

## Original Investigation

# Outcomes Associated With Concurrent Iris-Sutured Intraocular Lens Placement and Subluxated Crystalline Lens Extraction

Scott F. McClellan, MD, MPH; Uri Soiberman, MD; Peter L. Gehlbach, MD, PhD; Peter N. Murakami, ScM; Walter J. Stark, MD

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**IMPORTANCE** We have developed a novel surgical technique, to our knowledge, for the management of subluxated crystalline lenses involving preplacement of an iris-sutured posterior chamber intraocular lens (PCIOL) before pars plana vitrectomy and lensectomy.

**OBJECTIVE** To investigate the outcomes of eyes with subluxated crystalline lenses, predominantly a result of Marfan syndrome (14 eyes [58%]) or trauma (5 eyes [21%]), that underwent pars plana vitrectomy and lensectomy with placement of an iris-sutured PCIOL.

**DESIGN, SETTING, AND PARTICIPANTS** We performed a retrospective, noncomparative case series of 24 eyes from 17 consecutive adult patients with surgically treated subluxated crystalline lenses presenting to the Wilmer Eye Institute at Johns Hopkins Hospital from October 6, 2006, through May 1, 2013. The mean (SD) postoperative follow-up was 24.4 (20.5) months for eyes with at least 6 months of follow-up (last date, October 13, 2014). We performed the analysis from January 21, 2014, through January 3, 2015.

**MAIN OUTCOMES AND MEASURES** Improvement in best-corrected visual acuity using an automated Snellen chart and induction of astigmatism for eyes with at least 6 months of follow-up (n = 18) and IOL stability during follow-up for all eyes (n = 24).

**RESULTS** The mean (SD) age at surgery was 49.4 (10.7 [range, 29-67]) years. We found an improvement in mean (SD [95% CI]) best-corrected visual acuity from 0.66 (0.71 [0.30-1.02]) logMAR preoperatively (Snellen equivalent, approximately 20/90; range, 20/30 to hand motions) to 0.07 (0.11 [95% CI, 0.01-0.12]) logMAR postoperatively (Snellen equivalent, approximately 20/23; range, 20/15 to 20/50). We found little change in astigmatism postoperatively (mean change, -0.1 [95% CI, -0.5 to 0.13] diopters). Postoperative complications included retinal detachment (1 eye [4%]), retained cortical fragment (1 [4%]), cystoid macular edema (2 [8%]), and IOL subluxation (3 [13%]) owing to haptic slippage within 3 months of the procedure. The overall probability of successfully achieving placement of a centered iris-sutured PCIOL in patients with follow-up of longer than 6 months (n = 18) was 100% (95% CI, 81.5%-100%).

**CONCLUSIONS AND RELEVANCE** Placement of iris-sutured PCIOLs at the time of subluxated lens extraction with a pars plana surgical approach yields favorable results in terms of postoperative visual outcomes and surgical complications. This technique offers an effective procedure for surgeons to use when treating clinically significant subluxated crystalline lenses.

**Author Affiliations:** Division of Cornea, Cataract and External Diseases, Wilmer Eye Institute at Johns Hopkins Hospital, Baltimore, Maryland (McClellan, Soiberman, Stark); Retina Division, Wilmer Eye Institute at Johns Hopkins Hospital, Baltimore, Maryland (Gehlbach); Johns Hopkins Biostatistics Center, The Johns Hopkins University, Baltimore, Maryland (Murakami).

**Corresponding Author:** Scott F. McClellan, MD, MPH, Division of Cornea, Cataract and External Diseases, Wilmer Eye Institute at Johns Hopkins Hospital, 5000 Fredericks Bequest Ct, Bowie, MD 20720 ([scott.f.mcclellan.mil@mail.mil](mailto:scott.f.mcclellan.mil@mail.mil)).

