Anterior chamber and sutured posterior chamber intraocular lenses in eyes with poor capsular support

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Purpose: To compare the clinical outcomes and complications of patients who had surgical placement of anterior chamber (AC IOLs) and sutured posterior chamber intraocular lenses (PC IOLs) after cataract surgery resulting in poor capsular support.

Setting: Department of Ophthalmology, Bascom Palmer Eye Institute, Miami, Florida.

Methods: A retrospective interventional comparative case series of 181 eyes of 181 patients that had implantation of an intraocular lens with inadequate capsular support was conducted. A chart review of all patients that had implantation of AC IOLs or sutured PC IOLs at a tertiary care eye hospital between 1995 and 2001 was conducted.

Results: Outcome measures included final best-corrected visual acuity, spherical equivalent, and postoperative complications (pseudophakic bullous keratopathy, elevated intraocular pressure [IOP] inflammation, retinal detachment, suture erosion, cystoid macular edema). Of 702 charts reviewed, 181were found to fit inclusion and exclusion criteria. The postoperative complication risk ratio was 0.80 (95% confidence interval [CI]: 0.52–1.23) for AC IOLs compared with PC IOLs. The most common complication experienced by patients having implantation of either lens type was elevated IOP (AC IOL: 38%; PC IOL: 42%). The incidence of other complications was similar between the groups. Best-corrected visual acuity was similar; however, final spherical equivalent trended toward more myopic values in the PC IOL group (-0.82 ± 1.67 for AC IOL versus -1.32 ± 2.12 for PC IOL).

Conclusions: The findings suggest that no significant differences in outcome exist when comparing AC IOLs to sutured PC IOLs in complicated cataract extraction with poor capsular support. Recent advances in AC IOL design have yielded lenses that provide a safe, effective alternative to sutured PC IOLs.

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Cataract extraction is the most commonly performed surgery in the United States with approximately 2.12 million phacoemulsification procedures and 206 464 extracapsular cataract extractions performed in the year 2000.[1] Capsular rupture is noted to occur in approximately 0.9% of cases.[2] Posterior chamber intraocular lenses (PC IOLs) have been considered the standard of care, while anterior chamber intraocular lenses (AC IOLs) have long been associated with intraocular inflammation, pseudophakic bullous keratopathy, glaucoma, and lower visual acuity outcomes.[3–5] However, more recent studies have revealed a decrease in incidence of complications associated with redesigned, open-loop AC IOLs of the 1990s and beyond.[5–7] Although the incidence of complications now appears to be much improved with open-loop lenses, few studies have directly compared the outcomes of patients having implantation of AC IOLs and transsclerally sutured PC IOLs for cases in which capsular support is lacking.

Although there are a variety of lens options which exist for patients who lack adequate capsular support for a bag-fixated or sulcus-fixated posterior chamber lens (iris-fixated retropupillary AC IOLs, iris-sutured

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PC IOLs, iris claw AC IOLs, flexible open-loop AC IOLs, and trans-sclerally sutured PC IOLs), most surgeons consider the flexible open-loop AC IOL and the trans-sclerally sutured PC IOL to be the most acceptable alternatives. A controversy ensues regarding which of these 2 lens types is most appropriate in this clinical situation. The purpose of the current study was to compare visual outcomes and complications of sutured posterior chamber lenses with anterior chamber lenses in patients who lack capsular support after cataract surgery.

Patients and Methods

After receiving approval from the Human Subjects subcommittee of the University of Miami School of Medicine Institutional Review Board, the charts of all patients that had implantation of an AC IOL or sutured PC IOL at the Bascom Palmer Eye Institute between January 1995 and December 2001 were reviewed. Cases were identified using a computer tracking system of all intraocular lenses (IOLs) designed for anterior chamber or sutured posterior chamber placement. Patients were excluded if a PC IOL was implanted without suturing, if there was any visually significant preexisting retinal or optic nerve pathology (proliferative diabetic retinopathy, retinal detachment, epiretinal membrane, retinal tear, macular hole, prior vascular occlusion, optic neuropathy, or end-stage glaucoma), or if follow-up did not exceed 1-month duration. Second eyes in the same patient were also excluded.

