IOLs, particularly the AcrySof®, are associated with less PCO formation than poly(methyl methacrylate) (PMMA) and silicone IOLs.¹¹⁶ This lower incidence might be explained by 2 factors. First, the AcrySof has a sharp square-edge design that creates a sharp bend on the posterior capsule. Second, physicochemical properties of the lens material make the IOL optic adhere well to the posterior capsule.

This study compared lens epithelial cells (LEC) migration, PCO formation, and neodymium:YAG (Nd:YAG) capsulotomy rates 1 and 3 years after uneventful phacoemulsification and in-the-bag implantation of 2 polyacrylic intraocular IOLs in fellow eyes of patients who had bilateral cataracts.

Patients and Methods

Fifty patients having bilateral cataract surgery were included in this prospective randomized clinical study. No patient had systemic or ocular disease such as diabetic retinopathy, age-related macular degeneration, or glaucoma that would interfere with postoperative visual acuity. Patients with nuclear cataract were selected so that a fully dilated fundus examination could be done preoperatively in all eyes. Patients with intraoperative or postoperative complications were also excluded from the study.

In all patients, an AcrySof IOL was implanted in 1 eye and a MemoryLens® in the fellow eye in a randomized fashion (computer-generated randomized numbers). The AcrySof has a hydrophobic optic material with PMMA haptics, and the MemoryLens has a

hydrophilic acrylic optic material with polypropylene haptics. Table 1 shows the characteristics of both lenses.

The AcrySof lenses were implanted using the original folding and the insertion forceps recommended by the manufacturer. The MemoryLens has a glass transition temperature of 27°C, above room temperature and below eye temperature. Thus, the lens remains rolled at room temperature during insertion by any type of insertion forceps. About 20 minutes after reaching body temperature, the lens unfolds completely.

Surgical Technique

The same surgeon (Ö.F.Y.) performed all operations. After peribulbar anesthesia and an O'Brien facial block were administered, a temporal clear corneal 2-step self-sealing incision was made with a 3.0 mm diamond knife. The anterior chamber was filled with sodium chondroitin sulfate-sodium hyaluronate (Viscoat®), and a 5.0 to 5.5 mm capsulorhexis (slightly smaller than the IOL optic diameter) was created with a capsulorhexis forceps. A side-port incision and hydrodissection followed.

Phacoemulsification was performed using the stop and chop technique. All equatorial cortex was meticulously aspirated with the irrigation/aspiration (I/A) tip, and the posterior capsule was polished when necessary with a Geuder polisher. The anterior chamber and capsular bag were filled with sodium hyaluronate 1.0% (Healon®), and the corneal incision was enlarged to 3.5 mm. All IOLs were implanted in the bag, and the viscoelastic material was removed with the I/A tip. Stro-

Table 1. Characteristics of the IOLs used in the study.

Characteristic	AcrySof	MemoryLens
Model	MA60BM	U940A
Optic material	UV-absorbing acrylate/methacrylate copolymer	UV-absorbing methyl/2-hydroxyethyl methacrylate/ethylene glycol dimethacrylate
Index of refraction	1.55	1.47
Optic configuration	Biconvex	Biconvex
Optic diameter (mm)	6.0	6.0
Total diameter (mm)	13.0	13.0
Haptic material	PMMA (Monoflex)	Polypropylene
Haptic configuration	Modified-C	Modified-C

UV = ultraviolet

mal hydration of the corneal incision was done, and no sutures were used in any eye. At the end of surgery, a subconjunctival injection of dexamethasone and gentamicin mixture was given.

The time between surgery in the fellow eyes was between 1 week and 3 months.

Follow-up Examinations

During the first 3 postoperative months, follow-up examinations were done at 1 day, 1 week, and 1 and 3 months. At these visits, regular ophthalmological examinations including best corrected visual acuity (BCVA) on a Snellen chart at 6 meters, slitlamp biomicroscopy, fundus evaluation, and intraocular pressure measurements were done. At the 1 and 3 year visits, spherical equivalent of refraction, astigmatism, BCVA (Snellen), contrast sensitivity testing using Cambridge cards, and PCO scores were recorded.

Assessment of PCO

Posterior capsule opacification was graded with the pupils dilated by a trained person who did not know which IOL type was in which eye. Slitlamp photography of the IOL and posterior capsule were performed using retroillumination. During the grading, special attention was given to the posterior capsule under the IOL optic.²² The PCO grade included subjective assessment of the extent and the density (assessed by its adverse effect on BCVA) of LEC migration onto the posterior capsule as follows: 0 = posterior capsule completely clear and no LEC migration (Figure 1); 1 = LEC migration at the periphery with a clear visual axis (Figure 2); 2 = LEC migration onto the visual axis with no drop in BCVA (mild PCO, Figure 3); 3 = LEC migration onto the visual axis with a BCVA better than 20/40 (moderate PCO); 4 = LEC migration onto the visual axis and a BCVA of 20/40 or worse (severe PCO, Figure 4).