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A variety of surgical repair methods are available for the management of clinically significant subluxated crystalline lenses. Treatment is indicated in cases in which aphakic spectacle or contact lens correction is not tolerated and/or does not meet the patient's visual needs. Intervention may also be necessary to mitigate secondary adverse effects arising from lens subluxation, such as corneal decompensation, pupillary block, angle-closure glaucoma, or, in rare cases, retinal detachment.<sup>1</sup>

Techniques have used standard intracapsular lens extraction, extracapsular anterior lensectomy with or without anterior vitrectomy, or pars plana vitrectomy (PPV) and pars plana lensectomy (PPL) to facilitate initial lens removal.<sup>2</sup> Postoperative refractive correction with in-the-bag intraocular lens (IOL) placement may be accomplished using capsular tension rings; however, in cases of crystalline lens subluxation with more extensive zonular compromise (ie, >6 clock hours of zonulysis), modified capsular tension rings, capsular tension segments, capsule hooks, or capsular anchors used alone or in combination may be necessary to ensure capsular bag stability and IOL centration by securing the capsule to the sclera.<sup>3-8</sup> Other postoperative visual rehabilitation methods include residual aphakic spectacle or contact lens correction or placement of anterior chamber IOLs, iris-claw anterior chamber IOLs, scleral-fixated posterior chamber IOLs (PCIOLs), iris-fixated PCIOLs with the use of sutures, or iris-claw PCIOLs.<sup>2,9</sup>

This study aims to assess outcomes in adult eyes with visually significant subluxated crystalline lenses that underwent placement of an iris-sutured PCIOL with concurrent PPV and PPL. A unique feature of our technique involves preplacement of an iris-sutured PCIOL before the pars plana procedures. In cases involving severe lens instability and zonulopathy requiring a vitrectomy, this technique minimizes the tendency of the eye to collapse during surgical manipulation by maintaining initial vitreous support while the IOL is fixated to the iris before PPV and PPL. The technique also limits the potential for posterior iris bowing—often seen when PPV and PPL are performed first—that can make for a more technically challenging iris fixation procedure. Moreover, insertion of the IOL in front of the native subluxated crystalline lens and zonular network offers improved intraoperative IOL stabilization before iris suturing, even in situations with severe lens subluxation and extensive zonulopathy. To our knowledge, this novel approach has not been reported previously in the medical literature.

## Methods

This retrospective noncomparative case series was approved by the institutional review board at The Johns Hopkins University and was conducted in accordance with Health Insurance Portability and Accountability Act regulations. We included consecutive cases of surgically treated subluxated crystalline lenses presenting to the Wilmer Eye Institute at Johns Hopkins Hospital from October 16, 2006, through May 1, 2013. A single surgeon specializing in anterior segment procedures (W.J.S.) placed the iris-sutured PCIOL, and the same vitreoretinal surgeon (P.L.G.) performed all the PPV and PPL procedures after the PCIOL was secured to the iris.

### At a Glance

- We describe a novel surgical treatment for the management of visually significant subluxated crystalline lenses involving preplacement of an iris-sutured posterior chamber intraocular lens (PCIOL) before pars plana vitrectomy (PPV) and lensectomy (PPL).
- This technique minimizes the tendency of the eye to collapse during surgery by maintaining vitreous support while the PCIOL is fixated to the iris before PPV/PPL.
- Our approach mitigates the potential for posterior iris bowing—often seen when PPV/PPL is performed first—that can make iris fixation technically challenging.
- Insertion of the PCIOL in front of the native subluxated crystalline lens and zonular network offers improved intraoperative PCIOL stabilization before iris suturing.
- We observed a better mean postoperative best-corrected visual acuity and comparable postoperative complications when assessed against analogous surgical methods used to manage subluxated crystalline lenses.

Eyes with vision-limiting comorbidities (ie, corneal disease, glaucoma, and high myopia) were included in this study. We excluded cases with combined corneal surgery and iris suture fixation, prior lens extraction at the time of presentation, and complete posterior lens dislocations necessitating crystalline lens extraction by PPV before iris suturing of a PCIOL. Children and adolescents (aged <18 years) were also excluded. A total of 24 eyes from 17 consecutive patients were included for analysis. All patients signed a consent form for the original surgical procedure, but owing to the retrospective review of electronic and paper medical records, no consent forms were obtained for study purposes. We excluded personally identifiable information during the retrospective analysis. The institutional review board at The Johns Hopkins University waived the necessity for informed consent during the research phase of our study.

