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The effects of three-piece or single-piece acrylic intraocular lens implantation on posterior capsule opacification

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PURPOSE. *To evaluate the development of posterior capsule opacification (PCO) in patients implanted with 5.5 mm optics, single-piece or three-piece acrylic intraocular lens (IOL) in cataract surgery prospectively.*
METHODS. *This study was carried out on 267 eyes of 249 patients implanted with three-piece, 5.5 mm optics, acrylic IOL and 252 eyes of 244 patients implanted with single-piece, 5.5 mm optics, acrylic IOL by phacoemulsification technique between September 2001 and February 2003. A total of 519 eyes of 493 patients were prospectively evaluated for PCO development during the 25-month period. All the patients were analyzed periodically with anterior segment retroillumination photography. The data provided were analyzed with chi-square method.*
RESULTS. *The results between the two groups for PCO development were not statistically significant. However, there was a prominent opacification of the posterior capsule where the optic and haptic junction of IOL was positioned in some patients implanted with single-piece IOL. During the follow-up period, no patients implanted with either three-piece or single-piece acrylic IOL required Nd:YAG laser capsulotomy.*
CONCLUSIONS. *Biocompatibility and reduced rate of PCO development are among the leading features of new generation IOLs. The intracapsular implantation of 5.5 mm optics acrylic IOLs resulted in decreased incidence of PCO and therefore greater patient satisfaction. Further studies investigating the effects of IOL optics, haptic structure and length, capsulorrhexis size, and IOL material and design features on PCO development will clarify the subject. (Eur J Ophthalmol 2004; 14: 375-80)*

KEY WORDS. *Haptic structure, IOL, PCO, Phacoemulsification*

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INTRODUCTION

Posterior capsule opacification (PCO) is a major complication of cataract surgery. Postoperative lens epithelial cell (LEC) proliferation and migration within the capsular bag after extracapsular cataract extraction is the cause of PCO (1-3). Fibrotic membrane formation with or without Elschnig pearls on the posterior capsule brings about the opacification and patients experience a decrease in visual acuity (1). The standard treatment for PCO is neodymium:YAG (Nd:YAG) laser capsulotomy. However, it has been associated

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with retinal detachment, increase of intraocular pressure, cystoid macular edema, and damage to the intraocular lens (IOL) (3).

The current status of clinical research on the prevention of PCO has centered around surgical techniques such as the implantation site of the IOL (4), diameter of the capsulorrhexis (4, 5), extensive intraoperative polishing of the anterior and posterior capsules (6), changes in IOL material and designs (7-9), and pharmacologic methods, including the application of several antimitotic drugs or anti-LEC immunologic agents (10, 11).

IOLs are among the important factors having an effect on PCO development (12). Neither the removal of LECs nor pharmacologic interventions were effective on PCO development and so studies on IOL material and designs have increased (13). It has been shown that acrylic lenses, especially hydrophobic acrylic lenses, have a very low incidence of PCO development when compared with polymethyl methacrylate (PMMA) and silicone lenses (14-17). It is difficult to determine which feature of IOL is responsible for the low incidence of PCO. Recent investigations are focused on the structure of the material and edge designs of IOLs. In this prospective study, we compared the rate of PCO development and the need for Nd:YAG laser capsulotomy in patients implanted with 5.5 mm optics, single-piece and three-piece hydrophobic acrylic IOLs over 18 months postoperatively.

MATERIALS AND METHODS

This prospective, unmasked study compared two IOLs available on the market, the Acrysof MA30BA and SA30AL. The patients were randomized to have implantation of one of two types of IOLs. Patients were followed for the incidence and distribution of Nd:YAG capsulotomy, the time until Nd:YAG capsulotomy was performed, and the incidence and severity of PCO. Between September 1999 and February 2003, 519 eyes of 493 patients either implanted with single or three-piece hydrophobic acrylic IOL after phacoemulsification surgery were investigated prospectively for PCO development. The 493 patients were enrolled randomly to each IOL group: 267 eyes of 249 patients with 5.5 mm optics, three-piece, hydrophobic acrylic IOL (Group I) and 252 eyes of 244 patients with 5.5 mm optics, single-piece, hydrophobic acrylic IOL (Group II). Patient variability was limited. All patients participating in the study had senile cataract; they were similar in age and sex distribution. They had no ocular pathology except cataract.

