Dysphotopsia in phakic and pseudophakic patients:

Incidence and relation to commonly used intraocular lenses

MS 194-99

Rob Tester, BA

Nathan Leon Pace, MD, Mstat

Matthew Samore, MD

Randall J. Olson, MD

University of Utah Health Sciences Center

Salt Lake City, Utah

Corresponding Author

Randall J. Olson, MD

Ophthalmology Department

John A. Moran Eye Center

50 N Medical Drive

Salt Lake City, Utah 84132

Telephone: (801)585-6622 FAX: (801)581-3357

Supported in part by a grant from Research to Prevent Blindness, Inc., New York, NY, to the Department of Ophthalmology, University of Utah.

The authors have no proprietary or financial interest in the products mentioned.
Abstract

**Purpose:** To determine the relationship between various intraocular lens types and incidence of unwanted light images.

**Setting:** The Moran Eye Center, University of Utah, Salt Lake City, Utah, USA.

**Methods:** A telephone questionnaire was administered to 302 postoperative patients who had received one of six commonly used intraocular lenses between January and September, 1998. Patients were included only if they had uncomplicated cataract surgery, no additional ocular pathology, and a best corrected postoperative vision of 20/25 or better. A control group of 50 patients with the diagnosis of presbyopia only also participated in the questionnaire. Patients reported on incidence of glare, light-sensitivity, and unwanted images. The data were analyzed for statistically significant relationships between incidence of photopsias and lens-type.

**Results:** AcrySof 5.5-mm, AcrySof 6.0-mm and SI40 had a significantly higher number of complaints of unwanted images as compared to the control ($P = 0.0014$). The two AcrySof lenses also had more complaints of light to the side causing a central flash and SI40 had a higher incidence of glare. The control group was more likely to experience symptoms of glare than any pseudophakic group. Overall, an average of 49% of patients reported some type of light-related complaints postoperatively. The majority of all groups reported being satisfied with their eyesight despite the light-related problems.
Conclusions: A significant number of pseudophakic patients suffer from dysphotopsia. Patients who receive an acrylic IOL with flattened edges are at increased risk of experiencing images associated with edge-reflections. The SI40 lens, although less than the AcrySof groups, showed a higher incidence of glare than the non-AcrySof groups; however, it also had the highest number still driving at night in this study. The phakic population commonly experiences glare reported as more severe than several IOL groups.

Synopsis: A total of 352 patients participated in a telephone questionnaire to determine the frequency and severity of IOL-related photopsias. Of six commonly used intraocular lenses, 5.5-mm and 6.0-mm AcrySof and to a lesser extent SI40 were found to have more complaints of unwanted images.
**Introduction**

Patients who have undergone cataract extraction with implantation of an intraocular lens (IOL) often complain of unwanted images. In the literature, such terms as "photopsias," "entoptic phenomena," and "photic phenomena" have been used to describe unwanted light images encountered by patients after undergoing implantation of an IOL. The authors introduce the term "dysphotopsia" to denote any light-related visual complaint encountered in phakic and pseudophakic patients. Dysphotopsias include flashes of light, increased light sensitivity, and worsened glare. Such dysphotopsias remain one of the most common sources of dissatisfaction amongst an otherwise satisfied pseudophakic population. These unwanted images are most often described as flashes, arcs, halos, or sprinkles of light usually encountered in scotopic light conditions in which the iris dilates, making the optic edge of the IOL more likely to reflect oblique light. Some patients report dysphotopsias only after specific inquiry; others are debilitated by the light phenomena and seek medical help or even request explantation.