The following data were collected: preoperative and final postoperative best corrected visual acuity (BCVA), spherical equivalent of final refractive error, and postoperative complications including pseudophakic bullous keratopathy, persistent elevation in intraocular pressure (IOP) (>21 mm Hg for more than 3 months requiring medical intervention), inflammation, retinal detachment, suture erosion, and cystoid macular edema.

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Continuous variables were compared using 2 sample 2-tailed Student *t* tests. Nominal variables were compared using the Chi-square or Fisher's exact test. Kaplan-Meier survival analysis with the log rank test was performed using time to first complication as the outcome variable. The groups were also compared using multivariate Cox survival regression analysis to adjust for important covariates.

Results

Seven hundred two charts were identified using a computer analysis tracking the following intraocular lens (IOL) models in use at the Bascom Palmer Eye Institute during the study period: Alcon models MTA2UO, MTA3UO, MTA4UO, MTA5UO, P366UV, CZ70BD (Alcon). One hundred eighty-one eyes of 181 patients were found to fit the inclusion criteria. Two hundred seventy-one patients were excluded because they had received a PC IOL that was not sutured in place. In these cases, the surgeon had used a lens that was designed for trans-scleral suturing either in the bag or in the sulcus without suturing. One hundred seventy-three patients were excluded for preexisting retinal or optic nerve pathology as defined above. Seventy-seven patients with no complications at the time of their last visit at the Bascom Palmer Eye Institute were excluded because they were either lost to follow-up or returned to the care of their referring ophthalmologist before 1 month.

Eighty-three of 181 patients had implantation of an AC IOL (46%) and 98 of 181 patients received a trans-sclerally sutured PC IOL (54%). Demographic and clinical information for the 2 groups is summarized in Table 1. Patients who received an AC IOL were significantly older than patients receiving sutured PC IOLs ($P<.001$). The surgeon was more likely to choose a sutured PC IOL if the patient had a history of pseudophakic bullous keratopathy secondary to failure of a prior AC IOL. Patients were more likely to receive an AC IOL if he or she had preexisting pseudoexfoliation syndrome. Patients were more likely to receive a sutured PC IOL if they were having concurrent penetrating keratoplasty, or if they had prior intraocular surgery (including AC IOL placement).

Baseline and final visual acuity outcomes and spherical equivalent are presented in Table 2. There was no difference in preoperative visual acuity. After a median follow-up of 14.2 months (range 1 to 68.4) for

Table 1. Demographic and preoperative characteristics.

Parameter	AC IOL	PC IOL	*P* Value	Total
n	83 (46%)	98 (54%)		181
Men	40 (49%)	49 (50%)	.88*	89 (49%)
Mean age (SD)	75 (11)	63 (21)	<.001†	69 (18)
Indication for IOL			.016§	
Complicated CE/aphakia	35 (42%)	30 (31%)		65 (36%)
Prior failed AC IOL	14 (17%)	32 (33%)		46 (25%)
Pseudoexfoliation	9 (11%)	3 (3%)		12 (7%)
Other	25 (30%)	33 (34%)		58 (32%)
Mean (SD) no. of prior procedures [range]	0.5 (0.5) [0–2]	1.0 (0.7) [0–3]	<.001†	0.8 (0.7) [0–3]
History of glaucoma	23 (31%)	28 (32%)	1.00*	51 (31%)
Concurrent PK	19 (23%)	37 (38%)	.036*	56 (31%)
Concurrent glaucoma filtering procedure	5 (6%)	4 (4%)	.73§	9 (5%)
Other concurrent procedure	24 (29%)	38 (39%)	.21*	62 (34%)

PK = penetrating keratoplasty
*Chi-square test
†Two-tailed Student *t* test
§Fisher's exact test

Table 2. Visual outcomes.