We reviewed the electronic and paper medical records of the study participants from January 21, 2014, through January 3, 2015. We collected the following data: demographic information, ocular comorbidities, the cause of lens subluxation (if known), best-corrected visual acuity (BCVA) using an automated Snellen chart at presentation and the final follow-up visit, manifest refraction, preoperative keratometry and axial length measurements (using data obtained from a slitlamp biomicroscope [IOLMaster; Carl Zeiss Meditec]), and duration of follow-up. Intraoperative and postoperative complications, including suprachoroidal or vitreous hemorrhage, cystoid macular edema, hyphema, postoperative hypotony or elevation of intraocular pressure, corneal decompensation, retinal detachment, chronic uveitis, and IOL subluxations, were also recorded.

The primary outcome variables were improvement in BCVA, induction of astigmatism after IOL implantation, and IOL stability during follow-up. Visual and refractive outcomes were reported only for eyes with a minimum follow-up of 6 months ( $n = 18$ ). We transformed Snellen visual acuity measurements to logMAR equivalents to facilitate statistical analysis. Visual acuity of hand motions was set at 2.30 logMAR, and counting

fingers was equivalent to 1.85 logMAR.<sup>10,11</sup> Secondary outcome variables assessed were the number and types of intraoperative and postoperative complications. Surgical complications were reported for all eyes (n = 24), including those with a follow-up of less than 6 months (n = 6).

The postoperative manifest refraction astigmatic error reflected corneal and IOL-induced astigmatism. To assess the induction of astigmatism after IOL implantation with a standard corneal wound created at the 9-o'clock position, manifest refraction at the final follow-up visit was converted to a cross-cylinder notation and then calculated to the corneal plane, assuming a vertex distance of 13.75 mm.<sup>12</sup> This calculated astigmatic error was compared with the difference in preoperative keratometry values (ie, corneal astigmatism) obtained by IOLMaster. A detailed discussion of the surgical technique appears in the eMethods in the Supplement.

### Pars Plana Surgical Approach

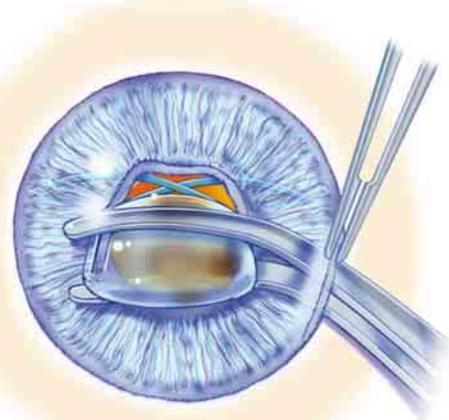
Eyes with decreased vision due to visually significant crystalline lens subluxation, severe lens instability, and/or subjective patient symptoms (ie, contact lens intolerance, refractive instability, monocular diplopia, or debilitating glare or halos) were eligible for iris-suturing surgery. This approach was desirable in cases of moderate to severe lens subluxation, for which capsular support was deemed more tenuous and an anterior capsulorrhexis was not feasible (ie, if the subluxated lens edge uncovered >25% of the dilated pupil or if >6 contiguous clock hours of zonular dehiscence existed).<sup>3,4</sup> With the pars plana approach, the anterior capsule of the crystalline lens was left intact initially, and the subluxated crystalline lens and existing zonular network provided posterior support and intraoperative IOL stabilization before lens extraction.

Iris suturing of the PCIOL was identical to the procedure previously described.<sup>13</sup> Depending on the size of the pupil after the retrobulbar block, an acetylcholine chloride intraocular solution (Miochol; Bausch and Lomb) was instilled into the anterior chamber to constrict the pupil to a size smaller than the biconvex optic diameter (6.5 mm) of the 3-piece IOL (Alcon AcrySof MA50BM IOL; Alcon Inc). We selected this type of 3-piece IOL because of the 10° posterior angulation of its polymethyl methacrylate (PMMA) haptics, which are less likely to induce postoperative iris trauma or pupillary block. The IOL was folded across its center with a lens-folding forceps in a mustache-style fashion (eFigure 1 in the Supplement). The IOL was inserted into the anterior chamber with a lens inserter forceps through a 3.5-mm corneal wound at the 9-o'clock position (regardless of laterality). The PMMA haptics were allowed to open behind the iris and settle into the ciliary sulcus in a reverse-S configuration (Figure, A, and eFigure 2 in the Supplement). Simultaneously, the IOL optic attained iris capture while being supported posteriorly with a Barraquer sweep.

