The Effect of Texturing the Intraocular Lens Edge on Postoperative Glare Symptoms

A Randomized, Prospective, Double-Masked Study

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Objective: To determine whether texturing the optic edge of the intraocular lens reduces photic symptoms in patients with square-edged acrylic intraocular lens implants.

Methods: Sixty patients underwent routine phacoemulsification performed by a single surgeon and were prospectively randomized to receive either the standard AcrySof MA30 intraocular lens (Alcon Laboratories, Ft Worth, Tex) (group 1) or an MA30 intraocular lens with a textured optic edge (group 2). Patients were seen at 1 month by an independent observer who was masked to treatment groups. A questionnaire on photic symptoms was completed, and attempts were made to elicit symptoms under mesopic and photopic conditions.

Results: At 1 month postoperatively, 20 (67%) of 30 patients in group 1 noticed symptoms compared with 4 (13%) of 30 patients in group 2 (P<.001). The mean duration of symptoms was 3.5 weeks in group 1 and 1 week in group 2 (P=.01). By provocative testing under photopic conditions, symptoms could be elicited in 26 patients (87%) in group 1 and 6 (20%) in group 2. No patients in either group were symptomatic at 3 months postoperatively. Under mesopic conditions, symptoms could be elicited in 27 patients (90%) in group 1 and 11 (37%) in group 2. There was no relationship between the incidence of symptoms and the degree of intraocular lens–rhexis contact.

Conclusion: Photic phenomena can be significantly reduced by texturing the edge of a square-edged profile AcrySof intraocular lens.

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POSTOPERATIVE GLARE phenomena after surgical treatment for cataract were first reported by Masket et al. They found that 45% of patients with ovoid (5.0 mm × 6.0 mm) 1-piece all–polymethyl methacrylate (PMMA) intraocular lenses (IOLs) described photic glare symptoms compared with 22% of patients with round (5.5 mm) PMMA IOLs. The optics of these 2 IOLs were studied using scatterometry, which measures the amount of light reflected off materials, and ray tracing analysis, which determines the fate of bundles of light rays passing through the IOL. Results showed that the thickened edge of the ovoid optic was associated with increased light scattering.

Posterior capsule opacification has been shown to be significantly reduced by IOLs with a square-edged profile, but in some patients, this has been associated with postoperative glare phenomena. Symptoms have been reported with square-edged acrylic (AcrySof, Alcon Laboratories, Ft Worth, Tex) and silicone IOLs. Symptoms are most commonly noticed in the first few weeks after surgical treatment, usually in conditions of mesopic illumination when there is a peripheral light source from overhead or the temporal side. Using ray-tracing techniques, Holladay et al have shown that these symptoms are due to internal light scattering from the IOL edge onto the retina. In most patients, these symptoms resolve over a period of a few weeks, probably due to fibrosis of the rhexis edge around the IOL. In some patients, symptoms persist, possibly due to a larger pupillary diameter in younger patients, a more posteriorly positioned IOL with a greater space between the IOL and the iris in myopic eyes, or from failure of the rhexis edge to adequately opacify with AcrySof IOLs. On occasion, symptoms have been intractable, and it has been necessary to explant the IOL. After it is replaced by a rounded-edged IOL, symptoms have re-
solved, providing circumstantial evidence that a square-edged optic is the cause of the symptoms.

Recently, a variation of the AcrySof IOL has been developed in which the optic has a textured edge. On examination, this has a frosted appearance. The aim of this prospective, randomized study was to determine whether texturing the square edge of an AcrySof IOL reduces postoperative photic glare phenomena.

METHODS

Following approval from the hospital ethics committee and informed consent, patients were recruited from October 1999 through March 2000. All patients were seen preoperatively by the same clinician (W.R.M.). Inclusion criteria were the presence of senile cataract in an otherwise normal eye in patients older than 60 years. Exclusion criteria were a history of any previous ocular disease, intraocular surgery, laser treatment, diabetes requiring medical control, glaucoma, previous uveitis, or posterior segment abnormalities that would preclude a postoperative visual acuity of 20/40 or better.