All patients were operated for cataract by one surgeon (A.H.B.) and the same surgical technique was used to remove the crystalline lens. Phacoemulsification was performed through a 4.5 to 5.0 mm anterior capsulorrhexis using a standard two handed phaco chop technique. The patients were randomly chosen preoperatively to receive either a three-piece or a single-piece acrylic hydrophobic IOL. One of these two IOLs was implanted in the capsular bag after it was refilled with Healon. Healon was aspirated from the capsular bag and the anterior chamber. The IOLs implanted were 5.5 mm optic diameter, 12.5 mm haptic length, single-piece or three-piece foldable, hydrophobic acrylic posterior chamber IOL (Alcon, SA30AL, MA30BA). The haptic material of the three-piece IOL was PMMA and of the single-piece was acrylic. Indomethacin 0.1% and prednisolone acetate 1% four times a day for 1 month and ciprofloxacin HCl 0.3% four times a day for 10 days were used topically during the postoperative period.

Group I consisted of 256 eyes of 198 patients; 240 eyes of 169 patients were included in Group II. Patient ages ranged from 57 to 87 years (mean 66). No difference existed in age and sex distribution between the two groups. At 6 months, 12 months, 18 months, and 25 months after surgery, pupils were dilated with a mixture of tropicamide and phenylephrine and the eyes were evaluated at the slit lamp. Standardized photographs of the pseudophakic anterior segment were obtained with a Nikon FS-2 digital slit lamp using retroillumination and lateral illumination. The PCO site is evaluated in relation to the capsulorrhexis edge location relative to the IOL optic and graded qualitatively as Grade I (peripheral), Grade II (paracentral), or Grade III (central).

Photographs taken at different time intervals were evaluated by two observers for the presence of PCO.

Nd:YAG laser capsulotomy was performed if clinically indicated by a decrease in visual acuity of two lines since the last appointment, in the presence of a clinically opaque capsule.

Chi-square test was used for analyzing the data.

RESULTS

A total of 519 eyes of 493 patients were included in this study. In Group I, 125 of the patients were male and 142 were female. In Group II, 121 patients were male and 131 were female. The mean age was 69.7±5.1 (55 to 85 years) in Group I and 70.3±4.1 (54 to 90) in Group II (Tab. I).

PCO development of Groups I and II at 6 months is shown in Table II. There is no statistically significant difference between the two groups. PCO development at 12 months, 18 months, and 25 months is shown in Tables III, IV, and V.

The evaluation of PCO development at 12 months did not reveal a statistically significant difference between the two groups. In this period, however, the opacification was more prominent at the optic-haptic junction in Group II patients with a Grade I (peripheral) PCO.

At 25 months, Grade I (peripheral) PCO was more frequent than Grade II (paracentral) PCO in both groups. Grade III (central) PCO was not detected in either group.

DISCUSSION

PCO is one of the most common complications of phacoemulsification with intraocular implantation and occurs in up to 50% of eyes by 5 years postoperatively. The standard treatment for PCO is Nd:YAG laser capsulotomy, which is an expensive procedure that has been associated with retinal detachment, IOP increase, cystoid macular edema, and IOL damage (3). For this reason, preventing PCO formation is very important.

IOLs with a sharp edge design cause a closer IOL-capsule contact on the posterior capsule forming a mechanical barrier against the LEC migration. On the contrary, the capsule-IOL contact in the IOLs with a rounded edge design is not tight enough to prevent LEC migration. Acrylic lenses may have an advantage in reducing the incidence of PCO formation with their sharp edge design. Both IOLs that we used in our study groups have a sharp edge design and the insignificant PCO rates between these two groups support this effect.

Nishi and colleagues investigated the importance of the optic diameter on the relationship between capsular bending and PCO formation (18). The histopathologic study carried out 3 weeks after surgery demonstrated that the PCO was more prominent in eyes implanted with 7 mm optic diameter when compared with 5.5 mm optic diameter. They defined the concept of capsular bending in their earlier articles. Capsular bending was initially formed by the adhesion of anterior capsular leaflet with IOL and then anterior and posterior leaflets of the capsule adhere to each other at the lens periphery and this adhesion advances toward the lens central. They concluded that the posterior capsule-IOL optic edge adhesion is completed during the first month and posterior capsule is bent toward the anterior capsule and proposed the term capsular bending. However, capsular bending is not detected with IOLs with 7 mm optic diameter and with most of the IOLs with 5.5 mm optic diameter in their latest work. They concluded that the optics and especially the haptics of the single-piece IOLs are thinner than most of the other IOLs, providing that the anterior and posterior capsular leaflet contact is much more frequent and capsular adhesion is easily realized. This adhesion is proposed as an important step in the prevention of PCO formation. There is more space between the anterior and posterior capsular leaflets in implantation of IOLs with thick haptics and the adhesion mechanism is much more difficult in these patients. This difficulty in capsular adhesion in IOLs with single-piece and 7 mm optic diameter causes incomplete capsular bending at the optic edge of the IOLs. As a result, the single-piece IOLs with a large volume seem inefficient in the prevention of PCO formation when compared with IOLs with three-piece and thin haptics. In our study, PCO formation at the periphery, especially at the optics-haptic junction, supports this hypothesis, although this observation was not significant.