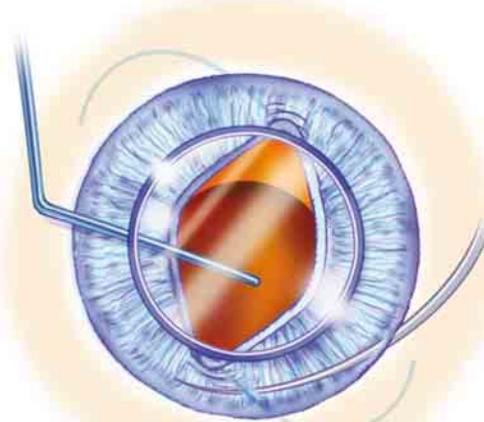
Iris suturing of the PCIOL was accomplished using a modified McCannel technique.<sup>14,15</sup> One end of a 10-0 polypropylene suture (Prolene; Ethicon) on a spatulated needle (CTC-6; Ethicon) was passed through clear cornea, through the midperipheral iris, and then underneath the PMMA haptic of the 3-piece IOL that was positioned posterior to the iris at the 6- or 12-o'clock position (Figure, B and eFigure 3 in the Supplement).

**Figure. Steps of Iris Suturing of the Posterior Chamber Intraocular Lens (IOL) Followed by Pars Plana Vitrectomy and Lensectomy**

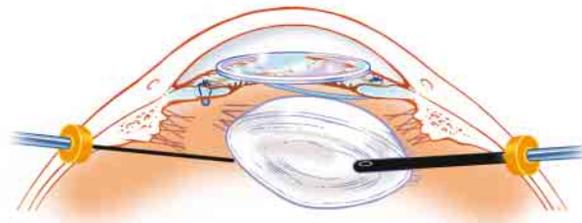
**A** Insertion of IOL haptics behind the iris



**B** First suture pass of iris fixation of the IOL



**C** Completion of the pars plana procedure after iris suturing of the IOL



A, The polymethyl methacrylate haptics of the IOL are allowed to open behind the iris and settle into the ciliary sulcus in a reverse-S configuration. B, One end of a 10-0 polypropylene suture (Prolene; Ethicon) on a spatulated needle (CTC-6; Ethicon) is passed through clear cornea, through the midperipheral iris, and then underneath the haptic of the IOL that is positioned posterior to the iris. C, Cross-sectional view of a pars plana lensectomy completed with the vitrectomy cutter or the phacofragmentation probe.

Table 1. Postoperative Visual Outcomes After Iris-Fixated PCIOL With PPV and PPL

Outcome	Data (n = 18) <sup>a</sup>
BCVA, logMAR	
Preoperative	
Mean (SD) [95% CI]	0.66 (0.71) [0.30 to 1.02] (Snellen equivalent, approximately 20/90; range, 20/30 to HM)
Median (IQR) <sup>b</sup>	0.35 (0.30)
Postoperative	
Mean (SD) [95% CI]	0.07 (0.11) [0.01 to 0.12] (Snellen equivalent, approximately 20/23; range, 20/15 to 20/50)
Median (IQR) <sup>b</sup>	0.05 (0.10)
Improvement, mean (95% CI)	0.35 (0.20 to 1.08)
Spherical equivalent, mean (95% CI), D <sup>c</sup>	
Postoperative	-0.55 (-0.89 to -0.21)
Shift from myopia toward emmetropia <sup>c</sup>	-2.81 (-8.31 to 1.81)
Postoperative astigmatic reduction, mean (95% CI), D <sup>c</sup>	-0.10 (-0.51 to 0.13)

Abbreviations: BCVA, best-corrected visual acuity; D, diopter; HM, hand motions; IQR, interquartile range; PCIOL, posterior chamber intraocular lens; PPL, pars plana lensectomy; PPV, pars plana vitrectomy.

<sup>a</sup> Indicates the number of eyes with at least 6 months of follow-up.

<sup>b</sup> The IQR is reported as the difference between the 75th and 25th percentiles of data.

