ARTICLE

Surgical management of positive dysphotopsia: U.S. perspective

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Purpose: To evaluate clinical outcomes of intraocular lens (IOL) exchange for intolerable positive dysphotopsia (PD).

Setting: Private practice, Advanced Vision Care, Los Angeles, California, USA.

Design: Retrospective review, case series.

Methods: Fifty-six eyes of 46 pseudophakic patients requiring surgical management of PD between 2013 and 2019 were reviewed. Thirty-seven eyes had PD alone and 19 had combined negative dysphotopsia and PD. Inclusion criteria: corrected distance visual acuity of 20/30 or better without significant corneal, retinal, or optic nerve pathology. Exclusion criteria: corneal, macular, or optic nerve disease and multifocal dysphotopsia alone (defined patterns of concentric multiple halos or spider web patterns when looking at a point source of light). Primary outcome measure was improvement or resolution of self-reported PD symptoms by 3 months postoperatively. Secondary outcome measures included analysis of intraocular lenses (IOLs) that induced PD for IOL material, index of refraction, and edge design.

Results: IOL materials successful in the alleviation of PD symptoms were as follows: 20 (87.8%) of 33 silicone, 15 (76.2%) of 21 copolymer, and 2 poly(methyl methacrylate) (100%). However, when considering IOL exchange for an acrylic to silicone optic or acrylic to collamer optic, the percentages of improvement are indistinguishable at 87% and 88%, respectively.

Conclusions: PD symptoms might be improved by changing the IOL material and, therefore, index of refraction. Although edge design plays an important role in etiology, changing the IOL material to a lower index of refraction may prove to be an effective surgical strategy to improve intolerable PD.

J Cataract Refract Surg 2020; 46:1474–1479 Copyright © 2020 Published by Wolters Kluwer on behalf of ASCRS and ESCRS

Positive (PD) and negative dysphotopsia (ND) represent unanticipated optical phenomena occurring after uneventful, seemingly "perfect" cataract surgery. They are likely in part related to intraocular lens (IOL) design and surgical methods. PD is described by patients as light streaks, light arcs, flashes, halos, and starbursts, which are all induced by an external light source, and ND is a temporal arc-shaped dark shadow that is typically stimulated by temporally oriented light sources.[1] The etiology and symptomatology of PD and ND are different; however, they can coexist in the same patient.[1] Although ND scotomas might be plotted with Goldmann kinetic perimetry, there are no specific objective tests to diagnose PD; the clinician relies primarily on patient-reported outcomes.[2,3] Moreover, there are some atypical cases in symptoms, causes, and course of both conditions that make diagnosis and treatment potentially more difficult.

Dysphotopsia is a leading cause of patient dissatisfaction after cataract surgery. Tester et al, in an earlier report indicated that 49% of patients had either PD or ND some time after cataract surgery.[4] In addition, Bournas et al. reported that 19.5% of patients complained of dysphotopsia on the first postoperative day.[5] PD must be distinguished from entoptic light flashes caused by vitreoretinal traction and a Maddox rod effect, which is caused by posterior capsule striae; the latter might be managed by posterior capsulotomy. Similarly, a fluttering of light might be experienced in the early postoperative period that resolves as the capsular bag fibroses around the implant and is not considered as PD. Finally, entoptic phenomena might occur under dark conditions, unlike PD, which requires an external light source to induce symptoms.[6] Because we have previously published our clinical experience with ND, this investigation will focus on PD.[7]

The etiology of PD is most likely multifactorial.[8] IOL design, material, and optic size have all been reported as causative factors.[1,5] PD induced by the truncated edge of ovoid IOLs was first reported by Masket et al.[9] They used ray tracing and reflectometry to demonstrate that light of oblique incidence (approximately 35 degrees) can strike the truncated square edge of the IOL and reflect onto the retinal surface inducing symptoms.[9] Prior to foldable IOLs, rigid poly(methyl methacrylate) (PMMA) IOLs were in use.