An Nd:YAG laser capsulotomy was performed when grade 4 PCO developed.

Statistical Analysis

One and 3 year data consisted of BCVA, spherical equivalent of refraction (in diopters), astigmatism (in diopters), Cambridge contrast sensitivity scores, PCO grades, and Nd:YAG capsulotomy rates of the fellow eyes, compared using the Wilcoxon signed rank test. Before the mean BCVA was calculated and statistical

Table 2. Patient characteristics (N = 50).

Characteristic	Value
Sex, n (%)	
Male	22 (44)
Female	28 (56)
Age (years)	
Mean \pm SD	67.2 \pm 6.9
Range	52 to 85
Preoperative BCVA (decimal)	
Mean \pm SD	0.21 \pm 0.34
Range	0.05 to 0.6
Preoperative BCVA (logMAR)	
Mean \pm SD	0.68 \pm 0.47
Range	1.30 to 0.22

BCVA = best corrected visual acuity

comparisons were made, all decimal visual acuities were translated into corresponding logMAR values and then translated back to decimal acuities. The PCO rate was also evaluated by Kaplan-Meier survival analysis. A *P* value of 0.05 or less was considered significant. All statistical calculations were done using SPSS for Windows (release 7.0).

Results

Mean age of the 28 women and 22 men was 67.2 years \pm 6.9 (SD) (Table 2). Mean preoperative BCVA was 0.21 \pm 0.34 (range 0.05 to 0.60).

One year postoperative data were available for 64 eyes of 32 patients (64% of eyes entering the study). The percentage of follow-up at 3 years was 42% (42 eyes of 21 patients).

Means and Standard deviations of BCVA, spherical equivalent of refraction (in diopters), astigmatism (in diopters), Cambridge contrast sensitivity scores, PCO grades, and Nd:YAG capsulotomy rates of the fellow eyes 1 and 3 years after surgery are shown in Table 3.

Incidence of PCO and Nd:YAG Capsulotomies

One year postoperatively, 30 of 32 eyes (93.7%) in the AcrySof group had clear posterior capsules. Two eyes (6.3%) had LEC migration that spared the visual axis (grade 1). In the MemoryLens group, 13 of 32 eyes

40.6%) had clear capsules, 9 (28.1%) had LEC migration outside the visual axis (grade 1), 8 (25%) had mild PCO (grade 2), and 2 (6.3%) had moderate PCO (grade 3). The difference between the AcrySof and MemoryLens groups was significant ($P < .001$). An Nd:YAG capsulotomy was not performed in the 2 eyes (6.5%) with moderate visual loss from PCO.

Three years postoperatively, 17 of 21 eyes (80.9%) in the AcrySof group had clear capsules, 3 eyes (14.4%) had partial LEC migration that spared the visual axis (grade 1), and 1 eye (4.7%) had mild PCO (grade 2). In the MemoryLens group, all but 1 of the 21 eyes (95.3%) had LEC migration, PCO formation, or both. Eleven eyes (52.4%) had grade 1, 4 eyes (19%) had grade 2, 2 (9.5%) had grade 3, and 3 eyes (14.4%) had grade 4 PCO. The difference between lenses was significant

($P < .001$). Four eyes (19.0%) in the MemoryLens group had an uneventful Nd:YAG capsulotomy to improve BCVA.

A Kaplan-Meier survival analysis of PCO rates showed that eyes with an AcrySof IOL had a significantly lower incidence of PCO than fellow eyes with a MemoryLens ($P < .001$, Figure 5).

Contrast Sensitivity, BCVA, Refractive Change

One year after surgery, contrast sensitivity, BCVA, spherical equivalent of refraction, and astigmatism were not significantly different between the AcrySof and MemoryLens groups ($P > .05$). No eye in the AcrySof group had a loss of BCVA of 2 lines or more, while 2 eyes (6.5%) in the MemoryLens group did.

Table 3. Postoperative results.