Currently, it is debated whether the incidence of dysphotopsia is related to lens type, i.e. if patients with acrylic lenses have more complaints of aberrant light flashes than those with poly-methyl methacrylate (PMMA) or silicone. Anecdotal evidence suggests that acrylic lenses with flattened lens edges may have a higher degree of these unwanted images.¹,²

The purpose of this study was to (1) determine the incidence of dysphotopsia within the phakic and pseudophakic populations, (2) identify any correlation between the
incidence of dysphotopsia and specific IOL types, and (3) assess overall satisfaction with vision within the group of patients experiencing dysphotopsias.
Materials and Methods

A total of 302 postoperative patients were selected from the following six different IOL groups: AcrySof 5.5-mm \( (n=50) \), AcrySof 6.0-mm \( (n=51) \), SI-40 \( (n=50) \), Staar/Chiron plate haptic \( (n=51) \), 5.5-mm PMMA \( (n=49) \), and 6.0-mm PMMA \( (n=51) \). A seventh group of 50 patients diagnosed with presbyopia only and no other ocular pathology comprised a control group. All patients had undergone uncomplicated cataract surgery (or a standard eye exam in the case of the control group) between January 1, 1998 and September 30, 1998. Patients were included only if their best-corrected postoperative visual acuity was 20/25 or better and if the patient had no additional ocular pathology (other than well-controlled glaucoma with no visual deficits). All patients except those from the two PMMA groups had been operated on at the Moran Eye Center. Because PMMA lenses are rarely used at the eye center, patients for the 5.5-mm and 6.0-mm PMMA lens groups were selected from the clientele of local community physicians who commonly used these lenses. The same criteria for inclusion including uncomplicated phacoemulsification were used for the PMMA groups.

Patients were contacted by phone and a brief telephone questionnaire was administered (Table 1). Telephone interviews were conducted from January 1999 to May 1999. To avoid creating bias, the patient list was randomized before contact and resorted into the various groups after all calls had been made. All interviews were conducted by one investigator (RT). The results of patient responses were tabulated and analyzed for statistical significance. Of those patients contacted, 17 were excluded for reasons of language barriers, illness precluding their participation, deaths, and inability to understand the questions yielding a response rate of 95\% \( (352 \text{ of } 369) \). Table 2 provides
information about the mean patient age by lens group and the average number of days elapsed between procedure and date of contact.

Results

Not all questions reached statistical significance. Of the six IOLs tested, AcrySof 5.5-mm, AcrySof 6.0-mm and SI40 were found to have the highest incidence of dysphotopsia. These results are summarized in Table 3. Although the questionnaire asked for a graded response (i.e., minimal, annoying, debilitating), too few patients reported "annoying" or "debilitating" to make an analysis of the differences statistically significant. Therefore, the results in Table 3 are reported in a "no complaint" vs. "any degree of complaint" fashion.

Questions 2.1-2.4, intended to identify conditions that cause the most dysphotopsias, showed no significant differences between lens groups or the control. Twenty-three percent (81 of 352) of patients reported some degree of problem when driving into the sunset or sunrise. Twenty-six percent (93 of 352) of patients reported problems when going outside on a bright, sunny day. Six percent (22 of 352) had complaints in a brightly-lit supermarket. Twenty-nine percent (101 of 352) had problems with oncoming headlights at night.

The SI-40 and control groups had significantly more people still driving at night than all other IOL groups. Those patients who did not drive at night were asked if this
was secondary to light-related problems. Forty percent (36 of 90) responded “yes” with no statistical significance between groups.

Questions 4.1-4.5 ascertained the most common type of dysphotopsia experienced by patients. Eleven percent (38 of 352) of patients described seeing halos, 33% (117 of 352) described a generalized light sensitivity, 7% (23 of 352) reported light to the side causing a central flash, and 5% (19 of 352) described arcs of light seen to the side at night. As described in Table 3, only the reports of light to the side causing a central flash reached significance between lens groups and this was definitely associated with the AcrySof lens groups.

Of the 352 patients interviewed, 90% (318 of 352) reported being either very satisfied or satisfied with their corrected distance vision. Of those that did have complaints (reporting satisfied to very dissatisfied), only 14% (14 of 102) linked it in any degree to light-related problems, with no lens group showing a statistically significant difference regarding overall satisfaction.

