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Comparison of Nd:YAG capsulotomy rate between 1-piece and 3-piece acrylic intraocular lenses

A STROBE-compliant article

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Abstract

The aim of the study is to compare Nd:YAG capsulotomy rate between acrylic 1- and 3-piece intraocular lenses. Among 924 eyes of 762 patients who received cataract surgery, we selected the 303 patients (404 eyes) implanted with an SN60WF 1-piece intraocular lens (Alcon, Fort Worth, TX) or a YA-60BBR 3-piece intraocular lens (Hoya Co., Tokyo, Japan). For intraindividual comparison, we enrolled the 17 patients implanted with an SN60WF in 1 eye and a YA-60BBR in the contralateral eye. We compared Nd:YAG capsulotomy rate between acrylic 1- and 3-piece intraocular lenses 24 months after the operation. Of the 404 eyes in this study, Nd:YAG capsulotomy was performed in 20 of 268 eyes (7.5%) in the SN60WF 1-piece intraocular lens group and 24 of 136 eyes (17.6%) in the YA-60BBR 3-piece intraocular lens group; the difference was statistically significant ($P = .002$). Among the 17 patients (34 eyes) who were implanted with 2 different inraocular lenses, Nd:YAG capsulotomy was performed in only 2 eyes (12%) in the SN60WF group and 9 eyes (53%) in the YA-60BBR group; the difference was statistically significant ($P = .020$).

The authors found a significantly greater incidence of Nd:YAG capsulotomy in eyes who received 3-piece lenses compared with those who received 1-piece lenses.

Abbreviations: BCVA = best-corrected visual acuity, IOL = intraocular lens, Nd-YAG = neodymium–yttrium–aluminum–garnet, PCO = posterior capsule opacification, PMMA = poly-methyl methacrylate.

Keywords: acrylic intraocular lens, neodymium, posterior capsule opacification, YAG capsulotomy

1. Introduction

Posterior capsule opacification (PCO) is the most common complication after cataract extraction with intraocular lens (IOL) implantation, and remains the leading cause of vision loss after cataract surgery. Neodymium–yttrium–aluminum–garnet (Nd-YAG) laser capsulotomy is a definitive treatment for PCO that involves the following rare but significant complications: cystoids macular edema, retinal detachment, increased intraocular pressure, IOL damage or dislocation, and exacerbation of localized endophthalmitis.[1,2] In addition, PCO treatment with Nd-YAG capsulotomy requires close patient follow-up and has a substantial socioeconomic impact.[3] Other limitations of Nd-YAG laser capsulotomy include its inability to restore complete visualization of the peripheral retina,[4] and the potential to increase the risk of neovascular glaucoma in diabetic patients.[5] Modern cataract surgery is now approaching the realm of refractive surgery. Patients expect perfect results, often with emmetropia. Satisfactory use of multifocal IOLs requires a low PCO rate.[6] Therefore, many attempts to prevent PCO have been proposed, including modifications in IOL design and material, surgical technique, and application of drugs. A number of clinical studies have addressed the influence of different IOLs on the incidence of PCO. However, the difference in PCO rate between 1- and 3-piece IOLs remains controversial.[7–17] This study compared 2 different commonly used blue-blocking acrylic IOLs: the AcrySof SN60WF (Alcon, Fort Worth, TX) and the AF-1 YA-60BBR (Hoya Co., Tokyo, Japan; Table 1). These are hydrophobic acrylic IOLs with enhanced square edges made from different haptic materials. The AcrySof SN60WF is a 1-piece IOL, while the AF-1 YA-60BBR has thin poly-methyl methacrylate (PMMA) haptics. The present study assessed the Nd:YAG capsulotomy rate of these 2 IOLs including a paired fellow-eye comparison during a follow-up period of 2 years.

2. Methods

A retrospective review was performed of eyes that had phacoemulsification with posterior chamber IOL implantation between July 2006 and December 2010. Exclusion criteria included previously intraocular surgery, laser treatment, glaucoma, intraoperative complications (such as capsular tears or wound leakage) or retinal pathology that would make a postoperative visual acuity of 20/40 (decimal equivalent, 0.5) or better unlikely. Among 924 eyes of 762 patients, we selected the 303 patients (404 eyes) implanted with an AcrySof SN60WF 1-piece IOL (Alcon) or an AF-1 YA-60BBR 3-piece IOL (Hoya

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Table 1

Intraocular lens characteristics.