<sup>c</sup> Preoperative and postoperative spherical equivalent data were available for 13 eyes (5 with follow-up of 0.5 to 2 years; 8 with follow-up longer than 2 years).

The pass was completed back through the iris and clear cornea on the opposite side. The needle was removed from the suture. A paracentesis was created at a position adjacent to the location where the PMMA haptic had been fixated. Using a Lester hook, each end of the polypropylene suture was drawn from the anterior chamber external to the eye through the paracentesis (eFigure 4 in the Supplement). The 10-0 polypropylene sutures were tied securely together using at least 4 throws, and the iris was allowed to fall back into its normal anatomic position. A similar procedure was performed 180° away through an additional paracentesis (eFigures 5 and 6 in the Supplement).

Once the IOL had been secured to the iris, a standard 3-port PPV was initiated using a 23-gauge system with incisions 3.5 mm posterior to the limbus (eFigure 7 in the Supplement). A PPL was completed with the vitrectomy cutter or the phaco-fragmentation probe (Figure, C, and eFigure 8 in the Supplement). After removal of the lens material, the remaining capsule was drawn into the optical axis with a forceps and removed with the vitrectomy cutter. A standard core vitrectomy was then performed removing any loose lens fragments from the vitreous cavity and ensuring no residual vitreous was adherent to the iris-sutured IOL. Scleral depression was conducted in a 360° fashion to identify any retinal tears or breaks. After the PPV, a Sinsky hook was used to push the optic of the IOL behind the iris to complete the procedure.

### Statistical Analysis

We used Wilcoxon signed rank tests to determine the mean (pseudomedian) change in BCVA (measured in logMAR units), spherical equivalent (measured in diopters [D]), and induction of astigmatism after IOL implantation (measured in D) from preoperative baseline to the final postoperative follow-up visit. We calculated 95% CIs for preoperative and postoperative estimates based on robust sandwich estimates of variance. All results were based on complete-case analysis. Analyses were performed using R statistical software (version 3.0.2; <http://www.r-project.org>). Unless otherwise indicated, data are expressed as mean (SD).

## Results

This study included 24 eyes from 17 adult patients. Eleven patients (16 eyes) were men and 6 patients (8 eyes) were women. Fourteen eyes were diagnosed as having Marfan syndrome at the time of initial presentation. Five eyes had a history of blunt ocular trauma, and 1 eye carried a clinical diagnosis of homocystinuria. One eye had isolated microspherophakia.

For the remaining 3 eyes, the cause of the subluxated crystalline lens could not be determined definitively by historical inquiry or by results of the physical or ocular examination. Two eyes had megalocornea but no systemic abnormality, and 1 eye had a dense cataract with glaucoma and an axial length of 21.93 mm. No patient in this study had pseudoexfoliation syndrome.

The mean age at surgery was 49.4 (10.7 [range, 29-67]) years. The mean postoperative follow-up was 24.4 (20.5 [range, 8.0-82.7]) months (n = 18) for those eyes with a follow-up of at least 6 months (last follow-up, October 13, 2014). The median postoperative follow-up was 21.7 months. The mean axial length was 24.67 (1.59) mm. Postoperative visual outcomes are listed in Table 1 and Table 2. For the 18 eyes with a minimum follow-up of 6 months, the mean preoperative BCVA was logMAR 0.66 (0.71; 95% CI, 0.30-1.02) (Snellen equivalent, approximately 20/90; range, 20/30 to hand motions). The mean postoperative BCVA was logMAR 0.07 (0.11; 95% CI, 0.01-0.12) (Snellen equivalent, approximately 20/23; range, 20/15 to 20/50).

