

CASE REPORT

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Implantation of single-piece hydrophobic acrylic intraocular lens in the ciliary sulcus

ABSTRACT

Objective

To report the association of sulcus-fixated, single-piece hydrophobic acrylic intraocular lenses (HAIOL) with pigment-dispersion syndrome (PDS) and pigmentary glaucoma (PG).

Methods

This is a noncomparative consecutive case series of 20 eyes that underwent sulcus implantation of a single-piece HAIOL after posterior-capsule rupture (PCR) during phacoemulsification. The following data were analyzed: postoperative best-corrected visual acuity (BCVA); manifest refraction; frequency of IOL decentration, dislocation, and repositioning; intraocular pressures; gonioscopic findings; and postoperative complications.

Results

The postoperative BCVA was 20/40 or better in all eyes. The mean postoperative sphere was -0.05 ± 0.7 diopters (range, +1.25 to -2.00) and the mean postoperative cylinder was -1.2 ± 0.8 diopters (range, 0 to -2.50). None of the HAIOLs became decentered, dislocated, or required repositioning. Seven eyes (35%) developed PDS while 3 eyes (15%) developed PG that required IOP-lowering medications or filtering surgery. The average follow-up period was 17.2 ± 9.4 months (range, 6 to 36).

Conclusion

Implantation of single-piece HAIOLs in the ciliary sulcus is associated with PDS and PG. Alternative methods of aphakic correction should be considered in cases of PCR.

Keywords: *Ciliary sulcus, Hydrophobic acrylic intraocular lenses, Pigment-dispersion syndrome, Pigmentary glaucoma, Aphakic correction*

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ONE of the challenges presented by posterior-capsule rupture (PCR) during complicated cataract surgery is intraocular-lens (IOL) implantation for aphakic correction. Current alternatives to in-the-bag implantation include anterior-chamber (AC) IOL, iris, scleral, and sulcus fixation of rigid polymethylmethacrylate (PMMA) or foldable multipiece IOL.¹⁻⁶ Ideally, the aphakic-correction method should be easy to perform, achieve good anatomic and visual outcomes, maintain the small-incision wound, and avoid postoperative complication.⁷⁻⁹

Sulcus-implantation of a single-piece hydrophobic acrylic IOL (HAIOL) is a controversial procedure. Recent case reports demonstrated that this technique leads to iritis, pigment dispersion, iris atrophy, and the uveitis-glaucoma-hyphema syndrome.¹⁰ We report here the incidence of pigment-dispersion syndrome (PDS) and pigmentary glaucoma (PG) in eyes where a single-piece HAIOL was implanted in the ciliary sulcus.

METHODOLOGY

The medical records of 20 eyes that developed PCR at the Asian Eye Institute from January 1, 2003 to December 31, 2004, and underwent sulcus implantation of a single-piece HAIOL (Acrysof SA60AT, Alcon Surgical, Fort Worth, TX, USA) were reviewed. The SA60AT is the standard HAIOL used at our center, replacing the multipiece model. The following data were retrieved: best-corrected visual acuity (BCVA); manifest refraction; intraocular pressure (IOP); gonioscopic findings; IOL decentration, dislocation, and need for IOL repositioning; additional intraoperative procedures; surgical time; follow-up duration; and postoperative complications including PDS, PG, retinal detachment (RD), cystoid macular edema (CME), and endophthalmitis.

During follow-up visits, the pupils were dilated to facilitate examination of the fundus and determination of IOL centration. IOL decentration was defined as visible optic edge in a 5-mm mid-dilated pupil. IOL dislocation was defined as displacement of the entire IOL into the vitreous cavity or anterior chamber. IOL repositioning was indicated for double vision, pupillary capture, or astigmatism (0.3 diopters) from IOL tilt. Gonioscopy was performed whenever IOP exceeded 25 mm Hg by applanation tonometry.

PDS was diagnosed when pigment was present on anterior-segment structures (aqueous humor, corneal endothelium, IOL, or trabecular meshwork). PG was diagnosed when IOP exceeded 25 mm Hg in the presence of a dark, circumferential band of trabecular-meshwork hyperpigmentation observed on gonioscopy.

Anterior-chamber-cell grading was based on the system of Nussenblatt.¹¹ Fluorescein angiography (FA) was performed when BCVA was less than 20/40 or when CME was suspected.

Descriptive data were reported and statistical analysis was performed using Microsoft Excel 2000 (Microsoft Corporation, Redmond, WA, USA).