The preliminary results of a study with implantation of a single-piece Acrysof IOL showed that the Acrysof SA 30 AL IOL has good biocompatibility, haptic flexibility and resistance, and stability in the capsular bag and very low PCO rates (19). A recent clinical comparison of single-piece and three-piece truncated hydrophobic acrylic IOLs revealed that although similar in centration and refractive stability, single piece truncated, hydrophobic, acrylic IOLs had more PCO but less anterior capsule opacification (20). In another study, three IOLs of different materials and design were com-

TABLE I - PATIENT CHARACTERISTICS

Characteristics	Group I (n=267)	Group II (n=252)	p
Age, y, mean±SD	69.7±5.1	70.3±4.1	0.512 0.784
Age range	55-85	54-90	
Sex, n (%)			
Male	125 (46.8)	121 (48.0)	
Female	142 (53.2)	131 (52.0)	

SD = Standard deviation

TABLE II - THE EVALUATION OF PCO DEVELOPMENT IN GROUPS I AND II AT 6 MONTHS

PCO	Group I, n (%)	Group II, n (%)	Total	p
Clear	187 (72.2)	163 (66.5)	350 (69.4)	0.369
Peripheral	63 (24.3)	73 (29.8)	136 (27.0)	
Paracentral	6 (3.5)	9 (3.7)	18 (3.6)	
Central	-	-	-	
Total	259 (100)	245 (100)	504 (100)	

PCO = Posterior capsule opacification

TABLE III - THE EVALUATION OF PCO DEVELOPMENT IN GROUPS I AND II AT 12 MONTHS

PCO	Group I, n (%)	Group II, n (%)	Total	p
Clear	157 (75.5)	128 (67.0)	285 (71.4)	0.138
Peripheral	45 (21.6)	58 (30.4)	103 (25.8)	
Paracentral	6 (2.9)	5 (2.6)	11 (2.8)	
Central	-	-	-	
Total	208 (100)	191 (100)	399 (100)	

PCO = Posterior capsule opacification

TABLE IV - THE EVALUATION OF PCO DEVELOPMENT IN GROUPS I AND II AT 18 MONTHS

PCO	Group I, n (%)	Group II, n (%)	Total	p
Clear	63 (68.5)	56 (68.3)	119 (68.4)	0.836
Peripheral	27 (29.3)	23 (28.0)	50 (28.7)	
Paracentral	2 (2.2)	3 (3.7)	5 (2.9)	
Central	-	-	-	
Total	92 (100)	82 (100)	174 (100)	

PCO = Posterior capsule opacification

TABLE V - THE EVALUATION OF PCO DEVELOPMENT IN GROUPS I AND II AT 36 MONTHS

PCO	Group I, n (%)	Group II, n (%)	Total	p
Clear	56 (68.3)	53 (69.7)	109 (69)	0.765
Peripheral	25 (30.5)	21 (27.6)	46 (29.1)	
Paracentral	1(1.2)	2 (2.6)	3 (1.9)	
Central	-	-	-	
Total	82 (100)	76 (100)	158 (100)	

PCO = Posterior capsule opacification

pared for the formation of PCO. The Nd:YAG capsulotomy rates were also recorded. After 2 years, the PMMA IOL group was found to have significantly more PCO than the silicone and Acrysof IOL groups. The least PCO development was seen in the Acrysof group. The Nd:YAG capsulotomy rate was 20% in the PMMA group, 22% in the silicone group, and 8% in the Acrysof group (21).

PCO development during the longer postoperative period in cases with three-piece acrylic IOL is lower and capsulorrhexis size is an important factor for Nd:YAG laser capsulotomy. The capsulorrhexis size in our study is minimally less than the IOL optic diameter and anterior capsule covers the IOL optic edge. We did not perform any Nd:YAG laser capsulotomy during the 18-month postoperative period and this finding is compatible with other studies in the literature.

Development in IOL materials and design is an ongoing process to prevent PCO formation. In our study, we did not find any statistically significant difference between the two groups in PCO development. We conclude that the sharp edge design of the IOL optic is responsible for this effect. The more prominent PCO at the optic-haptic junction in cases with single-piece IOLs is statistically insignificant but studies of the three-piece IOLs involving long-term follow-up may clarify this subject.

