

# Risk factors for anterior capsule contraction syndrome with polypropylene or poly(methyl methacrylate) haptics

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## ABSTRACT

**Purpose:** To determine the effect of haptic composition on the development of anterior capsule contraction syndrome (CCS) requiring neodymium:YAG anterior capsulotomy.

**Setting:** Ophthalmology practice in Lancaster, Pennsylvania, USA.

**Methods:** This retrospective study covered a 30 month period during which 1 surgeon discontinued implanting AMO® SI-30NB intraocular lenses (IOLs) with polypropylene haptics (n = 216) in favor of SI-40NB IOLs with poly(methyl methacrylate) (PMMA) haptics (n = 127). The transition was motivated by the suspicion that the PMMA haptics would maintain the capsulorhexis opening better and reduce the need for an anterior capsulotomy.

**Results:** Three eyes with SI-30NB IOLs (1.4%) required anterior capsulotomies; 2 eyes had preoperative pseudoexfoliation syndrome and required the capsulotomy within 3 months of surgery. Three eyes with SI-40NB IOLs (2.4%) required anterior capsulotomies within 4 months; 2 eyes had preoperative pseudoexfoliation syndrome and 1 had traumatic zonular weakness. The incidence of anterior capsulotomy did not differ significantly between the 2 IOL populations ( $P > .5$ ), although preoperative pseudoexfoliation syndrome was a significant risk factor in both groups ( $P < .005$ ).

**Conclusions:** The polypropylene haptics of the SI-30NB IOL and the PMMA haptics of the SI-40NB IOL did not differ significantly in their ability to prevent CCS requiring anterior capsulotomy. Regardless of IOL haptic composition, eyes with preoperative zonular weakness associated with pseudoexfoliation syndrome or ocular trauma can develop CCS within 3 months of surgery and should, therefore, be followed closely in the early postoperative weeks to minimize the sequelae of anterior capsule fibrosis. *J Cataract Refract Surg* 1999; 25:1356–1361 © 1999 ASCRS and ESCRS

Capsulorhexis, or continuous curvilinear capsulotomy, is currently the most commonly used technique for opening the anterior lens capsule during phacoemulsification and extracapsular cataract extrac-

tion. Clinical and experimental evidence suggests that capsulorhexis provides a stronger anterior capsule edge than the can-opener or envelope capsulotomy.<sup>1</sup> Postoperatively, however, a small-diameter capsulorhexis may result in progressive shrinkage or complete closure of the anterior capsule opening marked by lens epithelial cell (LEC) proliferation and fibrosis.<sup>2–4</sup> This phenomenon

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has been termed capsule contraction syndrome (CCS) and has been associated with conditions including pseudoexfoliation syndrome and other diseases of zonular weakness, cataract surgery combined with trabeculectomy, diseases of intraocular inflammation and blood-aqueous barrier (BAB) compromise, and posterior chamber IOL (PC IOL) optic and haptic composition.<sup>2-15</sup>

Secondary complications of CCS include reduction of the equatorial capsular bag diameter, malposition of the anterior capsule opening, anterior subcapsule opacification, hyperopic shift, PC IOL displacement or encapsulation, zonular traction, ciliary body detachment with resultant hypotony, and retinal detachment.<sup>2,5,9,15,16</sup> Several case studies have reported CCS that developed within 3 months of surgery.<sup>2,5,14,15,17</sup> It has even been suggested that LECs can proliferate from the capsule edge to the surface of the anterior capsule as early as the second postoperative day.<sup>18</sup> Because of the potentially rapid onset of CCS and its associated complications, at-risk patients should be closely followed postoperatively. If indicated, early intervention, such as a neodymium:YAG (Nd:YAG) laser anterior radial relaxing capsulotomy, may reduce the sequelae of CCS.

The present study reviewed the need for an Nd:YAG laser anterior capsulotomy in eyes that had the AMO® PhacoFlex II SI-30NB or the SI-40NB silicone PC IOL (Allergan Medical Optics). The 2 models were identical except in haptic composition: polypropylene and flexible poly(methyl methacrylate) (PMMA), respectively.