Surgical Technique

All patients underwent stop-and-chop phacoemulsification by a single surgeon using a standard phacoemulsifier (Legacy 2000, Alcon Surgical, Fort Worth, TX, USA) and ophthalmic viscoelastic device (OVD). Following PCR, anterior vitrectomy (AV) was performed using the Advance Technology Irrigating Ocutome Probe (ATIOP, Alcon Surgical). For large dropped nuclear material (>1/4 lens nucleus), phacofragmentation and pars plana vitrectomy (PPV) was immediately performed by a vitreoretinal surgeon. After vitrectomy, the anterior capsule was examined and an HAIOL implanted in the ciliary sulcus space if adequate support was present ($\geq 1/2$ of the anterior capsule rim). The HAIOL was inserted through the clear corneal incision into an OVD-filled anterior chamber using a screw-type injector (Monarch II, Alcon Surgical, Fort Worth, TX, USA). The leading haptic was inserted in the ciliary sulcus plane distal to the clear corneal incision (CCI) and the trailing haptic was guided with a dialing hook into the ciliary sulcus space proximal to the CCI. The OVD was aspirated and the pupil constricted with carbachol. The CCI wound was not sutured. Postoperatively, ciprofloxacin and prednisolone acetate eye drops were applied every 4 hours. Postoperative eye examinations were performed 1, 7, 14, and 28 days after surgery, then quarterly thereafter.

RESULTS

The mean age of the patients was 66.3 ± 13.7 years (range, 46 to 87). Seventeen of 20 eyes (85%) developed vitreous loss. Four eyes (20%) underwent phacofragmentation and PPV for removal of dropped lens material while 13 (65%) underwent AV. None of the CCI needed enlargement for HAIOL insertion. The average operating time was 43.9 ± 33.5 minutes (range, 11 to 137). The average follow-up duration was 17.2 ± 9.4 months (range, 6 to 36).

Postoperatively, all HAIOL remained centered and well positioned. No HAIOL needed repositioning. All eyes had postoperative BCVA equal to or better than 20/40. The mean manifest refractive sphere was $-0.50 \pm 0.7D$ (range, +1.25 to -2.00). The mean manifest cylindrical refraction was $-1.2 \pm 0.8D$ (range, 0 to -2.50).

Transient corneal edema was observed in 7 eyes (44%), transient AC inflammation (>1+AC cells) in 7 (35%), and transient IOP rise (>25 mm Hg) in 4 (20%). Two eyes had postoperative BCVA of 20/40 due to macular degeneration. Two patients developed transient CME. One patient developed pseudophakic RD two years after surgery but eventually obtained BCVA of 20/25 after

successful RD repair (Table 1).

Seven of 20 eyes (35%) developed PDS with deposition of brown pigment material on the corneal endothelium, HAIOL, and trabecular meshwork (TM). Of these, 3 eyes (15%) developed PG that necessitated additional IOP-lowering treatment. PG manifested 6, 9, and 24 months after surgery among these 3 eyes. The mean duration to onset of PG was 13.0 ± 9.6 months (range, 6 to 24). Two of these 3 eyes later underwent filtering surgery by a glaucoma specialist.

DISCUSSION

A recent review of literature concluded that there was insufficient evidence to substantiate the superiority of any method for achieving pseudophakia after PCR.¹² ACIOLs, while easy to implant, are associated with uveitis, glaucoma, and corneal decompensation because they chafe the anterior iris, erode the angles, or contact the corneal endothelium.⁷ Scleral fixation avoids these problems but is more invasive, technically difficult, and associated with posterior-segment complications like endophthalmitis.⁶⁻⁷ Iris-fixated IOLs are associated with short recovery times, good visual outcomes, stable surgical results, and low complication rates but are not widely available and have steep learning curves.¹ Sulcus implantation using a rigid, large optic, single-piece PMMA IOL has been an effective method for aphakic correction.^{2,8,10} However, PMMA IOLs

require enlargement of the surgical incision, which increases the risk for intraoperative hypotony, choroidal detachment, hemorrhage, vitreous incarceration, and astigmatism.¹³⁻¹⁴ Multipiece foldable HAIOLs have been used for sulcus fixation and produce good visual outcomes, but are associated with a higher decentration rate.⁵ Moreover, implantation of any of these IOL models into the ciliary sulcus may produce PDS and PG.¹⁰