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REFERENCES

1. Apple DJ, Solomon KD, Tetz MR. Posterior capsule opacification. Surv Ophthalmol 1992; 37: 73-116.
2. Ohadi C, Moreira H, Mc Donnell PJ. Posterior capsule opacification. Curr Opin Ophthalmol 1991; 2: 46-52.
3. Kappelhof JP, Vrensen GFJM. The pathology of after-cataract; a minireview. Acta Ophthalmol 1992; 205 (Suppl): S13-24.
4. Laurel CG, Zetterstrom C, Lundgren B. Phacoemulsification and lens implantation in rabbit eyes: capsular bag vs ciliary sulcus implantation and 4.0 versus 7.0 mm capsulorhexis. J Cataract Refract Surg 1998; 24: 143-4.
5. Aykan U, Bilge AH, Karadayı K, Akin T. The effect of capsulorhexis size on PCO development: small (4.5 to 5.0 mm) versus large (6.0 to 7.0 mm). Eur J Ophthalmol 2003;13: 541-5.
6. Nishi O, Nishi K, Sakka Y. Intercapsular cataract surgery with lens epithelial cell removal. Part IV: capsular fibrosis induced by poly(methylmethacrylate). J Cataract Refract Surg 1997; 17: 471-7.
7. Sterling S, Wood TO. Effect of intraocular lens convexity on posterior capsule opacification. J Cataract Refract Surg 1986; 12: 655-7.
8. Sellman TR, Lindstrom RL. Effect of a plano-convex posterior chamber lens on capsular opacification from Elschnig pearl formation. J Cataract Refract Surg 1988; 14: 68-73.
9. Born CP, Ryan DK. Effect of intraocular lens optic design on posterior capsular opacification. J Cataract Refract Surg 1990; 16: 188-91.
10. Legler UFC, Apple DJ, Assia EI. Inhibition of posterior capsule opacification: the effect of colchicine in a sustained drug delivery system. J Cataract Refract Surg 1993; 19: 462-9.
11. Power WJ, Neylan D, Collum LMT. Daunomycin as an inhibitor of human lens epithelial cell proliferation in culture. J Cataract Refract Surg 1994; 20: 287-90.
12. Nishi O. Incidence of posterior capsule opacification in eyes with and without posterior chamber intraocular lenses. J Cataract Refract Surg 1986; 12: 519-22.
13. Ursell PG, Spalton DJ, Pande MV, et al. Relationship between intraocular lens biomaterials and posterior capsule opacification. J Cataract Refract Surg 1998; 24: 352-60.
14. Hollick EJ, Spalton DJ, Ursell PG, et al. The effect of polymethylmethacrylate, silicone, and polyacrylic intraocular lenses on posterior capsular opacification 3 years after cataract surgery. Ophthalmology 1999; 106: 49-54; discussion 54-5.
15. Ursell PG, Spalton DJ, Pande MV, et al. The relationship between intraocular lens biomaterials and posterior capsule opacification: a 2-year prospective randomized trial comparing PMMA, silicone and polyacrylic lenses. J Cataract Refract Surg 1998; 24: 350-60.
16. Beltrame G, Salvetat ML, Chizzolini M, et al. PCO and

Nd:YAG capsulotomy rates after implantation of silicone, hydrogel and soft acrylic intraocular lenses: a two-year follow-up study. Eur J Ophthalmol 2002; 12: 388-94.
17. Pohjalainen T, Vesti E, Uusitab RJ, Laatikainen L. PCO in pseudophakic eyes with silicone or acrylic intraocular lenses. Eur J Ophthalmol 2002; 12: 212-8.
18. Nishi O, Nishi K. Effect of the optic size of single-piece acrylic intraocular lenses on posterior capsule opacification. J Cataract Refract Surg 2003; 29: 348-53.
19. Caporossi A, Casprini F, Tosi GM, Balocchi S. Preliminary results of cataract extraction with implantation of a single-piece Acrysof intraocular lens. J Cataract Refract Surg 2002; 28: 625-5.
20. Wallin TR, Hinckley M, Nilson C, Olson RJ. A clinical comparison of single-piece and three-piece truncated, hydrophilic acrylic intraocular lenses. Am J Ophthalmol 2003; 136: 614-9.
21. Wejde G, Kugelberg M, Zetterstrom C. Posterior capsule opacification: comparison of 3 intraocular lenses of different materials and design. J Cataract Refract Surg 2003; 29: 1556-9.