Submitted: March 24, 2020 | Final revision submitted: May 28, 2020 | Accepted: June 1, 2020

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0886-3350/$ - see frontmatter
https://doi.org/10.1097/j.jcrs.0000000000000307

Oval PMMA IOLs were fabricated by truncating parallel edges of the round optic so that the IOL was implantable through a smaller incision. Although the truncated edge seems partly responsible for PD, square edge design remains in common use because it reduces posterior capsule opacification by inhibiting the migration of equatorial lens epithelial cells along the posterior capsule.[10] Supporting the theory that square IOL edges contribute to PD, the work of Holladay et al has shown that square edges concentrate stray light into an arc on the retina opposite to the image of the light source, whereas round-edged IOLs disperse stray light over a larger portion of the retina, thus reducing PD symptoms.[11] Franchini et al also found that square edge design is associated with halos, rings, and arcs of light and suggested that rounding the anterior edge of a square-edged IOL might be beneficial; that concept was later addressed by the ophthalmic industry.[12] Texturing the square edge can also contribute to reduction of PD, as demonstrated in a double-blinded trial.[13] This strategy is in use by the ophthalmic manufacturing industry. In addition to theoretical findings, clinical experience also suggests that square-edged IOLs play a role in the development of PD.[14,15]

High refractive index IOLs are associated with higher rates of PD due to internal reflection from the IOL surfaces. Erie et al. also demonstrated that biconvex IOL design and flat anterior radius of curvature play a role in the etiology of PD.[16]

Several authors found that PMMA and round-edged silicone IOLs were associated with decreased incidence of PD. These studies also suggest that square edge design is associated with a higher incidence of PD irrespective of IOL material.[1,5,14] Overall, the ophthalmic industry addressed PD by rounding the anterior aspect of the square edge, reducing square edge thickness, leaving the IOL edge unpolished, and moving the IOL optical power more to the anterior rather than the posterior optic surface.

Conservative treatment methods for PD include correction of any refractive error, treatment of any coexisting ocular surface disease, treatment of posterior capsule opacification, and pharmacologic miosis.[8] Potentially, other opportunities to reduce PD include using IOL materials with a lower index of refraction (IR) or reduced surface reflectivity. IOL exchange to PMMA or silicone IOLs in the capsular bag or sulcus has also been reported to be generally successful.[1] However, fully round-edged silicone IOLs are no longer available in the U.S. market, and PMMA IOLs are rigid and require large incisions, limiting their use.

Given that PD might be highly symptomatic, we elected to review our results in surgical management of this disturbing consequence of otherwise uneventful cataract surgery. Moreover, some patients had combined ND and PD. Previously, we have reported our outcomes regarding management of ND and when PD and ND coexist.[7]

METHODS

A nonrandomized retrospective review of 56 eyes of 46 patients (13 men, 33 women) with an average age of 66 years, requiring surgical management of intolerable PD between March 2013 and May 2019 in a private practice setting by surgeons S.M. and N.F. (Advanced Vision Care) was performed. The study adhered to the tenets of the Declaration of Helsinki and received IRB approval as a retrospective investigation.

Patients and Cases

Thirty-seven (66.1%) of 56 eyes had isolated PD, and the remaining 19 eyes (33.9%) had a combination of ND and PD. PD was defined as glare, light streaks, arcs of light, starbursts, or halo in the operated eye in an otherwise anatomically normal pseudophakic eye. Attention was made to ensure that the symptoms were not entoptic or caused by a Maddox rod effect from radial striae in the posterior capsule. For the purpose of this study, diffractive optic and multifocal dysphotopsias were considered as a defined pattern of concentric halos or spider web starburst around point sources of light and were not categorized as pseudophakic PD, although patients with diffractive optic IOLs and true PD symptoms were included in the study. PD symptoms were specifically defined as light arcs, light streaks, shimmering, flickering, halos, and nonconcentric starbursts persisting for greater than 1 month postoperatively. Other symptoms were described as a "flashlight" emanating from a white surface. It is important to note that some patients will note fluttering or shimmering in the early postoperative period that reduces as the capsule bag fibroses around the posterior chamber IOL (PC IOL). This subjective finding alone was not defined as PD. Of note, persistent (temporal only) flickering or shimmering has been reported with some cases of ND. This phenomenon has not been well investigated.

ND was defined as a subjective temporal dark arc, line, or shadow in an otherwise anatomically normal pseudophakic eye. All patients had a history of uneventful phacoemulsification with a well-centered PC IOL in the capsular bag. Subjects were existing patients of Advanced Vision Care, referred by other ophthalmologists, or were self-referred. Patients were not age or sex matched, and there was no control group because this was a retrospective investigation. There were no deviations from the follow-up schedule of 1 day, 1 week to 2 weeks, 3 to 4 months, and 1 year. PD and ND symptoms were self-reported; thus, no formal questionnaires were used. Eyes with a history of corneal refractive surgery, corneal transplantation, or retinal pathology were excluded from the study.