Since 1999, the Acrysof SA60AT has achieved widespread use. At our institution, this model has replaced multipiece foldable HAIOLs as the standard for aphakic correction. We initially surmised that the SA60AT may be suitable for sulcus implantation because of several biomechanical qualities: (1) Planar haptics that limit axial displacement and reduce the incidence of decentration/dislocation and A-constant unpredictability, (2) Single-piece haptics that withstand greater deformation forces and provide improved handling characteristics and greater tolerance for surgical manipulation, (3) Thinner optics that allow greater separation from the posterior iris surface, minimizing chafing of the iris by the optic leading to less risk for uveitis and pupillary block.¹⁵⁻¹⁶ HAIOL biocompatibility, however, has not been fully established. Some investigators have demonstrated fewer small-cell deposits on the surface of HAIOL implanted in uveitic eyes while others reported a greater affinity of foreign body giant cells for HAIOL surface.¹⁷⁻¹⁸

Table 1. Outcomes of sulcus-implanted, single-piece foldable acrylic IOL after posterior capsular rupture.

Patient Number	Preoperative BCVA ¹	Postoperative BCVA ¹	Spherical Refraction (D)	Astigmatic Refraction (D)	AC ² Cells	Maximum IOP ³ (mm Hg)	Vitreous Loss	Surgery Duration (Minutes)	Follow-up (Months)	Adverse Events
1	20/70	20/20	-1.75	-1.25	3	29	AV ⁴	30	36	
2	20/70	20/20	-1.25	-0.75	3	34	AV	45	35	P ⁶
3	20/200	20/40	-1.75	-0.75	0	8	PPV ⁵	106	30	
4	HM	20/40	0	0	2	56	PPV	50	28	P, G ⁷
5	20/200	20/25	+1.25	-0.75	1	11	PPV	137	25	
6	20/40	20/25	-1.25	-1.25	0	21	AV	35	22	P
7	20/40	20/20	-1.25	-1.00	1	18	AV	31	20	
8	20/70	20/20	0	-0.5	2	14	AV	23	19	
9	20/200	20/20	-0.5	-1.25	1	10	AV	38	17	
10	20/50	20/20	-0.5	-0.5	0	20	PPV	74	15	P
11	20/25	20/20	0	-2.25	1	15	AV	63	14	
12	20/400	20/30	-0.25	-3.0	1	24	None	15	13	P
13	20/70	20/30	-2.0	-0.75	3	22	AV	38	12	
14	20/200	20/20	-0.25	-1.25	1	9	AV	26	11	
15	20/200	20/30	-0.25	-2.00	1	23	AV	82	9	P, G
16	20/70	20/25	-0.5	-2.25	0	24	AV	31	9	
17	20/70	20/20	-0.5	0	0	14	None	15	8	
18	20/100	20/20	0	-0.5	0	20	AV	20	8	
19	20/200	20/20	-0.5	-0.5	0	19	AV	11	7	
20	20/40	20/40	-2.5	-2.5	0	36	None	12	6	P, G

1. Best-corrected visual acuity
2. Anterior chamber
3. Intraocular pressure
4. Anterior vitrectomy

5. Pars plana vitrectomy
6. Pigment dispersion
7. Pigmentary glaucoma

This series demonstrated that single-piece, sulcus-implanted HAIOL was associated with a significant risk for PDS and PG. Chafing of the posterior pigmented iris by the unpolished, thicker haptics of these HAIOLs results in the release of iris pigments which are then carried to the TM. In small amounts, these pigments are phagocytosed by the endothelial cells of the trabecular beams without leading to IOP elevation. With greater particulate loads, obstruction of the intertrabecular spaces or Schlemm's canal leads to occlusion of outflow facility and IOP elevation. PG may develop months or years after onset of PDS. Pigment regression may sometimes lead to remission of PG.^{10, 19}

For eyes with single-piece HAIOL previously implanted in the ciliary sulcus, regular visits are needed to monitor IOP and examine the anterior segment for PDS. Anti-inflammatory and IOP-lowering medications may be indicated for these patients. IOL exchange, laser trabeculoplasty, or filtering surgery should be considered for patients with recalcitrant IOP elevation.¹⁹ The ultrasound biomicroscope is useful for evaluating iris-IOL contact and may identify patients at greater risk for PDS and PG.

While single-piece HAIOLs are easily implanted in the sulcus, the risk for developing potentially sight-threatening complications discourage the use of this technique. We recommend using the multipiece HAIOL or single-piece PMMA IOL that may have lesser propensity to cause PDS and PG. If alternative IOLs are unavailable, a secondary implantation should be considered.

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