Finding	1 Year (n = 32)			3 Years (n = 21)		
	AcrySof	MemoryLens	P Value	AcrySof	MemoryLens	P Value
BCVA (Decimal)	0.96 ± 0.09	0.87 ± 0.18	.46	0.93 ± 0.10	0.75 ± 0.29	.02*
BCVA (logMAR) (%)	0.02 ± 0.06	0.06 ± 0.23	.28	0.03 ± 0.06	0.12 ± 0.34	.02*
Number of eyes with 2 lines or more loss of BCVA (%)	0	2 (6.3)	.16	0	5 (23.8)	.02*
Mean spherical refraction (D)	-0.48 ± 0.88	-1.12 ± 1.82	.38	-0.47 ± 1.01	-1.18 ± 2.66	.23
Mean astigmatism (D)	-1.08 ± 0.94	-1.27 ± 1.21	.82	-1.01 ± 0.75	-1.18 ± 0.93	.56
Mean contrast sensitivity	26.5 ± 4.2	25.1 ± 7.2	.44	25.2 ± 4.9	23.4 ± 6.0	.21
PCO scores, n (%)						
Grade 0	30 (93.7)	13(40.6)		17(80.9)	1 (4-7)	
Grade 1	2 (6.3)	9(28.1)		3(14.4)	11 (52.4)	
Grade 2	0	8 (25.0)		1 (4.7)	4(19.0)	
Grade 3	0	2 (6.3)		0	2 (9.5)	
Grade 4	0	0		0	3(14.4)	
Mean	0.06 ± 0.04	1.25 ± 0.95	<.001*	0.16 ± 0.41	1.76 ± 1.20	<.001*
Nd:YAG capsulotomy, n (%)	0	0	Not done	0	4(19.0)	.046*

Note: All means ± SD
 BCVA = best corrected visual acuity
 *Statistically significant

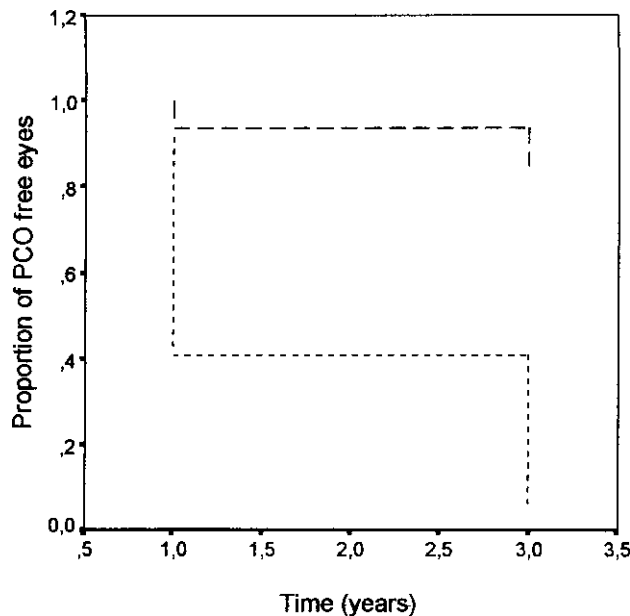


Figure 5. (Küçükşümer) A Kaplan-Meier survival analysis of PCO rates (—AcrySof; - - MemoryLens).

After 3 years, before an Nd:YAG capsulotomy was performed, BCVA was significantly better in the AcrySof than in the MemoryLens group ($P < .005$). Other

parameters, such as contrast sensitivity, spherical equivalent of refraction, and astigmatism, were not significantly different between fellow eyes ($P > .05$).

Five eyes (23.8%) with a MemoryLens lost at least 2 lines of BCVA before having an NdrYAG capsulotomy; no eye with an AcrySof group had a similar loss of BCVA. After the NdrYAG capsulotomies, BCVA in the MemoryLens group improved and was not significantly different from that in the AcrySof group ($P > .05$).

Discussion

Preventing or reducing the rate of PCO continues to be a major goal of most cataract surgeons and researchers, as well as health insurance companies. By achieving this, potential complications and the high cost of Nd:YAG laser capsulotomy will be reduced or eliminated.

Four factors are important in the risk of PCO development after cataract surgery: (1) patient characteristics (age, cataract type, concurrent ocular or systemic diseases),² (2) surgical technique (type of cataract surgery [planned extracapsular extraction versus phacoemulsification], capsulorhexis size relative to optic

diameter, complete cortical cleanup, sulcus versus in-the-bag IOL placement),^{3,17} (3) IOL material and biocompatibility,^{8,16} and (4) IOL optic and haptic design.^{17,21} Because of this complex pathogenesis, some researchers recommend that clinical studies of PCO should be designed so that 3 of the 4 factors are equivalent.¹⁷

In our study, fellow eyes of the same patients were operated on by the same cataract surgeon. An identical surgical phacoemulsification technique composed of a capsulorhexis smaller than the IOL optic, complete cortical cleanup, and in-the-bag IOL implantation was used in all eyes. Therefore, the first 2 factors known to influence PCO were identical.