Inclusion Criteria Patients with corrected distance visual acuity of 20/30 or better and no significant corneal, retinal, or optic nerve pathology were included. Note that patients with LASIK/photorefractive keratectomy were included in the study as long as they had a centered ablation and no symptoms of glare or starburst prior to the original cataract surgery.

Exclusion Criteria Patients with corneal, macular, or optic nerve disease, multifocal dysphotopsia alone (defined patterns of concentric multiple halos or spider web patterns while looking at a point source of light), and malpositioned or dislocated PC IOLs were excluded.

Outcome Measures

The primary outcome measure was improvement or resolution of self-reported PD by 3 months postoperatively. For the purpose of this investigation, only the results of treatment for PD are included, although some cases had combined PD/ND. The results for management of ND in those particular cases have been previously reported.[7] Secondary outcome measures included analysis of the PD inciting IOLs, IOL materials, IR, and edge design.

Surgical Technique

Surgeries were performed by 1 of 2 surgeons (S.M., N.F.). Surgical strategies included bag-to-bag PC IOL exchange, bag-to-sulcus IOL exchange (including cases with iris suture fixation [ISF] for stability), and reverse optic capture (ROC) with IOL exchange. Incision sizes varied from 2.2 to 7.0 mm depending on the technique required to remove and replace the existing IOL. For a clear corneal entry, the incision size ranged from 2.2 to 3.5mm. For eyes requiring a scleral tunnel, incision size ranged from 5.0 to 7.0 mm. Sutures or wound sealants were used when appropriate.

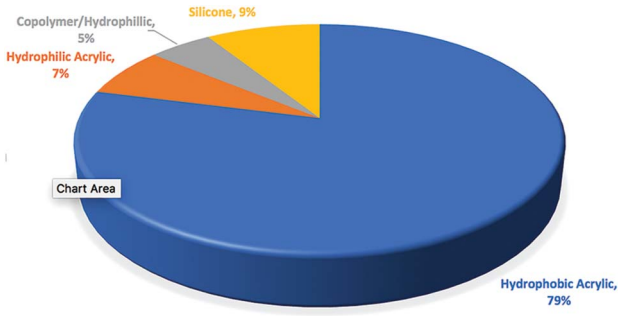

Figure 1. Percentages of inciting intraocular lens material associated with positive dysphotopsia.

Bag-To-Bag Exchange

This technique involved the removal of the original IOL and the replacement of a different IOL in the capsular bag. This concept required an intact anterior capsulotomy and posterior capsule. This method was applied for patients with isolated PD symptoms; this strategy was not applied to any patients with combined PD/ND.

Exchange of PC IOL with Reverse (Anterior) Optic Capture

Patients in this surgical category experienced both ND and PD symptoms. Surgery for this group involved removal of the originally placed IOL from the capsular bag and replacement with a different IOL in a ROC position. PD symptoms were addressed by changing the material or design of the IOL, and the ND symptoms were addressed by placing the IOL in the ROC position with the haptics at 6 and 12 o'clock positions and the optic above the (nasal and temporal) anterior capsule.[7] This method required an appropriately sized and centered anterior capsulotomy.

Capsule Bag to Ciliary Sulcus with Optic Capture

Patients with an adequate continuous anterior capsulotomy had the inciting IOL removed and a new 3-piece IOL placed with the haptics in the sulcus and the optic behind the anterior capsule in the optic capture position. This strategy was only applied for pure PD with an appropriate anterior capsulotomy and adequate integrity of the zonule. It was used for those cases with an open posterior capsule, precluding in the bag fixation.

Ciliary Sulcus PC IOL Exchange

An existing PC IOL was removed from the capsular bag and replaced (for PD) with a 3-piece IOL in the ciliary sulcus. This strategy was used if the posterior capsule was open and not suitable for an in-the-bag placement or if the patient also had ND and the capsule could not accommodate ROC positioning. It was opted to use ISF with 10-0 polypropylene for long-term fixation stability. This technique was used in cases with either PD or combined ND/PD when the condition of the capsule bag so dictated. Note that secondary IOLs were not passively placed in the sulcus due to the concern of movement or dislocation over time.