After 1 or more suture fixation procedures, the overall probability of success of a stable and centered placement of an iris-sutured PCIOL in patients with more than 6 months of follow-up (n = 18) was 100% (95% CI, 81.5%-100%). Three eyes experienced IOL subluxation postoperatively, 2 of which underwent repeated iris fixation before the follow-up end point. Intraocular lens subluxation was secondary to haptic slippage from its intended iris fixation position. No IOL subluxations were caused by suture failure. One of the patients with megalocornea had IOL subluxation 1 week postoperatively, and 1 patient with a traumatic lens subluxation who experienced an intraoperative IOL subluxation later presented with an IOL

Table 2. Outcomes of Follow-up Groups After Iris-Fixated PCIOL With PPV and PPL

Outcome	Length of Follow-up, y	
	0.5 to 2 y (n = 7)	>2 y (n = 11)
BCVA, logMAR		
Preoperative		
Mean (SD) [95% CI]	0.91 (0.96) [0.12 to 1.70] (Snellen equivalent, approximately 20/163; range, 20/30 to 20/HM)	0.50 (0.48) [0.19 to 0.81] (Snellen equivalent, approximately 20/63; range, 20/30 to 20/CF)
Median (IQR) <sup>a</sup>	0.40 (1.16)	0.30 (0.24)
Postoperative		
Mean (SD) [95% CI]	0.10 (0.15) [-0.02 to 0.22] (Snellen equivalent, approximately 20/25; range, 20/20 to 20/50)	0.04 (0.07) [-0.01 to 0.09] (Snellen equivalent, approximately 20/22; range, 20/15 to 20/30)
Median (IQR) <sup>a</sup>	0 (0.15)	0.10 (0.10)
Overall improvement	0.30 or better in 6 eyes (Snellen equivalent, 20/40) (86% of eyes)	0.30 or better in 11 eyes (Snellen equivalent, 20/40) (100% of eyes)
Spherical equivalent, mean (95% CI), D		
Postoperative <sup>b</sup>	-0.55 (-0.93 to -0.17)	-0.55 (-1.06 to -0.04)
Shift from myopia toward emmetropia <sup>b</sup>	-2.81 (-7.38 to -1.00)	-3.13 (-10.5 to 4.00)

Abbreviations: BCVA, best-corrected visual acuity; CF, counting fingers; D, diopter; HM, hand motions; IQR, interquartile range; PCIOL, posterior chamber intraocular lens; PPL, pars plana lensectomy; PPV, pars plana vitrectomy.

<sup>a</sup> The IQR is reported as the difference between the 75th and 25th percentiles of data.

<sup>b</sup> Preoperative and postoperative spherical equivalent data were available for 13 eyes (5 with follow-up of 0.5 to 2 years; 8 with follow-up >2 years).

resubluxation 3 months after the procedure. Both IOL subluxations were corrected by resuturing the IOL to the iris and were otherwise uncomplicated. Postoperative IOL subluxation occurred 1.5 months postoperatively in a third patient with Marfan syndrome and high myopia (axial length, >26.5 mm; >6 D of myopia). This patient desired aphakic correction (with a BCVA of 20/20) rather than a second IOL-repositioning procedure. The IOL in this latter patient was decentered outside the visual axis but was stable in position and not dislocated to the posterior segment.

No patients experienced any hemorrhagic complications intraoperatively. Postoperative complications included retinal detachment (1 eye [4%]), retained cortical fragment (1 eye [4%]), and cystoid macular edema (2 eyes [8%]). The single case of retinal detachment occurred 3 years postoperatively and was most likely associated with an underlying diagnosis of Marfan syndrome rather than prior surgery for iris fixation. The retinal detachment was successfully repaired with a PPV, resulting in a final visual acuity of 20/25. None of the remaining postoperative events required surgical intervention. The case with a retained cortical fragment resolved with topical corticosteroid therapy alone, and the 2 cases of cystoid macular edema abated after topical corticosteroid therapy, with final visual acuities of 20/20. No patient experienced postoperative corneal decompensation, suprachoroidal hemorrhage, hyphema, chronic uveitis, glaucoma, or endophthalmitis.

## Discussion

The findings of our study suggest that iris suturing of a PCIOL before subluxated crystalline lens extraction with a pars plana surgical approach yields favorable clinical results. More than one-half of the eyes in our study sample (58%) carried a diagnosis of Marfan syndrome, and 21% had a history of trauma at the time of presentation to our tertiary referral center. Table 3

depicts analogous studies describing the surgical management of subluxated crystalline lenses and their respective mean postoperative logMAR BCVA, follow-up, and associated surgical complications.<sup>7,16-19</sup> Those studies largely involved adult patients with sample sizes similar to that of our study.