Parameter	AC IOL	PC IOL	*P* Value	Total
Preoperative acuity				
Median	20/200	20/250	.58*	20/200
[Range]	[20/25-LP]	[20/20-LP]		[20/20-LP]
Postoperative Day 1 acuity				
Median	20/400	20/400	.44*	20/400
[Range]	[20/25-NLP]	[20/40-LP]		[20/25-NLP]
Final acuity				
Median	20/60	20/50	.21*	20/50
[Range]	[20/20-Enuc]	[20/15-LP]		[20/15-Enuc]
Final spherical equivalent				
Mean (SD)	−0.8 (1.7)	−1.3 (2.1)	.089†	−1.1 (1.9)
[Range]	[−6.0, 5.0]	[−7.0, 3.0]		[−7.0, 5.0]
Months followed				
Mean (SD)	14.2 (14.4)	18.8 (20.5)	.25*	16.7 (18.0)
Median	10.4	11.4		10.7
[Range]	[1 to 68.4]	[1 to 80.6]		[1 to 80.6]

*Mann-Whitney *U* test
†Two-tailed Student *t* test

the AC IOL group and 18.8 months (range 1 to 80.6) for the PC IOL group ($P = .25$), final mean BCVA was similar between the 2 groups. The sutured PC IOL group tended to have a final spherical equivalent that was more myopic than the AC IOL group (-0.80 ± 1.70 versus -1.30 ± 2.10); however, this difference was not statistically significant ($P = .09$).

Table 3 presents complications by type of IOL used. The most common postoperative complication in both groups was an elevation in intraocular pressure (IOP), which occurred in 39% of the cases. There were no differences in complication rates, except that 3 patients (3%) in the sutured PC IOL group had suture erosion and 4 patients (4%) in the sutured PC IOL group had retinal detachments during the follow-up period, compared to none in the AC IOL group. These rates cannot be directly compared due to the wide range of follow-up times in the study subjects. To assess if type of IOL was associated with a shorter time to complications, it was included in a multivariate Cox proportional hazards survival regression with possible baseline risk factors (Table 4). The model was stratified by indication for IOL placement. A concurrent procedure other than a glaucoma filter or a penetrating keratoplasty (PK) was significantly associated with shorter time to a new complication ($P = .043$) and previous ocular surgery was borderline ($P = .056$) associated with increased time to a new complication.

Table 3. Complications by type of IOL used.

Complication	AC IOL (n = 83)	PC IOL (n = 98)	Total (n = 181)
Corneal edema	5 (6%)	3 (3%)	8 (5%)
Retinal detachment	0	4 (4%)*	4 (2%)
Inflammation	8 (10%)	12 (12%)	20 (11%)
CME	12 (15%)	10 (11%)	22 (13%)
Elevated IOP	31 (39%)	40 (42%)	71 (41%)
Pain	12 (15%)	21 (22%)	33 (19%)
Suture erosion	0	3 (3%)	3 (1.7%)
Implant malposition	2 (3%)	4 (4%)	6 (3%)
Other	24 (65%)	36 (74%)	60 (70%)
Any	55 (67%)	66 (68%)	121 (68%)

*All 4 retinal detachments occurred in the PC IOL group within 3 months of IOL placement; however the difference between the 2 types of IOL was not significant ($P = .15$, logMAR). Data not account for differences in length of follow-up.

There was no significant difference in time to new complications by type of IOL used; however, the 95% confidence interval cannot exclude a substantially increased risk with use of a PC IOL. A second analysis that was identical except that elevated pressure was not counted yielded similar results. Figure 1 displays cumulative Kaplan-Meier proportions without complications by type of IOL used.

Discussion

Anterior chamber IOLs have been closely associated with a variety of complications in the past that have caused physicians to feel reticent about their use. Use of closed-loop AC IOLs marketed during the 1970s and 1980s was wrought with complications including uveitis/glaucoma/hyphema syndrome, corneal decompensation, and others listed in Table 3.[3–5] These lenses were generally reserved for use in the elderly and for those cases in which decreased operative time and complexity was essential. However, modern advances in AC IOL design may provide a safe, effective alternative to sewn-in PC IOLs. Several studies have recently supported the hypothesis that advancements in AC IOL design have led to a significant decrease in incidence of complications.[3–8]