The decision regarding which IOL to use for exchange and how to fixate it was made on the basis of the inciting IOL, the condition of the anterior capsulotomy, the status of the posterior capsule, and unforeseen intraoperative observations. The existing inciting IOLs associated with PD symptoms are depicted in Supplemental Figure 1 (available at, http://links.lww.com/JRS/A169 and http://links.lww.com/JRS/A170) and Figure 1. The materials of the existing IOLs were hydrophobic acrylic in 44 (79%) of 56 cases, hydrophilic acrylic in 4 (7%) of 56 cases, silicone in 5 (9%) of 56 cases, and copolymer in 3 (5%) of 56 cases. The IOL material, IR, and edge design are listed in Table 1.

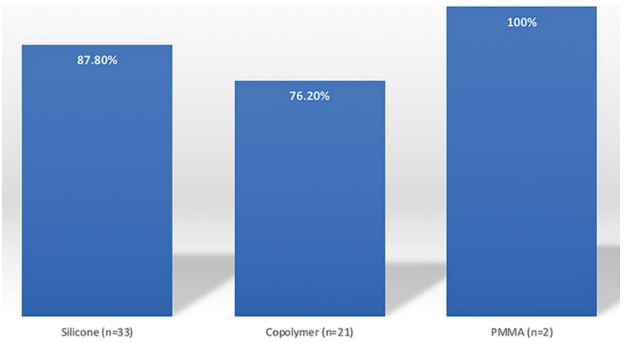

Figure 2. Success rate for overall IOL material exchanged. IOL materials that resulted in improvement of PD symptoms (all eyes). Note the CZ70BD IOL number is too small for relevant comparison [PMMA = poly(methyl methacrylate)].

RESULTS

The study comprised of 56 eyes of 46 patients. There were 37 eyes of 30 patients with PD and 19 eyes of 16 patients with PD and ND. In total, there were 56 procedures to treat PD, and there were 8 treatment failures after a single procedure. Of the 8 failures, 3 eyes had an additional IOL exchanges and achieved success (see Discussion section). Five treatment failure eyes had no additional surgery because the patients declined. Of note, no patients' symptoms were worsened by surgery.

IOLs used at surgical exchange were copolymer (Collamer, STAAR Surgical), silicone (STAAR Surgical, Bausch & Lomb, Inc., and Johnson & Johnson Vision Inc.), and PMMA (Alcon Laboratories, Inc.). The implanted IOL models used for exchange are depicted in Table 2. It should be recognized that the 3-piece Collamer IOL (CQ2015A, STAAR Surgical) and 3-piece silicone IOL (AQ2010V, STAAR Surgical), used during the study period, are no longer available in the marketplace; the other IOLs remain in use.

The percentage of patients who reported resolution of PD with each implanted IOL as follows: LI61AO IOL (Bausch & Lomb, Inc.), 24 (88.8%) of 27 cases; AQ2010V IOL, 4 (80%) of 5 cases; ZA9002 IOL (Abbott Medical Optics, Inc.), 1 (100%) of 1 case; CC4204A IOL (STAAR Surgical Company), 1 (100%) of 1 case; CQ2015A IOL, 15 (75%) of 20 cases; and CZ70BD IOL (Alcon Laboratories, Inc.), 2 cases (100%). These numbers are too small for statistical comparisons.

IOL materials that were successful in the alleviation of PD symptoms were as follows: 20 (87.8%) of 33 silicone IOLs, 15 (76.2%) of 21 copolymer IOLs, and 2 PMMA IOLs (100%) (Figure 2). However, when considering IOL exchange for an acrylic to silicone optic or acrylic to collamer optic, the percentages of improvement were indistinguishable at 87% and 88%, respectively (Figure 3).

DISCUSSION

PD is among the chief causes of patient discontent after otherwise uneventful contemporary cataract surgery and represents a challenge for patients, the profession, and the manufacturing sector.[4] Although most patients report spontaneous resolution of symptoms and others benefit from topical miotic therapy, some experience persistent PD that might impact vision and quality of life.

Table 1. Positive dysphotopsia inciting IOLs: index of refraction and edge/optic design.