During the study, the SI-30NB was abandoned in favor of the SI-40NB because reports suggested that PMMA haptics might maintain shape memory and therefore prevent rapidly progressive CCS better than polypropylene haptics.<sup>2,3,19</sup> The study attempted to identify risk factors and compare the incidence of rapidly progressive CCS associated with these 2 IOLs.

## Patients and Methods

All cases that had phacoemulsification with implantation of a PhacoFlex II SI-30NB or SI-40NB IOL performed by 1 surgeon (M.A.P.) from January 1995 through June 1998 were evaluated. Although the IOL models differed in haptic composition, they had similar

compression forces and force decays (personal communication, Tom McNicholas, Allergan, 1999).

For the sake of independent sampling, if a patient had surgery in both eyes during this period, only the first eye was considered. Additionally, patients who had combined procedures or were lost to follow-up within 6 months were excluded.

In each case, forceps-assisted anterior capsulorhexis using a viscoelastic agent was performed to make a capsulotomy opening of 5.0 mm or greater as viewed through the cornea. The 3-piece SI-30NB (January 1995 to February 1997) or SI-40NB (January 1997 to June 1998) IOL was implanted through a scleral tunnel or clear corneal incision. All eyes were examined a minimum of 1 day and 1 month postoperatively; long-term follow-up ranged from 6 to 33 months. A radial anterior capsulotomy was performed to treat reduced vision associated with CCS using a Nidek YC-1400 Nd:YAG laser. Typically, such visual loss was associated with segmental anterior capsule fibrosis or a generalized reduction in the capsulorhexis to a diameter of less than 3.0 mm. All capsulorhexis diameters were measured through the cornea and are, therefore, approximate.

Statistical analyses were performed using a *z* test with SigmaStat 2.0 software (SPSS Inc.), and *P* values of less than 0.05 were considered statistically significant.

## Results

Six cases required an anterior capsulotomy (Table 1). All except 1 also had a prophylactic posterior Nd:YAG laser capsulotomy.

Capsule contraction syndrome developed within 8 months in 3 of the 216 eyes with SI-30NB IOLs (1.4%). Two of these eyes had preoperative pseudoexfoliation syndrome. In 1 eye, the capsulorhexis closed completely (Figure 1). The CCS developed within 4 months in 3 of the 127 eyes with SI-40NB IOLs (2.4%). As in the SI-30NB group, 2 of these eyes had preoperative pseudoexfoliation syndrome.

The incidence of rapidly progressive CCS did not differ significantly in the 2 groups ( $P > .5$ ). However, preoperative pseudoexfoliation syndrome was a significant risk factor in both ( $P < .005$  in the SI-30NB group and  $P < .001$  in the SI-40NB group). In the SI-30NB group, 2 of 15 eyes with preoperative pseudoexfoliation syndrome (13.3%) and 1 of 201 without

**Table 1.** Summary of cases requiring Nd:YAG anterior capsulotomies

Case/ Sex	Age (Years)	Eye	IOL	Preoperative Ocular History	Systemic Diseases	First Visual Complaint (Days After IOL Implantation)	YAG (Days After IOL Implantation)
1/M	79	OD	SI-30NB	PEX	None	57	71
2/F	88	OD	SI-30NB	PEX Narrow angles Iridectomy	Diabetes mellitus	78	78
3/M	75	OD	SI-30NB	ARMD	None	192	196
4/F	83	OS	SI-40NB	PEX ARMD	None	43	43
5/M	87	OD	SI-40NB	PEX	None	103	120
6/M	62	OD	SI-40NB	Trauma Corneal scarring Zonular weakness	None	39	57

AC = anterior capsulorhexis; ARMD = age-related macular degeneration; BCVA = best corrected visual acuity; OD = right eye; OS = left eye; PEX = pseudoexfoliation; YAG = Nd:YAG anterior capsulotomy

\*In case 3, the anterior capsulorhexis opening was not concentric with the pupil. The fibrosis extended from the inferonasal rim of the capsulorhexis and impinged on the center of the pupil and visual axis.

(0.5%) developed CCS. In the SI-40NB group, 2 of 7 eyes with (28.6%) and 1 of 120 (0.8%) without developed CCS. The prevalence of pseudoexfoliation syndrome did not differ significantly between the populations: 6.9% and 5.5%, respectively ( $P > .5$ ).