All patients underwent phacoemulsification with continuous curvilinear capsulorrhexis, performed by a single surgeon (D.J.S.) using peribulbar anesthesia. The surgical technique and medication were standardized. A temporal clear corneal section was made, and the anterior chamber was re-formed with Healon (Pharmacia, Uppsala, Sweden). A continuous curvilinear capsulorrhexis of approximately 5 mm was performed so that the anterior capsule flap lay on the implant optic. The nucleus was removed by irrigation-aspiration with balanced salt solution (Alcon Laboratories) 4 times a day for 1 month. No attempt was made to remove lens epithelial cells by polishing the anterior capsule. The bag was re-formed with Healon and the section enlarged to 3.5 mm. Preoperatively, patients were randomized to receive either a 5.5-mm, 3-piece AcrySof IOL manufactured via the old process (MA30BM) (group 1) or a 5.5-mm, 3-piece AcrySof IOL manufactured with the new process, resulting in a textured optic edge (designated for this study as MA30BT) (group 2) (Figure 1). The material and geometry of both IOLs were otherwise identical. The IOLs were inserted in the bag, and Healon was removed by irrigation aspiration with balanced salt solution. If there were any surgical complications, such as capsulorrhesis rim tear, zonular dehiscence, posterior capsule rupture, or vitreous loss, the patient was excluded from the study and replaced. Postoperatively, all patients used Maxitrol drops (neomycin sulfate, polymyxin B sulfate, and dexamethasone 0.1%; Alcon Laboratories) 4 times a day for 1 month. No nonsteroidal anti-inflammatory preparation was used preoperatively, per-operatively, or postoperatively. Postoperatively, all IOLs were confirmed to have in-the-bag placement.

At 1 month postoperatively, all patients were assessed by an ophthalmologist (W.R.M. or S.K.) who was masked to which group the patients had been assigned. Pelli-Robson contrast sensitivity and ETDRS (Early Treatment of Diabetic Retinopathy Study) visual acuity were measured. All patients completed a questionnaire to determine the following: (1) presence of symptoms, (2) their postoperative duration, (3) the time of day they were most noticeable, (4) the relationship to the direction of light that induced the phenomena, (5) their impact on daily activities, and (6) the pattern of glare experienced, with reference to a sheet illustrating the various forms of glare phenomena (Figure 2). Patients were then examined under both photopic and mesopic conditions to provoke the symptoms. With the patient looking in the primary position at all times, a penlight was moved in an arc toward the peripheral visual field. The visual field was divided into 8 segments, and patients were asked to describe the presence and type of glare with reference to the pattern sheet. If symptoms were elicited in any sector, the test was regarded as positive. Following pupillary dilatation, slitlamp biomicroscopy was performed to determine the degree of IOL-iris contact and the presence of vertical striae through the center of the posterior capsule. Pupil diameter was not measured in the study. Patients with symptoms still present at 1 month postoperatively were reassessed at 3 months postoperatively using the same protocol.

The Fisher exact test was used to analyze the proportion of patients with symptoms, the impact of symptoms on the patients, and the type of photic phenomena under mesopic and photopic conditions. An unpaired t test was used to compare the duration of symptoms and the means of visual acuity and contrast sensitivity data.

RESULTS

Of 60 patients, 30 were allocated to each group. All patients in group 1 (untextured IOL) were available for postoperative assessment at 1 month and 3 months, when necessary. In group 2, (textured-edged IOL) 1 patient failed to attend the 1-month assessment because of illness. The mean age was 76 years in group 1 (range, 65-83 years) and 74 years in group 2 (range, 60-86 years). There was no difference between the 2 groups in age and sex distribution.

At 1 month postoperatively, the mean ETDRS visual acuity was 0.02 for group 1 and 0.00 for group 2 ($P = .70$). Mean Pelli-Robson contrast sensitivity was 1.48 and 1.51 for groups 1 and 2, respectively ($P = .30$).
At 1 month postoperatively, 20 patients (67%) in group 1 experienced photic glare symptoms compared with 4 (13%) in group 2 ($P < .001$; relative risk, 5.00; 95% confidence interval, 1.9-12.9). The mean duration of symptoms was 3.5 weeks for patients in group 1 and 1 week in group 2 ($P = .01$). No patients in either group had symptoms at 3 months postoperatively. The symptomatic patients in both groups noticed the photic phenomena more commonly from peripherally directed light, particularly from overhead light. In group 1, patients tended to experience symptoms more commonly at night (Figure 3). In group 1, the symptoms had no impact in 6 (30%) of 20 patients, 13 patients (65%) were aware of them, and in 1 patient (5%) they were a nuisance. In group 2, symptoms had no impact in 3 (75%) of 4 patients, and 1 patient (25%) was aware of them (Figure 4).

With provocative testing under photopic conditions it was possible to elicit symptoms in 26 patients (87%) in group 1 and 6 patients (20%) in group 2 ($P < .001$) (Figure 5A). Under mesopic conditions, photic phenomena were elicited in 27 patients (90%) in group 1 and in 11 patients (37%) in group 2 (Figure 5B). Flare (Figure 2, patterns 7-11) was the most commonly elicited glare pattern in group 1 under both light conditions. In group 2, there was no pattern bias.