The Department of Veterans Affairs Cooperative Cataract Study Group recently published a comparison of AC IOLs and PC IOLs in patients with vitreous loss that retained adequate capsular support.[9] This large prospective multicenter study found that in the presence of sufficient capsular support, placement of a PC IOL yields a better visual outcome at the 1 year postoperative evaluation. Over 91% of the PC IOL group had visual acuity of 20/40 or better, whereas only 79% of the AC IOL group had visual acuity better than 20/40. The 2 groups had similar perceptions of their vision and a similar incidence of adverse events (including cystoid macular edema and retinal detachment) at 1 year postsurgery. Although this study clearly indicates that use of a nonsclerally fixated PC IOL is better than an AC IOL they did not examine cases in which capsular support was insufficient for lens placement.[9]

This study seems to be the first direct comparison and largest long-term evaluation of complications associated with the 2 lens options available for complicated cataract surgery involving poor capsular support. This study reveals no difference in the overall incidence of complications associated with AC IOLs as compared with PC IOLs in cases with poor capsular support. After multivariate adjustment for potential risk factors, the risk ratio of postoperative complications in the AC IOL group compared with the PC IOL group was 0.80 (95% CI: 0.52–1.23). Thus, although the difference between groups is not significant, the possibility of a 2-time higher risk for complications in the PC IOL group cannot be excluded. The incidence of any postoperative complication was examined and no difference between PC IOLs and AC IOLs was found with extrapolation to 60 months, as illustrated in Figure 1.

Table 4 shows the type of IOL by surgical indication. Patients having secondary IOL for complications related to a preexisting AC IOL were more likely to have a PC IOL sutured in. Patients with pseudoexfoliation syndrome were more likely to have an AC IOL placed. A Chi-square test found a relationship between

Table 4. Type of IOL by surgical indication.

	IOL Type		
Diagnosis	**AC IOL**	**PC IOL**	**Total (n)**
Complicated cataract extraction/aphakia	35 (53.8%)	30 (46.2%)	65
Prior failed AC IOL	14 (30.4%)	32 (69.6%)	46
Pseudoexfoliation	9 (75%)	3 (25%)	12
Other	25 (43.1%)	33 (56.9%)	58
Total	83 (45.9%)	98 (54.1)	181

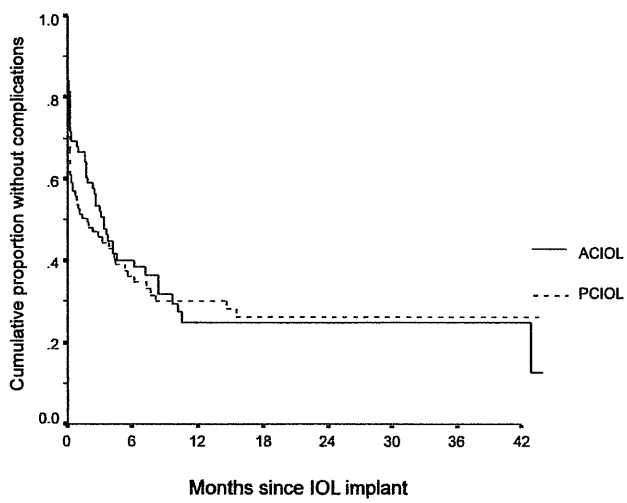

Figure 1. Cumulative proportion of patients without complications per study group over time.

surgical indication and choice of IOL surgery ($P = .016$). However, even when controlling for this effect, there was no difference in visual outcome or incidence of complications. The choice of IOL by individual surgeon and surgical subspecialty was examined. This analysis indicated individual preferences for a particular lens type with posterior segment surgeons trending toward greater use of scleral fixated PC IOLs, as would be expected. Some surgeons used only 1 of the 2 lens types in all cases with lack of capsular support, whereas others appeared to vary their lens choice based on the patient and clinical scenario.

As with any retrospective analysis, the current study has several potential weaknesses, including inability to randomize patients to receive a particular lens type. This resulted in some unavoidable differences that existed between the 2 study groups. Patients having implantation of an AC IOL were typically older than the PC IOL group (75 years versus 63 years; $P<.001$). There was a higher incidence of pseudoexfoliation and aphakia in the AC IOL group, however there was a similar incidence of open-angle glaucoma between the 2 groups (Table 1). Patients with a history of a failed AC IOL were more likely to have placement of a PC IOL. Additionally, patients who were having PK or a concurrent vitreoretinal procedure were more likely to receive a sutured PC IOL.