The present study showed a better final mean postoperative BCVA compared with other surgical methods used to manage subluxated crystalline lenses. Although evidence suggests that anterior chamber IOLs and iris-fixated anterior chamber IOLs may promote the best results in terms of IOL stability, follow-up is limited to approximately 12 months in studies of adult patients with subluxated crystalline lenses.<sup>16,17,19,20</sup> In addition, overall postoperative visual outcomes appear less desirable with anterior chamber IOLs, and the secondary ocular adverse events, such as chronic uveitis, glaucoma, and corneal decompensation, that may arise years after these procedures remain problematic.<sup>21,22</sup>

Most of the complications in our study were comparable to those associated with other posterior chamber surgical techniques. One notable exception was the IOL subluxation rate. Even with similar causes of subluxated lenses, postoperative IOL subluxation was found in 3 eyes (13%), which was high compared with the study of modified capsular tension rings (6 eyes [6.7%]) by Cionni et al.<sup>7</sup> However, this difference is limited given the sizes of the samples, and a direct comparison between these 2 surgical approaches may be problematic because of differing durations of follow-up, patient comorbidities, and the degree of existing zonular support. Modified capsular tension rings may not always be applicable in cases of severe lens subluxation when a pars plana approach for lens extraction is more advisable. Moreover, progressive zonulopathy is often seen in patients with Marfan syndrome, and long-term suture stability with the use of eyelets remains a concern.<sup>23</sup>

Alternative methods involving surgery in the posterior chamber are available in these instances (ie, scleral-fixated PCIOLs) but may result in higher IOL instability rates than our

Table 3. Various Surgical Approaches for Subluxated Crystalline Lens Extraction With IOL Placement in Adult Patients<sup>a</sup>

Source	Diagnosis (No. of Eyes)	Surgical Technique (No. of Eyes)	Patient Age, Mean (Range), y	Mean Postoperative Data		
				Follow-up, mo	LogMAR BCVA	Complications (No. of Eyes)
Cionni et al, <sup>7</sup> 2003	MFS (56); idiopathic (30); Weill-Marchesani syndrome (4)	Phacoemulsification + MCTR/PCIOL (90)	35.6 (3-75)	14.6	≤0.30 (88.9%)	VTX required (14); RD (1); mild persistent iritis (3); 10.0 polypropylene suture breakage (9); pseudophacodonesis (1); postoperative IOL decentration (6); OHT (2); PCO (18)
Hirashima et al, <sup>16</sup> 2010	MFS (31)	Phacoemulsification or ECCE/VTX + IF-PCIOL (16) or IF-ACIOL (15)	25 (15-40)	12	0.29 (SD, 0.26) for IF-PCIOL 0.48 (SD, 0.61) for IF-ACIOL	IF-PCIOL: iris atrophy (5); IOL dislocation (3); RD (2); IOL capture (1); OHT (1) IF-ACIOL: iris atrophy (5); RD (1); pupillary block (1); OHT (1)
Kazemi et al, <sup>17</sup> 2000	MFS (14); trauma (9); idiopathic (7); PXF syndrome (6)	PPV/PPL + open-loop flexible ACIOL (36)	52 (17-83)	14	0.26	Pupillary block (3); CME (3); RD (1); wound leak (1); transient VH (1); hyphema (1)
Oh and Smiddy, <sup>18</sup> 2010	Trauma (23); MFS (12); idiopathic (7); PXF syndrome (4)	PPV/PPL + ACIOL (3); SF-PCIOL or sulcus IOL (43) <sup>b</sup>	51 (15-86)	7.1	0.18	Transient VH (6); CME (6); RD (3); choroidal detachment (2); iris capture (2)
Zheng et al, <sup>19</sup> 2012	MFS (71)	Phacoemulsification +/- anterior VTX + SF-PCIOL (39) or IF-ACIOL/PI (32)	19.8 (8-48) [SD, 9.5]	12	0.22 (SD, 0.20) for SF-PCIOL 0.22 (SD, 0.28) for IF-ACIOL	SF-PCIOL: IOL decentration (19); OHT (4); RD (2); hyphema (1); CB bleeding (1) IF-ACIOL: OHT (1)