	SN60WF	YA60BBR
Optic material	Hydrophobic acrylic	Hydrophobic acrylic
Haptic material	Hydrophobic acrylic	PMMA
Optic diameter, mm	6.0	6.0
Overall length, mm	13.0	12.5
Loop angulation	0°	5°
Refractive index	1.55	1.51
	Aspheric	Aspheric

Co.). For intraindividual comparison, we enrolled the 17 patients implanted with an SN60WF 1-piece IOL in 1 eye and a YA-60BBR 3-piece IOL in the contralateral eye within 2 weeks of the first surgery. The following data were collected from the medical record for each procedure: age, sex, ocular history, preoperative and postoperative best corrected vision, date of cataract extraction, IOL type, date of Nd:YAG capsulotomy (if performed), pre- and postcapsulotomy best corrected vision, and date of last ocular examination.

The study followed the guidelines of the Declaration of Helsinki and was approved by the Institutional Review Board and the Ethics Committee of our hospital. In retrospective case–control study, informed consent was not given. Both lenses used in this study are made of the foldable hydrophobic acrylic optics with a diameter of 6 mm and a square optic edge (Table 1). They contain a blue-light filter (AF-1[UY]) that attenuates the transmission of visible light in the 400 to 500 nm range. The 1-piece SN60WF IOL has acrylic haptics with no angulation. The 3-piece YA60BBR IOL has haptics made of PMMA and an angulation of 5°.

Cataract surgery was performed by a single surgeon (SYK) in a standardized fashion. After the application of retrobulbar or topical anesthesia, a clear corneal temporal incision was made with a 2.8-mm keratome blade. Viscoelastic was used to inflate the anterior chamber and continuous curvilinear capsulorhexis approximately 5.5 mm in diameter was created. Its size was intended to be slightly smaller than the IOL optic size. After careful hydrodissection and hydrodelineation using balanced salt solution (Alcon), phacoemulsification of the nucleus was performed and the residual cortex was cleared by an irrigation/aspiration system. The posterior capsular polishing was performed. Viscoelastic was then inserted into the capsular bag, followed by "in-the-bag" placement of the posterior chamber IOL.

Follow-up examinations were done at 1 week, 1 month, 2 months, 6 months, 1 year, and 2 years after surgery. Snellen best-corrected visual acuity (BCVA) was measured at the 1- month, 1-year, and 2-year follow-up examinations. Nd:YAG capsulotomy was performed based on a measurable decrease in visual acuity compared with the best postoperative visual acuity, coupled with the presence of PCO detected on dilated slit lamp examination. We compared Nd:YAG capsulotomy rate between acrylic 1- and 3-piece IOLs 24 months after the operation.

Statistical analysis was performed with SPSS software (version 18.0; SPSS, Chicago, IL). The level of statistical significance was calculated using the *t* test and the chi-squared test. Nd-YAG capsulotomy rates of the 2 IOLs were compared using the Fisher exact test. A P value $\leq .05$ was considered statistically significant.

3. Results

Mean age of the 303 patients at the time of cataract surgery was 67.23 ± 12.73 years. There were 189 women and 114 men.

Table 2

Patients characteristics.

	SN60WF	YA60BBR	*P*
Total patients (eyes)	199 (268)	104 (136)	
Mean age, mo	67.25 ± 13.62	67.20 ± 10.87	.975
Females/males	121/78	68/36	.589
Preop BCVA (log MAR)	0.57 ± 0.33	0.62 ± 0.39	.357
Postop BCVA (log MAR)	0.14 ± 0.27	0.13 ± 0.31	.554

Postoperative BCVA was obtained 1 month after the cataract surgery. Data are expressed as mean ± standard deviation.

BCVA = best-corrected visual acuity as tested on the Snellen chart and transformed into the Log MAR unit, Log MAR = logarithm of the minimal angle of resolution.

Patient characteristics are shown in Table 2. Of the 404 eyes in this study, Nd:YAG capsulotomy was performed in 20 of 268 eyes (7.5%) in the SN60WF 1-piece IOL group and 24 of 136 eyes (17.6%) in the YA-60BBR 3-piece IOL group. The difference in capsulotomy rate was statistically significant ($P = .002$, Table 3). Patient characteristics of the 34 eyes in fellow eye study are shown in Table 4. Of the 34 eyes in this study, Nd:YAG capsulotomy was performed in only 2 eyes (12%) in the SN60WF 1-piece IOL group and 9 eyes (53%) in the YA-60BBR 3-piece IOL group (Table 5). The difference in capsulotomy rates was statistically significant ($P < .05$). The mean time to Nd:YAG capsulotomy was 3.9 months (range, 2–9) in the 3-piece lens group and 6 months (range, 3–9) in the 1-piece lens group. There was no significant difference in BCVA between groups at any measured time point (postphacoemulsification, precapsulotomy, postcapsulotomy, and 2 years postoperatively).

4. Discussion

Several factors have been shown to influence PCO formation. Risk factors for PCO include younger age, female sex, diabetes, uveitis, and type of IOL used. Apple et al[3] reported 6 factors that prevent or delay PCO: 3 related to the IOL and 3 related to surgical technique.