The surgeon may be biased due to the patient's clinical characteristics and history, as previously mentioned, or by the comfort level with a particular surgical procedure. For example, posterior segment surgeons were noted to be more likely than anterior segment surgeons to sew in a PC IOL. Cases were selected from a tertiary care center, thus patients may have had more severe disease than would be found in a comprehensive ophthalmology practice. Many were referred from a general ophthalmologist for a particular procedure (ie, trans-sclerally–sutured IOL). Additionally, patients were excluded if they did not have 1 month of postoperative follow-up. This situation occurred most commonly when a patient was referred by his or her primary ophthalmologist, had uncomplicated placement of a secondary IOL, and was sent back to the referring physician for follow-up. All patients with posterior segment pathology were excluded, because it would confound the vision assessment and visual acuity outcome. Several complications occur years after surgery (ie, corneal decompensation and suture erosion), so some complications may have been overlooked due to limited follow-up. Finally, despite being the largest study to evaluate this question, the numbers were still relatively small. Within this group of patients, each complication is relatively rare and may not be easily assessed in a small subpopulation. Despite these potential drawbacks and given the inability to perform a multicenter, prospective, randomized clinical trial for evaluation of this relatively rarely performed procedure, a retrospective comparison of the 2 groups after adjustment for risk factors predisposing to failure provides very useful information for determining appropriate lens choice.

The early AC IOLs were most commonly associated with a high incidence of pseudophakic bullous keratopathy and damage/fibrosis of the angle structures and adjacent corneal endothelium.[3,5] It was once thought that a patient with preexisting corneal pathology should not have placement of an AC IOL. Hahn and coauthors[10] compared endothelial loss in patients having secondary lens implantation with AC IOLs compared with sutured PC IOLs and found endothelial cell loss to be greater in patients with AC IOLs. However, 20 percent of their patients had implantation of a rigid AC IOL and 37 percent had implantation of a flexible open-loop lens. They did not stratify their analysis by subtype of AC IOL, thus the endothelial cell loss may be predominantly in the rigid lens subgroup. Three percent of patients with PC IOLs compared with 46.7 percent of patients with AC IOLs experienced greater than 30 percent endothelial cell loss within the first 6 postoperative months.[10] However, Kraff and coauthors[11] monitored endothelial cell loss after implantation of both rigid and flexible AC IOLs and found the endothelial cell counts to be acceptable with open-loop lenses. Conditionally, they advise the count be checked preoperatively to avoid AC IOL implantation in high-risk patients. In this study group, we found a slightly greater incidence of pseudophakic bullous keratopathy in the AC IOL group (6% versus 3%); however, this difference was not found to be statistically significant. This suggests the possibility of endothelial cell damage from the close proximity of the lens haptics to the angle structures. On the contrary, Lass et al.[12] revealed no significant difference between trans-sclerally sutured PC IOLs and AC IOLs when

comparing endothelial cell loss after penetrating keratoplasty.

In the cohort of patients, no difference was found in visual acuity outcomes between the 2 groups ($P = .21$) (Table 5). Weene[8] evaluated 61 eyes that had AC IOL implantation for complicated cataract extraction or aphakia and found that 72 percent and 86 percent, respectively achieved a visual acuity equal to or better than their preoperative BCVA. Hahn and coauthors[10] examined visual acuity of patients having secondary lens implantation for aphakia and found that 85 percent of patients with AC IOLs and 57 percent of patients with scleral fixated IOLs achieved a visual acuity of 20/40 or better. The visual outcomes of patients having PK with simultaneous lens implantation of an AC IOL or sutured PC IOL have also previously been compared and found to be similar.[13,14] Although BCVA is similar between the 2 groups, final spherical equivalents trended to be slightly more myopic in the PC IOL group (-0.80 ± 1.70 versus -1.30 ± 2.10) as illustrated in Table 2. This error may stem from blindly suturing beneath the iris. The lens may come to rest in an unpredictable position with tilting commonly inducing significant astigmatism. Heidemann and Dunn documented an 11% incidence of lens tilting and 3.5% incidence of decentration in 56 patients having trans-scleral fixation of a PC IOL.[15] Hence, several alternative methods of trans-scleral fixation have been devised in an attempt to improve visual outcomes and predictability of the procedure.