Inciting PC IOL	IOL Material	Refractive Index	Manufacturer	Edge Design	Optic Design
ZCB00*	Hydrophobic acrylic	1.47	Johnson & Johnson Vision	Frosted, posterior square	1-piece, aspheric, 6.0 mm optic lenticular biconvex
ZCTXXX*	Hydrophobic acrylic	1.47	Johnson & Johnson Vision	Frosted, posterior square	1-piece, aspheric, 6.0 mm optic lenticular biconvex
ZMB00*	Hydrophobic acrylic	1.47	Johnson & Johnson Vision	Frosted, posterior square	1-piece, aspheric, 6.0 mm optic lenticular biconvex
ZKB00*	Hydrophobic acrylic	1.47	Johnson & Johnson Vision	Frosted, posterior square	1-piece, aspheric, 6.0 mm optic lenticular biconvex
ZXTXXX*	Hydrophobic acrylic	1.47	Johnson & Johnson Vision	Frosted, posterior square	1-piece, aspheric, 6.0 mm optic lenticular biconvex
ZXR00*	Hydrophobic acrylic	1.47	Johnson & Johnson Vision	Frosted, posterior square	1-piece, aspheric, 6.0 mm optic lenticular biconvex
SN60WF	Hydrophobic acrylic	1.55	Alcon	Square	1-piece, aspheric, 6.0 mm optic biconvex
SN6ATX	Hydrophobic acrylic	1.55	Alcon	Square	1-piece, aspheric, 6.0 mm optic biconvex
SN6AD1	Hydrophobic acrylic	1.55	Alcon	Square	1-piece, aspheric, 6.0 mm optic biconvex
Softec HDO	Hydrophilic acrylic	1.43	Lenstec	Square, oval optic	1-piece, aspheric, 5.75 mm × 6.5 mm oval optic biconvex
Akreos AO60	Hydrophilic acrylic	1.46	Bausch & Lomb	Square	1-piece, aspheric, 6.0 mm optic biconvex
AQ2010V	Silicone	1.41	STAAR Surgical	Round	3-piece, spherical, 6.3 mm carrier and 6.0mm optic biconvex
L161AO	Silicone	1.43	Bausch & Lomb, Inc.	Square	3-piece, aspheric, 6.0 mm optic biconvex
ZA9002*	Silicone	1.46	Johnson & Johnson Vision	Rounded anteriorly, square posteriorly	3-piece, aspheric, 6.0 mm optic biconvex
Crystalens AO	Silicone	1.43	Bausch & Lomb	Square	1-piece, aspheric, 5mm optic biconvex
CC4204A	Collamer/copolymer	1.44	STAAR Surgical	Plate haptic	1-piece, aspheric, 6.0 mm optic biconvex
CQ2015A	Collamer/copolymer	1.44	STAAR Surgical	Rounded anteriorly, square posteriorly	3-piece, aspheric, 6.0 mm optic biconvex

*Effective optic diameter varies inversely with IOL power.

Regarding etiology, it seems clear that PD is related to IOL material, IR, and square edge design. Masket et al first demonstrated that the truncated square edge of an IOL could induce internal reflection and resulting PD symptoms.[9] Currently, all foldable IOLs available in the United States have some form of posterior square edge. Nevertheless, from the seminal work of Nishi et al., we know that the IOL square edge is associated with very significant retardation of posterior capsule opacification and, therefore, remains in popular use.[10] Although there are a number of proprietary edge design concepts to reduce PD, such as chamfering or using a round anteriorly curved edge (ie, Johnson & Johnson

Table 2. PC IOLs used to treat positive dysphotopsia: index of refraction and edge design.

PC IOL	IOL Material	Manufacturer	Refractive Index	Edge Design	Optic Design
CZ70BD	PMMA	Alcon	1.49	Round thin	1-piece, spherical, 7.0 mm optic biconvex
AQ2010V	Silicone	STAAR Surgical	1.41	Round	3-piece, spherical, 6.3 mm carrier and 6.0mm optic biconvex
L161AO	Silicone	Bausch & Lomb	1.43	Square	3-piece, aspheric, 6.0 mm optic biconvex
ZA9002	Silicone	Johnson & Johnson Vision	1.46	Rounded anteriorly, square posteriorly	3-piece, aspheric, 6.0 mm optic biconvex
CC4204A	Collamer/copolymer	STAAR Surgical	1.44	Plate haptic	1-piece, aspheric, 6.0 mm optic biconvex
CQ2015A	Collamer/copolymer	STAAR Surgical	1.44	Rounded anteriorly, square posteriorly	3-piece, aspheric, 6.0 mm optic biconvex