The surgical factors are hydrodissection-enhanced cortical cleanup, a continuous curvilinear capsulorhexis diameter slightly smaller than that of the IOL optic, and "in-the-bag" fixation of the posterior chamber IOL. The IOL-related factors are a square, truncated edge; the biocompatibility of lens materials to mitigate cellular proliferation; and maximal IOL optic posterior capsule contact. There is current scientific interest in the effect of IOL design and biomaterial composition on the incidence of PCO.

In our study, all surgeries were performed by a single surgeon using the same technique, including thorough cortex removal. We included only patients with lens placement in the capsular bag without posterior capsular abnormalities at the time of surgery.

Table 3

Nd:YAG capsulotomy results and patient follow-up.

	SN60WF	YA60BBR	*P*
Nd:YAG (n/total %)	20/268 (7.5%)	24/136 (17.6%)	.002
Pre-YAG BCVA log MAR	0.42 ± 0.39	0.48 ± 0.36	.476
Post-YAG BCVA log MAR	0.15 ± 0.22	0.20 ± 0.38	.332
Mean time to YAG, mo (range)	6.2 (2–23)	7.6 (2–22)	.470

Post-YAG BCVA was obtained 1 week after the Nd:YAG capsulotomy. Data are expressed as mean ± standard deviation.

BCVA = best-corrected visual acuity as tested on the Snellen chart and transformed into the Log MAR unit, Log MAR = logarithm of the minimal angle of resolution.

Table 4

Patients characteristics of fellow eye study.

	SN60WF	YA60BBR	P
Total patients (eyes)	17		
Mean age, mo (range)	66.3 ± 8.0		
Females/males	11/6		
Diabetes	2 (12%)		
Mean time to fellow-eye surgery, d (range)	1.59 (0–7)		
Preop BCVA (log MAR)	0.53 ± 0.40	0.62 ± 0.42	.482
Postop BCVA (log MAR)	0.14 ± 0.18	0.12 ± 0.12	.326

Postoperative BCVA was obtained 1 month after the cataract surgery. Data are expressed as mean ± standard deviation.
BCVA = best-corrected visual acuity as tested on the Snellen chart and transformed into the Log MAR unit, Log MAR = logarithm of the minimal angle of resolution.

Table 5

Nd:YAG capsulotomy results and patient follow-up in fellow eye study.

	SN60WF	YA60BBR	P
Eyes, n	17	17	
Nd:YAG (n/total %)	2 (12%)	9 (53%)	.020
Pre-YAG BCVA log MAR	0.20 ± 0.28	0.40 ± 0.35	.565
Post-YAG BCVA log MAR	0.00 ± 0.00	0.13 ± 0.41	.678
Mean time to YAG, mo (range)	6.0 (3–9)	3.9 (2–9)	.688

Post-YAG BCVA was obtained 1 week after the Nd:YAG capsulotomy. Data are expressed as mean ± standard deviation.
BCVA = best-corrected visual acuity as tested on the Snellen chart and transformed into the Log MAR unit, Log MAR = logarithm of the minimal angle of resolution.

By comparing outcomes of the 2 lenses between the eyes of the same patient, we reduced the influence of confounding patient factors, which indicates that the significant difference in Nd-YAG capsulotomy rate between the IOLs is likely lens-related. Both IOLs are made of the hydrophobic acrylic material and have similar designs (optic size, sharp edge). However, those IOLs have different haptic design and material.

Numerous studies reported lower or similar PCO rates of 3-piece IOLs compared with 1-piece IOLs (Table 6). Previous authors have suggested that the thin haptics of the 3-piece lens allow for better adhesion between the anterior and posterior capsules and bend formation because they are closer together.[9,11–15] They have also proposed that the bulky haptics of the 1-piece lens extend directly from the posterior optic surface without a sharp edge at the haptic junction, leading to a loss of the barrier effect to the migration of lens epithelial cells in this region and possibly increasing the risk of PCO.[10]

In contrast to the majority of these published results, we found a significantly lower Nd:YAG capsulotomy rate in eyes with a 1-piece IOL. Although this result may be influenced by lens design, the primary difference between the lenses tested was their material compositions: the AcrySof SN60WF is a 1-piece IOL made of hydrophobic acrylate/methacrylate copolymer (phenylethyl acrylate and phenylethyl methacrylate cross linked with 1,4-butanediol diacrylate), while the AF-1 YA-60BBR IOL has a hydrophobic acrylic optic (phenylethyl methacrylate, n-butylacrylate, and perfluoroalkyl methacrylate) with chemically fused PMMA haptics. Another important factor is the difference in haptic material: the 1-piece lens is made of acrylate and the 3-piece of PMMA. The stronger binding of the capsule to the

Table 6

Comparison of published rates of posterior lens opacification and Nd:YAG laser capsulotomy between 1- and 3-piece intraocular lenses.