**Statistical Analysis**

Sample size planning was performed with the simplifying assumption that only two groups (lens) were being compared. The principal investigator was asked to assign a typical set of scores for a lens with acceptable dysphotopsia and a lens with unacceptable dysphotopsia. A sample size of 48 in each group will have 80% power to detect such a difference. The software program nQuery Advisor 3.0 was used for sample size calculations.
For comparison between groups for ordinal variables, the Kruskal-Wallis rank sum test was used. For the comparison of continuous variables, one way analysis of variance was used. If statistically significant, all possible pairwise comparisons between groups were made. Statistical significance was asserted for $P < 0.05$. S-Plus statistical software version 3.4 was used for analysis of variance, Kruskal-Wallis, and pairwise comparison tests.

**Discussion**

In the last decade, several improvements to IOLs have been made in an attempt to eliminate edge-glare and other IOL related dysphotopsias. Positioning holes were eliminated after anecdotal complaints related them to unwanted images.\textsuperscript{3,4,5} Masket et al. suggested that ovoid intraocular lenses correlate with an incidence of dysphotopsia as high as 45% compared with 17% in round IOLs.\textsuperscript{6} He suggested that ovoid lenses had sharply truncated lens edges which, with iris dilation, became exposed on the short axis and increased the amount of edge-glare.\textsuperscript{7} Several follow-up studies were performed with differing results: Arnold\textsuperscript{8} reported only 20% of postsurgical patients complained of photic phenomena with no preference toward ovoid or round lenses, while Anderson et al.\textsuperscript{9} reported a statistically significant increase in the number of visual symptoms in patients with oval-optic IOLs. Armstrong reported an overall incidence of 18% of dysphotopsia when comparing 5 x 6-mm intraocular lenses to 6.5-mm round IOLs with no statistical difference between lenses.\textsuperscript{10} Regardless of the differences in reported incidence, general use of ovoid lenses fell from popularity, most likely due to this dysphotopsia concern.\textsuperscript{11}
The questionnaire in this study was designed to determine if a patient was experiencing any form of dysphotopsia. If the participant answered "yes" to any one of the questions 1.1-1.3, the entire questionnaire was administered in an effort to further determine the nature of the dysphotopsia. If they answered "no" to 1.1-1.3, then only question 6 was subsequently asked. In this way, the more general questions of "glare," "light sensitivity," and "unwanted images" were used as a screening tool to ascertain which patients were having problems, and the more detailed questions comprising the remainder of the questionnaire were asked of these patients only.

When considering complaints of unwanted images, an important concern is whether the patient is reporting edge-related images or photic phenomena associated with posterior vitreous separations. Although the questionnaire did not specifically attempt to separate the two, the incidence of complaints caused by posterior vitreous detachments should be statistically uniform across all pseudophakic groups and thus should not be a confounding factor.

We assumed that complaints of unwanted optical images would be related to two things: 1) Conditions of dim lighting, in which pupillary dilation makes it more likely for oblique light to reflect off the optic edge; 2) The size of the IOL would be expected to have a bearing on the number of complaints, specifically a smaller diameter IOL having more problems because a dilated pupil would expose its edge more easily. The questionnaire had a free response allowing patients to describe other unwanted images they were experiencing. The varied responses supported our assumptions about scotopic light conditions, with many patients describing very similar scenarios. For instance,
several participants recounted the scenario of walking into a movie theater and suddenly seeing many pin-point-lights ahead of them—the small overhead lights reflecting off the inferior edge of the IOL. Other stories were also similar: reading at night with a lamp to the side elicited flashes of light when the head was turned at the wrong angle; street lamps at night created crescent-shaped flashes of light. Many patients described a light source at an oblique angle under scotopic light conditions causing internal reflections off the edge of the IOL. This symptom was most commonly noted with the AcrySof groups. Some knew exactly what was causing these images and could solve the problem by adjusting the angle of their head. Others were surprised and somewhat relieved that they were not alone in experiencing these unwanted images.