PMMA = poly(methyl methacrylate)

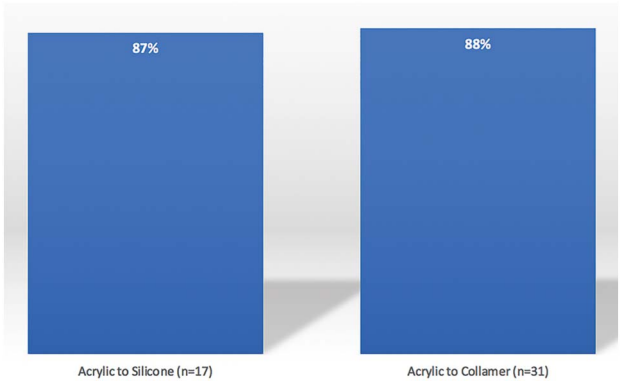

Figure 3. IOL materials that resulted in improvement of PD symptoms (acrylic only as the inciting IOL) (PD = positive dysphotopsia).

TECNIS Optiedge and STAAR Surgical CQ2015A IOLs), PD persists as a clinical problem, although not well studied epidemiologically. Eire et al. also reported that anterior and posterior radii of curvature play a role in etiology of PD. In accordance with their theory, a very flat anterior IOL radius of curvature (<17.0 mm) might induce PD symptoms because light rays might be reflected to the retina from the internal aspect of the anterior curvature of the IOL optic.[16] For this reason, most current IOL designs are either equally biconvex or have greater power on the anterior surface.

We believe that IOL material might also play a sizeable role in the etiology of PD. High IR is generally associated with high surface reflectivity and a greater chance for internal light reflection. However, Radmall et al, found that when comparing ZCB00 (IR 1.47) with SN60WF (IR 1.55) IOL platforms, there was no difference in incidence of PD symptoms.[17]

The data of this study reveal that, overall, 79% of the inciting IOLs in this study were of hydrophobic acrylic material and, overall, 86% had some form of an acrylic IOL (including hydrophilic material). For patients with only PD, we found that 30 (81%) of 37 patients had hydrophobic acrylic IOLs as the inciting device. However, it should be recognized that approximately 85% of currently implanted IOLs in the U.S. market are fabricated from that material.[A] However, PD has been associated with virtually all IOL materials and it seems that edge design is the greatest contributing factor. That being said, our present strategy to manage PD surgically requires use of an IOL with a lower IR than the inciting IOL because all foldable IOLs in use in the United States have some form of a square edge. Only rigid (PMMA) IOLs are available without square edges.

Although PD seems to be related to IOL material and edge design, from our previous work, it is evident that ND is more related to IOL position and not specific to IOL material or design; as a result, ND requires a different management strategy.[7] However, the 2 conditions might coexist or have overlapping symptoms. When both are present, chronic and unresponsive to conservative measures, surgery must approach both conditions. In this investigation, we report our results for surgical management of patients with chronic PD for whom miotic therapy failed or was otherwise unacceptable to the patient. However, some of the cases required simultaneous management for both conditions; we have previously reported our results for surgical management of ND when combined with PD.[7]

Overall, in this investigation, we performed corrective (secondary) surgery for PD in 56 eyes of 46 patients; a total of 56 procedures were performed because some eyes required more than 1 corrective procedure. Regarding cases with both ND and PD, we performed IOL exchange to manage the PD aspect of the condition and used ROC (anterior) for ND in a single combined procedure for 10 of 19 cases with ND/PD; the 9 remaining cases had IOL exchange to the sulcus (with ISF) to accomplish both IOL material change for PD symptoms and the optic placed above the (nasal) anterior capsule to alleviate ND symptoms as previously published.[7] With these strategies, we successfully managed PD in 16 (84%) of 19 eyes in the ND/PD group. As noted in Supplemental Tables 2 and 3 (available at, http://links.lww.com/JRS/A171 and http://links.lww.com/JRS/A172), for this group, 9 eyes received an LI61AO IOL of which 7 were successful, 7 eyes received a CQ2015A IOL of which 6 were successful, and 2 eyes received an AQ5010V IOL; both were successful. One patient received a CZ70BD IOL placed in the sulcus alleviating both ND and PD.