We selected the AcrySof and MemoryLens for our prospective study because both are composed of acrylate/methacrylate copolymers, and the AcrySof in particular has been shown to have a significantly lower PCO incidence than PMMA and silicone IOLs.^{11,6} A 4 year clinical study comparing the MemoryLens with a PMMA IOL found a lower rate of PCO in eyes with the hydroacrylic lens.⁴

When eyes with no PCO and LEC migration that spared the visual axis were excluded, our PCO incidence was 0% in the AcrySof group and 31.3% in the MemoryLens group 1 year after surgery. The rates increased to 5.0% for AcrySof and 42.9% for MemoryLens 3 years postoperatively. The differences in PCO incidence between the 2 IOLs were significant.

In addition to the low incidence of PCO, no eye with an AcrySof IOL lost 2 or more lines of BCVA as a result of PCO; none required an Nd:YAG capsulotomy even 3 years postoperatively. The low PCO and Nd:YAG capsulotomy rates in our AcrySof group agree with findings of other studies.^{11,6} However, our 42.9% PCO incidence in eyes with a MemoryLens was much higher than the 22.2% rate in a 4 year clinical study.⁴ The high rate of PCO in eyes with MemoryLens in our study was also higher than that reported for silicone lenses and approximately equal to that for PMMA lenses.¹

The statistically significant differences found in 7CO scores of fellow eyes in the same patients after AcrySof implantation in 1 and MemoryLens implantation in the other eye were due to differences in IOL material and geometry. Although both IOLs are of acrylate and methacrylate monomers, the monomers made of AcrySof contain tiny amounts of water (less

than 1%), making the IOL hydrophobic with a high refractive index. In contrast, the methacrylate monomers of MemoryLens contain hydroxyethyl (HEMA) groups and are of 20% water, making it a hydrophilic lens.

Intraocular lenses with a high water content, such as hydrogel and heparin-surface-modified PMMA lenses, are more biocompatible than unmodified PMMA, silicone, and hydrophobic acrylic lenses.^{8,12} In an *in vitro* study, the adhesiveness of human LECs to hydrogel lenses was significantly lower than to PMMA.⁸ Over time, the LECs decreased on the hydrogel lenses and increased on the PMMA. Biocompatibility was believed to prevent adhesion of inflammatory cells and macrophages on the lens. Because of this superior biocompatibility, one would expect to find a lower incidence of PCO with the use of MemoryLens. However, how biocompatibility influences PCO development is controversial. One study suggests that too much biocompatibility might accelerate LEC migration on the IOL surface while blocking inflammatory cells and macrophages, which were suggested to clean-up the capsule and IOL from the invasion of LECs.¹⁴

The major difference between the IOLs in our study was optic geometry and edge design. Both IOLs have a biconvex and 3-piece design; however, the AcrySof has a sharp optic edge and the MemoryLens, a rounded optic. The AcrySof's sharp optic is believed to be the major barrier to LEC migration through the posterior capsule.^{17,20} This sharp edge design was found to be more important than the geometry of IOL's back surface (plano-convex or biconvex) and material.¹⁸ A human study comparing IOLs with different edge designs and posterior side geometry found that the most significant factor in PCO prevention was optic edge sharpness.¹⁸ In a rabbit study, a PMMA IOL with a sharp optic edge similar to that of the AcrySof effectively blocked LEC migration onto the posterior capsule.¹⁷ We believe that the sharp capsule bend created by the sharp edge of the AcrySof on the equator probably had a mechanical barrier effect and prevented LEC migration by inhibiting contact.

Despite the high PCO by the fifth year, slit lamp photographs in eyes with a MemoryLens, the percentages of eyes with a 2 or more line drop in BCVA (10.5% and 23.8% at 1 and 3 years, respectively) were low and considered acceptable, as were the Nd:YAG capsulotomy

rates (0% and 19.0% at 1 and 3 years, respectively). The differences in BCVA between fellow eyes were small and statistically significant only 3 years after IOL implantation. The contrast sensitivity scores in eyes with an AcrySof did not differ significantly from those in eyes with a MemoryLens. In most eyes, PCO had a minimal effect on visual function, and both AcrySof and MemoryLens IOLs performed well clinically.

In conclusion, we found that the AcrySof led to significantly less PCO than the MemoryLens after 3 years of follow-up. We believe the AcrySof's sharp optic edge and resultant contact inhibition of LEC migration make a strong contribution to the low rates of PCO. However, we cannot exclude the possible effect of lens material and its biocompatibility. Therefore, we conclude that both lens design and lens material probably have some influence on PCO formation.

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