The numbers did not support our second assumption that a smaller diameter IOL would have a greater incidence of rim-effects. Questions 1.3, 4.3, and 4.4 dealt with edge-glare and showed that AcrySof 5.5-mm, although showing more complaints than control or Staar/Chiron, did not vary statistically from the larger diameter AcrySof 6.0-mm lens. The 5.5-mm and 6.0-mm PMMA groups also did not vary statistically.

The acrylic lenses in this study were shown to have a higher incidence of edge-related complaints. Both AcrySof 5.5-mm and AcrySof 6.0-mm had more complaints than other lens groups of unwanted images and specifically of light to the side causing a central flash, a phenomenon fairly specific to edge-glare. We suggest that this increase in unwanted flashes is directly attributable to the AcrySof’s flattened lens-edge. Holladay et al. has recently shown with ray-tracing analysis that lenses with “cropped” edges have an increased potential to focus reflections of light from the lens edge onto the retina in
arc-shaped images. Interestingly, the numbers in our study show that patients are not likely to discern the shape of an arc, but are more likely to report a simple, central flash of light. Our own experience with a growing list of AcrySof patients demanding explantation for dysphotopsia confirms the fact that any rounded edge lens is effective in either eliminating or dramatically decreasing the patient's complaints.

The higher incidence of dysphotopsia reported by the SI40 patient group was surprising. The concerns were non-specific and not consistent with the fact that the SI-40 group had statistically more patients driving at night than any other lens group. This suggests positive attributes for a very difficult optical task: night driving. We have no good explanation for these contradictory findings and expect one or the other is a false positive. Because the lens profile is most like the Starr/Chiron group (though it did better than Starr/Chiron in regard to night driving), its actual dysphotopsia profile is also probably similar to or better than Starr/Chiron. Furthermore, the SI-40 lenses have been very effective in eliminating patient complaints after lens exchange for dysphotopsia due to AcrySof lenses. Admittedly, this area of outcomes research is in its infancy and is in need of further exploration.

The control group in this study was selected as a random group of 50 patients seen at the Moran Eye Center who only had the diagnosis of presbyopia (no cataract) with a best-corrected visual acuity of 20/25 or better. A control group devoid of ocular pathology with an average age comparable to the pseudophakic groups would be nearly impossible to fine, so the average age of our control was by necessity younger than that of the other groups. We expected this group to experience a minimal amount of
dysphotopsia. However, the control actually had more complaints in some areas than several of the IOL groups. For instance, when reporting the incidence of dysphotopsia (questions 1.1-1.3), the control group had a significantly higher number of complaints of glare than Staar/Chiron and the two PMMA groups. In fact, the only area in which the control group performed markedly better was question 1.3 about unwanted images. We explain these findings by acknowledging that questions 1.1 and 1.2 may describe phenomena experienced by people in the general population who have either early formation of cataract or other age-related increases in light sensitivity. The average age of the control group was 46.5 years with a range of 32 to 64 years. In that age group the development of early cataract not detected on the recent eye examination is certainly plausible. This could account for the high number of complaints of glare and sensitivity in this group. Also, the younger patients in the control group may be more alert and likely to report any visual problems. However, even if these patients were developing early cataracts, we would not expect reports of unwanted images, a premise supported by the numbers in this study. Within the 50 control patients, there were 11 (22%) complaints of glare and 17 (34%) complaints of increased light sensitivity, while only 2 (4%) patients had complaints of unwanted images. Question 1.3 made it clear that pseudophakic patients experienced more unwanted images than the general population. Of these pseudophakic patients, those with AcrySof and the SI40 lenses had higher number of complaints than other lens groups.

The control group also had the highest incidence of complaints on questions 2.1-2.4. These questions, meant to shed light on the types of situations most likely to elicit unwanted light images, showed that phakic patients actually had more complaints about
driving into the sunset and oncoming headlights than did any pseudophakic group. In addition, when questioned about problems in a bright-lit supermarket, only the SI40 group had as many complaints as the control group.