IOL exchange surgery failed to improve PD symptoms in 8 patients and 5 of those opted against additional surgery; however, 3 patients requested further assistance, and they were considered as separate case numbers as can be noted in Supplemental Tables 2 and 3 (available at, http://links.lww.com/JRS/A171 and http://links.lww.com/JRS/A172). Cases 16 and 17 concern a 56-year-old man who had a toric IOL (SN6AT3, Alcon Laboratories, Inc.) implanted at initial surgery. PD symptoms ensued, and the IOL was exchanged for a Collamer IOL (CQ2015A), but the patient noted no reduction of symptoms. At a third surgery, the second IOL was exchanged for a 7.0 mm PMMA IOL (CZ70BD) with improved PD symptoms. Cases 20 and 21 concern a 61-year-old man who had a hydrophilic Akreos AO60 IOL (Bausch & Lomb, Inc.) placed at initial cataract surgery with resultant PD symptoms. At IOL exchange surgery, he received a 3-piece Collamer IOL (CQ2015A) placed in the ciliary sulcus and supported by ISF; PD symptoms did not abate, and a second exchange for a 3-piece silicone IOL (LI61AO) placed with ISF was successful in eliminating PD. Moreover, a 52-year-old man, who was considered as 3 separate cases (50, 51, and 52), was referred initially for PD associated with a truncated ovoid hydrophilic acrylic IOL (Softec HDO, Lenstec). At surgery, the IOL was exchanged for an in-the bag placement of a 3-piece silicone IOL (AQ2010V), which successfully eliminated PD but generated ND symptoms. At a second surgery, the silicone bag–placed IOL was exchanged for a sulcus-placed Collamer IOL (CQ2015A). The secondary surgery eliminated ND but PD resurfaced, and ultimately that IOL was swapped for a sulcus placed 7.0 mm PMMA IOL (CZ70BD) with success.

From the results of this study, it seems that edge design, IOL material as related to IR, and perhaps size of the optic, all contribute to development of PD. Of interest, the seemingly most successful IOL for exchange was 3-piece silicone L161AO IOL that has a square edge. Unlike ND, regarding PD, IOL position relative to the capsule bag

does not seem to be an important causal factor. Therefore, when confronted with patients having both ND and PD, each optical condition requires specific attention.

Consistent with the published literature, squared-edged high IR hydrophobic IOLs are the most likely to be associated with PD. However, not studied in the current investigation are the influences of optic size or lenticular design of the optic, both might promote PD symptoms. It seems logical to consider reduced optic size or effective optic size as contributing to PD, but there is currently limited supporting evidence. However, in accordance with the concept of using an IOL with a lower IR than the inciting IOL, we noted improvement in PD symptoms in excess of 80% of our surgical cases.

Limitations of this investigation include its retrospective nature and mixed case type regarding some patients with both PD and ND. It would be ideal to perform a multicentered prospective investigation to achieve higher patient enrollment numbers and to randomize IOL exchange models. It must also be recognized that this investigation reflects experience only within the United States. As a result, we did not include IOLs from other geographic locations as the inciting IOL, nor did we consider a plethora of IOLs for exchange that is available in other markets.

In addition, this investigation did not include pupil size or IOL power as associated risk factors for PD; these items could prove interesting in future studies. Nonetheless, this study provides surgeons with a strategy for surgical management of PD and prediction of success rates of improvement.

WHAT WAS KNOWN

- Positive dysphotopsia (PD) is an undesired optical consequence of otherwise uneventful cataract surgery that consists of patient-reported peripheral light streaks, central light flashes, and halos. It might exist as an isolated condition or be combined with negative dysphotopsia (ND).
- PD seems to be related to square edge design, high index of refraction, and flat radius of curvature of the anterior optic surface.
- PD might respond to topical miotic therapy but might require intraocular lens (IOL) exchange for best management.

WHAT THIS PAPER ADDS

- PD seems to be related more to IOL material and design unlike ND that seems to be more associated with physical position of the optic.
- PD might be addressed surgically with approximately an 85% success rate by exchanging the IOL for one with a lower index of refraction or different edge design IOL.
- When PD coexists with ND, both conditions must be managed individually; this approach affords a high degree of success for the patient.

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Disclosures: *None of the authors has a financial or proprietary interest in any material or method mentioned.*

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