Table 5. Cox proportional hazards model of months until first complication occurred stratified by indication for IOL placement.

Risk Factor	Risk Ratio	*P* Value	95% Confidence Interval on Risk Ratio	
			Lower	Upper
Age (10-year interval)	1.03	.67	0.89	1.19
Men	0.98	.93	0.65	1.48
Previous ocular surgery	0.59	.056	0.34	1.01
Presenting acuity < 20/200	1.09	.71	0.70	1.69
History of glaucoma	1.26	.33	0.79	2.00
Concurrent PK	1.07	.82	0.60	1.90
Concurrent filter procedure	1.92	.11	0.86	4.30
Concurrent other procedure	1.65	.043	1.02	2.67
Use of PC IOL	1.33	.23	0.84	2.13

The model was stratified by indication for IOL placement.

Uveitis/glaucoma/hyphema syndrome was also previously associated with closed-loop AC IOL models. With newer IOL designs, the haptics are more flexible. Open-loops yield less fibrosis and angle damage and thus a lower incidence of elevated intaocular pressure. No significant difference was found in the postoperative incidence of elevated intraocular pressure. However, the most common complication was found to be experienced by patients having implantation of either lens type was elevated IOP (AC IOL 39%; PC IOL 42%).

There was a greater risk for retinal detachment in the patients having PC IOL implantation (0% versus 4%). The incidence of postoperative retinal detachment in patients with sutured PC IOLs has been reported to be as high as 5.4% in a series by Heidemann and Dunn.[15] The patients with sutured PC IOLs had a higher incidence of suture erosion (0% versus 3%) and implant malposition (3% versus 4%). However, the overall incidence of complications was not different between the 2 groups. In a series of 75 patients having secondary lens implantation, Wong and coauthors[16] found that complications were more closely associated with anterior vitrectomy and vitreous manipulation as opposed to lens type. Patients requiring anterior vitrectomy had the least favorable outcome, with a 28 percent incidence of retinal complications, including retinal detachment, epiretinal membrane, and cystoid macular edema.

The trans-sclerally sutured PC IOL procedure requires substantial expertise and is technically more demanding and time-consuming than placement of an AC IOL.[6] Sutured PC IOL placement usually involves an obligatory anterior vitrectomy with scleral fixation, which requires suturing through the highly vascularized ciliary body causing uveal irritation associated with chronic low-grade inflammation and an increased incidence of cystoid macular edema.[6] The interval to a patient's first postoperative complications tended to be shorter in the PC IOL group (1.1 months versus 3.4 months). Complications associated with PC IOLs may occur earlier due to magnitude and complexity of the surgical procedure. Later complications associated with AC IOLs may be sequelae of slowly declining endothelial cell counts.

Recently, Wagoner et al.[17] presented a comprehensive literature review supporting the safe and effective use of open-loop anterior chamber, sclerally-sutured posterior chamber, and iris-sutured PC IOLs for the correction of aphakia in eyes without adequate capsular support. Eighty-nine articles were reviewed (published between the years 1980 and 2001) that they deemed clinically relevant to IOL selection in these cases. Insufficient evidence was found to demonstrate superiority of one lens type over the others in eyes that lack capsular support. The current series, which is the largest comparative study to date, confirms these conclusions.

In conclusion, debate continues over the safety and efficacy of modern AC IOLs, however it appears that a reconsideration of AC IOL condemnation is warranted. The comparison of modern AC IOLs and transsclerally sutured PC IOLs is difficult because newer model lenses have only been available for approximately 10 years. Based on the similarity in incidence of complications, placement of an AC IOL may be considered a comparable, or even favorable, alternative depending on the surgeon's training and characteristics of the patient. Longer follow-up and prospective, randomized trials are needed to clearly establish the safety and efficacy of AC IOLs for various patient populations.

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