No lens group was predictive of whether the patient would have problems driving. The control group had a significantly larger number of night-drivers than did the other IOL groups. This is to be expected because the average age in the control group was much younger. In fact, the percentages of those who were still driving at night correlated inversely with the average age of the lens-group. Of those patients who no longer drive, the percent who discontinued driving specifically because of light-related problems ranged from 18% (Staar/Chiron; 2 of 11) to 57% (PMMA 5.5-mm; 8 of 14). Interestingly, the SI40 group had the greatest number still driving.

Overall, patients reported being happy with their surgical outcomes despite unwanted photic phenomena. This study supports the initial assumption that, although many patients suffer from some degree of dysphotopsia, the vast majority of patients are not bothered by it. Based on the degree of satisfaction experienced even by those patients experiencing dysphotopsia, it is indeed a rare occurrence that a patient would be so bothered by unwanted images that explantation is requested.

It is important to consider the amount of time elapsed between the procedure and contact date because, as time goes by, opacification of the anterior capsule may shield the optic edge from light thus protecting the patient from edge-effects. The two PMMA groups had the longest period of time elapsed since surgery before contact was made. In
the PMMA 6.0-mm group, in order to complete a cohort of 50 patients, contacts had to extend back to a surgery date of 5/97 because the 6.0-mm was so scarcely used. This unfortunate discrepancy in post-operative time frames was unavoidable in this type of retrospective study and may admittedly account for some degree of error in the findings. If the anterior capsule had opacified in this lens-group more than in others, one would expect to find fewer complaints of edge-effects (e.g., questions 1.3, 4.3, and 4.4). However, on question 1.3, the PMMA 6.0-mm had more complaints than Staar/Chiron. Patients in the PMMA 6.0-mm group also had as many complaints of arcs of light noticed to the side at night as Staar/Chiron and nearly as many as AcrySof 6.0. These findings suggest that any amount of additional opacification of the anterior capsule in the PMMA 6.0-mm group played little role in the number of edge-related complaints.

Conclusions

This study shows that dysphotopsia is still a common problem in the postsurgical, pseudophakic population. Although the average patient is very satisfied with the visual results of cataract surgery, elimination of rim-effects is still an area in need of improvement. Patients who receive acrylic lenses with flattened edges are at a significantly higher risk of experiencing unwanted images when compared to lenses with rounded edges. Patients in the general phakic population commonly experience dysphotopsia. Specifically, complaints of glare and eye sensitivity occur more often in phakic patients than in the postsurgical groups.

Acknowledgement: Special thanks to John C. Nelson, MD and John W. Nichols, MD.
References


Table 1: Telephone Questionnaire

1. Since your surgery, have you noticed any:

1.1 Light-caused glare (like driving into the sun with a dirty windshield)?

If yes, is it

- Minimal (Score 1)
- Annoying (Score 2)
- Debilitating (Score 3)

1.2 Increase in eye sensitivity (like when looking into high beams at night)

If yes, is it

- Minimal (Score 1)
- Annoying (Score 2)
- Debilitating (Score 3)

1.3 Unwanted images (such as beams of light, flashes of light, or partial circles of light off to the side of a light source)?

If yes, is it

- Minimal (Score 1)
- Annoying (Score 2)
- Debilitating (Score 3)

If no, score=0. Skip to number 5 if no to all.
2. Please evaluate your light-caused problems under the following situations:

(Same 0-3 scale as above)

2.1 Driving into the sunset or sunrise (0-3)

2.2 Bright sunny day at noon (0-3)

2.3 Brightly lit supermarket (0-3)

2.4 Oncoming headlights at night (0-3)

3. Do you drive at night? Yes or No

If no, are light-related eye problems the main reason why? Yes or No

4. How would you best describe the unwanted images:

4.1 Halo around lights? Yes or No

If yes, is this the main or a minor symptom?

4.2 Generalized light sensitivity? Yes or No

If yes, is this the main or a minor symptom?

4.3 Light to the side causes a central flash? Yes or No

If yes, is this the main or a minor symptom?