The relationship between the number of quadrants of IOL–rhexis contact and the presence of symptoms is given in the Table. At 1 month postoperatively, the in-
The excellent visual outcome from modern phacoemulsification can be impaired by the unwanted images produced by photic glare phenomena, and because of the increasingly high expectations of patients, the phenomena need to be eliminated. Several features related to the design of IOLs have been associated with photic glare phenomena. Apple et al\textsuperscript{11} reported a case of a pilot who had monocular glare symptoms at night after the implantation of a 6-mm round PMMA lens with 4 positioning holes around the optic edge. Symptoms were abolished by an IOL exchange. In a separate report, Landry\textsuperscript{11} indicated that IOL positioning holes were responsible for the unwanted photic images, and such observations have led to their subsequent removal from the majority of implants in the manufacturing process. In the late 1980s and early 1990s, IOLs with 5.0 mm × 6.0 mm ovoid optics, constructed from round PMMA IOLs with the opposing sides truncated, were popular, but if the implant was positioned horizontally, patients experienced glare symptoms from superiorly located light sources, such as room lights and the sun. The reports of glare phenomena with ovoid IOLs has since made them unpopular.\textsuperscript{12,13}

Mamalis and Spencer\textsuperscript{14} recently reported the results of a physician survey concerning the explanation of foldable IOLs. This survey reported that visual aberrations or optical phenomena were reported by 24% of patients with 3-piece monofocal silicone lenses, 27% of patients with 1-piece plate haptic silicone lenses, and 28% of patients with 3-piece acrylic lenses. A square edge is, therefore, not the only requirement for an IOL lens to produce photic phenomena. Tester et al\textsuperscript{15} conducted a telephone questionnaire to investigate the incidence of unwanted light images with different IOLs. They surveyed patients with 6 IOL types: AcrySof 5.5-mm (MA30) and 6.0-mm (MA60) IOLs, the Allergan SI-40 (Allergan, Inc, Irvine, Calif), the Staar/Chiron plate haptic lens (Staar Surgical Co, Monrovia, Calif, and Chiron Corporation, Emeryville, Calif), and 2 PMMA IOLs (5.5 mm and 6.0 mm) and compared them with 50 controls with presbyopia. Patients were contacted between 6 and 12 months after surgical treatment for cataract to identify their subsequent removal from the majority of implants in the manufacturing process. In the late 1980s and early 1990s, IOLs with 5.0 mm × 6.0 mm ovoid optics, constructed from round PMMA IOLs with the opposing sides truncated, were popular, but if the implant was positioned horizontally, patients experienced glare symptoms from superiorly located light sources, such as room lights and the sun. The reports of glare phenomena with ovoid IOLs has since made them unpopular.\textsuperscript{12,13}

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Our study investigated photic phenomena in 2 square-edged 5.5-mm 3-piece AcrySof IOLs, one with a smooth optic edge and the second with a textured edge. We have shown that patients who received the textured implant had a statistically significant reduction in the in-
incidence, duration, and severity of edge glare symptoms. From Holladay’s study using ray tracing in round-edged and square-edged IOLs, the most likely explanation for this result is that light reflected off the internal IOL edge surface is more scattered by the textured-edged lens, and a focused internal image is not created. It was important to take into account the effect of IOL-rhexis contact on the incidence of symptoms in both groups of patients. The capsule on the anterior surface of the IOL optic undergoes fibrotic changes (anterior capsule opacification [ACO]) in the early postoperative period. This decreases the transparency of the anterior capsule and will increase the dispersion of light entering the eye, with the potential to reduce glare. In a histological study, the rate of ACO was found to be dependent on the type of implant. Silicone plate haptic IOLs produced high ACO scores, whereas 3-piece acrylic optic/PMMA haptic IOLs produced little ACO. Increased ACO might be beneficial in preventing photic symptoms, although it could lead to IOL decentration if the forces on the IOL are asymmetrical. The low rate of ACO with acrylic IOLs has the potential therefore to make these IOLs more susceptible to photic glare phenomena. In our study, the Table shows that there was no relationship between the number of quadrants covered by the rhexis and the presence of symptoms. This is not surprising because by 1 month postoperatively, when the patients were first questioned, ACO would have had little time to develop.

No statistical differences in visual acuity or contrast sensitivity were detected between the 2 lens groups. Despite the high incidence of elicited symptoms with the smooth square-edged IOLs, only 1 patient reported any difficulties in daily visual tasks due to the presence of photic images, and none of the patients reported symptoms beyond 3 months postoperatively. This is not surprising given the relatively small group of patients studied and the fact that photic symptoms tend to be reported by younger patients with a high degree of critical awareness. This study has shown, however, that texturing the optic edge surface is very successful in reducing postoperative photic symptoms and has the potential to improve the quality of vision for patients.

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REFERENCES