Abbreviations: ACIOL, anterior chamber IOL; BCVA, best-corrected visual acuity; CB, ciliary body; CME, cystoid macular edema; ECCE, extracapsular extraction; ICCE, intracapsular cataract extraction; IF, iris-fixed; IOL, intraocular lens; MCTR, modified capsular tension ring; MFS, Marfan syndrome; OHT, ocular hypertension; PCIOL, posterior chamber IOL; PCO, posterior capsular opacification; PI, peripheral iridotomy; PPL, pars plana lensectomy; PPV, pars plana vitrectomy; PXF, pseudoexfoliation; RD, retinal

detachment; SF, scleral-fixed; VH, vitreous hemorrhage; VTX, vitrectomy; +/-, with or without.

<sup>a</sup> Adapted in part with permission from Utz et al.<sup>2</sup> The listed studies involved more than 10 eyes.

<sup>b</sup> Numbers of SF-PCIOLs vs sulcus IOLs placed were not differentiated in the study.

results demonstrated.<sup>19</sup> Other studies with scleral-fixed PCIOLs have shown improved IOL stability,<sup>18,20,24-27</sup> but those studies had limited follow-up periods and/or small sample sizes of cases with subluxated crystalline lenses. Scleral-fixation procedures are also prone to other associated complications, such as ocular hypertension, external suture or haptic erosion with the potential for higher rates of endophthalmitis, degradation of the method of haptic fixation (ie, sutures or glue with or without the use of a scleral flap), and haptic dislodgement with resultant IOL tilt, decentration, or complete dislocation.<sup>21,22</sup> These complications are particularly likely with the reduced scleral rigidity noted in patients with Marfan syndrome.<sup>28</sup>

Our study has several limitations. The low incidence rate of subluxated crystalline lenses did not allow for a prospective study design. Limitations of our retrospective noncomparative design include the lack of a control group, incomplete data on spherical equivalent results, a nonuniform duration of follow-up, a lack of randomization, and potential selection bias. The sample of 24 eyes was also drawn from an adult population (ie, aged >18 years), and results may not generalize to cases involving children, who have constituted a sizable portion of the study populations in previous work describing the management of subluxated crystalline lenses. Compared with other recent studies of adult eyes, our study had a longer mean follow-up of 24.4 months, and 18 eyes were followed up for more than 6 months. Longer follow-up is clearly needed for future studies. Of greatest importance, longer study durations will help to determine the optimal conditions necessary to promote IOL stability with placement of iris-sutured PCIOLs.

## Conclusions

The findings of this study of adult eyes suggest that placement of iris-sutured PCIOLs followed by PPV and PPL is a promising technique for the management of clinically significant subluxated crystalline lenses. Postoperative visual outcomes were improved compared with baseline, and we found a negligible induction of postoperative astigmatism after IOL implantation. No significant safety issues in terms of postoperative complications were experienced when compared with analogous surgical methods. Although postoperative IOL subluxation remains a concern, none of the IOL subluxations were secondary to suture failure. Perhaps a 3- or 4-point fixation procedure during iris suturing of the PCIOL may help to mitigate the problem of haptic slippage from its intended iris fixation position. However, our technique is relatively simple in its application and is independent of the degree of existing zonular support for successful implementation.

The unique option of iris suturing of the PCIOL before PPV and PPL is equally effective and allows for more safety and flexibility compared with phacoemulsification alone in the management of complex subluxated crystalline lenses. In cases involving severe lens instability and zonulopathy requiring a vitrectomy, this technique mitigates potential pitfalls that can make for a more technically challenging iris fixation procedure. The technique minimizes the tendency of the eye to collapse during surgical manipulation by maintaining initial vitreous support while the IOL is fixated to the iris before PPV and PPL, limits the potential for posterior iris bowing that is often seen when pars plana surgery is performed first, and, even in situations with

severe lens subluxation and extensive zonulopathy, offers improved intraoperative IOL stabilization before iris suturing when the IOL is inserted in front of the native subluxated crystalline lens and zonular network. Broader goals for presenting data on

this novel technique are to assist in the clinical decision-making process of managing subluxated crystalline lenses and to equip surgeons who treat the anterior segment with a versatile procedure to use in their surgical practice.

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