	Study design	Eyes, N	Lens type		PCO rate	Nd:YAG rate	Follow-up
			1 Piece	3 Piece			
Sacu et al[4]	Prospective, randomized, double-blind clinical trial with intraindividual comparison	104	AcrySof SA30AL or SA60AT	AcrySof MA30BA or MA60BM	Higher in 1-piece lens 1 y postoperatively, but no difference after 2 y	No capsulotomies were performed	2 y
Wallin et al[7]	Retrospective review	75	AcrySof SA30AL	AcrySof MA30BA	Higher in 1-piece lens	No difference	2 y
Mian et al[9]	Retrospective review	434	AcrySof SA30AL or SA60AT	AcrySof MA30AC or MA60AC	N/A	Higher in 1- piece lens (P = .01)	2 y
Leydolt et al[10]	Prospective, randomized, double-blind clinical trial with intraindividual comparison	104	AcrySof SA30AL or SA60AT	AcrySof MA30BA or MA60BM	No significant difference	Four patients in the 1-piece eye compared with 3 patients in the 3-piece eye (P = .68)	5 y
Zemaitiene et al[11]	Prospective, randomized, unblinded clinical trial	74	AcrySof SA30AL	AcrySof MA30BA	Higher in 1-piece lens 1 y postoperatively, but no difference after 2 y	No capsulotomies were performed	2 y
Nejima et al[17]	Prospective, randomized, double-blind clinical trial with intraindividual comparison	40	AcrySof SA30AL	AcrySof MA30BA	No significant difference	N/A	18 mo
Prinz et al[18]	Prospective, randomized, double-blind clinical trial with intraindividual comparison	80	AF-1 NY-60	AF-1 iMICS Y-60H	No significant difference in PCO rate, but a significantly lower incidence of capsular folds in the 1-piece group 1 y postoperatively	Only 2 eyes in the 3-piece lens group required capsulotomy at 1-y follow-up (P = .5)	1 y

PCO = posterior capsule opacification, N/A = not applicable, Nd-YAG = neodymium–yttrium–aluminum–garnet.

acrylate used in the 1-piece lens may have resulted in better adhesion to the haptics as well as the optic and, thus, the lower rate of PCO in 1-piece IOL. The third potential reason behind our results is the possibly greater tension force of the PMMA haptics compared with acrylic haptics. This greater tension force creates capsular folds or wrinkles along the axis of haptic orientation. Prinz et al[18] reported a significantly higher incidence of capsular folds in the 3-piece IOL group ($P = .02$). The Alcon IOL haptic design was reported to minimize compression force, which can help reduce bag stretch and striae in the lens capsule.[19,20] The resulting interspace may result in the higher PCO rate observed in the 3-piece lens group because pearls may form once lens epithelial cells migrate through the gap between the posterior capsule and the IOL. The fourth potential reason is haptic angulation, present only in the 3-piece lens. However, Schmidbauer et al[21] found no significant difference in central and peripheral PCO in rabbits between the 4 haptic angulations of 0°, 5°, 10°, and 15° of the Centerflex IOL (Rayner, Hove, UK) 3 weeks postoperatively.

This study has several limitations. We compared IOLs manufactured by different companies, whereas previous studies compared AcrySof lenses only. Using Nd:YAG capsulotomy as a marker of PCO may be an inaccurate estimate of degree of opacification. Nonetheless, this intrapatient comparison provides a functional measure of significance and imposes equal limitations on both groups.

Another doubtful point is that the intraindividual study had a higher Yag laser conduction rate compared with studies done in other labs or rates done by the same author on other patient groups. We analyzed this reason, that patients inserted with the different lens on each eyes showed more sensitive reaction in perceiving the distinction between the 2 eyes than other patients inserted with the identical lens on both eyes. Finally, the biggest regret is our small sample size and short follow-up period of 24 months, which prevents a definitive comparison of PCO rates. Thus, this study alone may not be enough to solidly argue that the 1-piece causes less PCO than the 3-piece. Nevertheless, the main focus should be made on the fact that this study presented an opposite result from the previous theory which argued that the 1-piece is likely to cause more PCO increase than the 3-piece. In addition, results from the prior studies have not reflected the latest IOL including square edge. Thus, this study retains its significance that it prompted the need for reconsideration of the previous theory. Further study is required to validate our results.

In this study, there was significant difference of Nd:YAG capsulotomy rate between acrylic 1- and 3-piece IOLs 24 months postoperatively among 404 eyes and among 17 intraindividual comparison. In contrast to the majority of published results, we found a significantly lower Nd:YAG capsulotomy rate in eyes with a 1-piece IOL. Several potential reasons of our results are difference of optic material compositions between the lenses, greater tension force of the PMMA haptics compared with acrylic haptics, higher incidence of capsular folds in the 3-piece IOL and different haptic angulation.

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