4.4 Arcs of light are noticed off to the side at night? Yes or No

If yes, is this the main or a minor symptom?

4.5 Other unwanted images? Please describe.

5. In regards to your current corrected distance vision, would you say you are:

0 - Very satisfied

1 - Satisfied
6. **If satisfied to very dissatisfied, how much of your dissatisfaction is related to unwanted images?**

   0 - None  
   1 - A little  
   2 - 50%  
   3 - Most  
   4 - All  

Thank you for your time and participation in this study.
Table 2: Median Patient Ages and Time Elapsed Between Procedure and Contact Dates

<table>
<thead>
<tr>
<th>Intraocular Lens Group</th>
<th>The Median Patient Ages by Group</th>
<th>The Average Time in Days Elapsed Between Procedure and Date of Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>AcrySof 5.5-mm</td>
<td>75</td>
<td>163</td>
</tr>
<tr>
<td>AcrySof 6.0-mm</td>
<td>71</td>
<td>183</td>
</tr>
<tr>
<td>S140</td>
<td>74.5</td>
<td>232</td>
</tr>
<tr>
<td>Staar/Chiron</td>
<td>76</td>
<td>224</td>
</tr>
<tr>
<td>PMMA 5.5-mm</td>
<td>67</td>
<td>299</td>
</tr>
<tr>
<td>PMMA 6.0-mm</td>
<td>77</td>
<td>341</td>
</tr>
<tr>
<td>Control</td>
<td>46.5</td>
<td>181</td>
</tr>
</tbody>
</table>
Table 3: Percentage of Patients Reporting any Degree of Light-related Eye Complaints (questions 1.1-1.3)

<table>
<thead>
<tr>
<th></th>
<th>Glare(%)</th>
<th>Sensitivity(%)</th>
<th>Unwanted Images(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AcrySof 5.5-mm**</td>
<td>26</td>
<td>34</td>
<td>30*</td>
</tr>
<tr>
<td>AcrySof 6.0-mm†</td>
<td>12</td>
<td>37</td>
<td>35*</td>
</tr>
<tr>
<td>SI40‡</td>
<td>20</td>
<td>38</td>
<td>24*</td>
</tr>
<tr>
<td>Staar/Chiron</td>
<td>6*</td>
<td>33</td>
<td>12</td>
</tr>
<tr>
<td>PMMA 5.5-mm</td>
<td>6*</td>
<td>33</td>
<td>18</td>
</tr>
<tr>
<td>PMMA 6.0-mm</td>
<td>4*</td>
<td>25</td>
<td>18</td>
</tr>
<tr>
<td>Control</td>
<td>22</td>
<td>34</td>
<td>4</td>
</tr>
</tbody>
</table>

*Reached significance when compared to control

** AcrySof 5.5-mm had more complaints of light to the side causing a central flash than did the control group, PMMA 5.5-mm, and PMMA 6.0-mm (p=0.0061). This lens also had more glare than Staar/Chiron, PMMA 5.5-mm, PMMA 6.0-mm and AcrySof 6.0-mm (p=0.0027).

† AcrySof 6.0-mm also showed more complaints of light to the side causing a central flash than did control, PMMA 5.5-mm, PMMA 6.0-mm, and Staar/Chiron (p=0.0061).

‡ SI40 had more complaints than PMMA 6.0-mm of light to the side causing a central flash (p=0.0061). In addition, every lens but SI40 had statistically fewer night-drivers than the control group (p=0.0167). SI40 also had more complaints of glare than did Staar/Chiron, PMMA 5.5-mm and PMMA 6.0-mm (p=0.0027).
1 Masket S. Consultation Section, Cataract Surgical Problem. J Cataract Refract Surg 1998; 24:1554-1561

2 Masket S. Consultation Section, Cataract Surgical Problem. J Cataract Refract Surg 1997; 23:979-984


7 Waller S, Steinert R. Symptomatic Intraocular Reflections From Oval Intraocular Lens Implants. Am J Ophth September 1993; 374-375