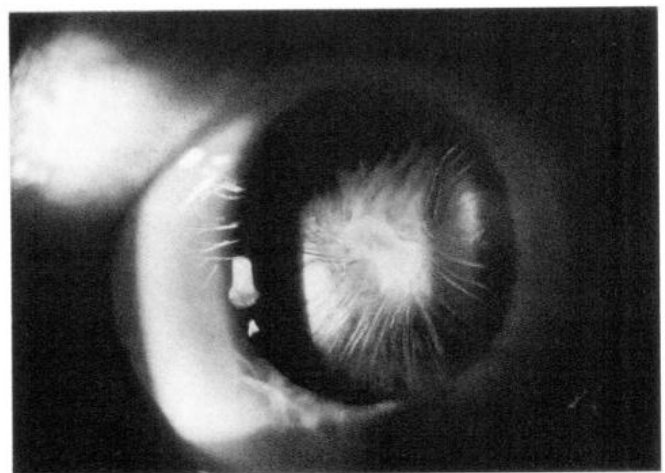
## Discussion

Although the pathogenic mechanisms responsible for excessive capsule fibrosis and contracture are not well understood, several histopathological studies have identified the cell types associated with pseudophakic fibrosis.<sup>16–18,20–24</sup> Metaplasia of residual LECs contributes to the fibrosis and “purse-string” contracture and closure of the anterior capsulotomy (Figure 2). This response may be exaggerated when unopposed by normal zonular tension. The stimulus for the LEC proliferation appears to be a reparative reaction to lens disruption, perhaps induced by exposure to aqueous-derived factors or by alterations in cell–cell contact interactions. In culture, epithelial cells have been shown to produce interleukin-1, interleukin-6, and other cytokines that affect cell proliferation.<sup>7</sup>

Several measures may reduce the severity of the fibrotic response; unfortunately, many may not be appropriate in eyes with zonular laxity. For example, the irrigation/aspiration probe can be used to vacuum the

undersurface of the anterior lens capsule to reduce residual LECs and the likelihood of fibrosis.<sup>13,25,26</sup> However, this method can be difficult, particularly in cases of zonular laxity. Such cases face an increased risk of capsular capture by the aspiration probe, resulting in worsening of the zonular compromise and capsular collapse.

Other studies suggest that the optic composition may influence the development of anterior capsule fibrosis. Specifically, IOLs with acrylate copolymer (Acry-Sof®) optics are probably better at maintaining large capsulorhexis diameters than IOLs with silicone optics.<sup>27</sup> This capability has been attributed to a unique



**Figure 1.** (Gallagher) Slitlamp photograph of the eye in Case 1 shows complete closure of the capsulorhexis.

Table 1. (Continued)

AC Opening Before YAG		BCVA		AC Diameter at Last Exam (mm)	Follow-Up (Months After YAG)	Comments
Horizontal (mm)	Vertical (mm)	Before YAG	At Last Exam			
0	0	20/200	20/20	3.5	26	—
1.5	1.5	20/80	20/30	3.0	32	—
3.0*	3.0*	20/80	20/30	3.5	18	Elevated IOP 1 day after IOL implantation
<1.5	<1.5	20/400	20/400	3.5	5	YAG subjectively improved vision
2.2	2.0	20/80	20/25	3.7	16	—
2.3	1.3	20/70	20/25	3.0	14	No prophylactic posterior capsulotomy: small pupil

adhesive reaction between the acrylate optic and the capsule that resists both posterior capsule opacification and CCS.<sup>28–30</sup> Therefore, it may be advantageous to implant IOLs with acrylate optics in eyes at risk for CCS because of zonular laxity. However, acrylate lenses can be difficult to explant because of their adhesive nature, and explantation may risk additional damage to already compromised zonules.<sup>28</sup>

In eyes with profound zonular weakness, an endocapsular tension ring can be implanted at the time of surgery to provide better and more symmetric capsular bag support than the haptics alone.<sup>31,32</sup> However, this step involves additional manipulation of the capsule during surgery and, as demonstrated in our study by the pseudoexfoliation syndrome eyes that did not develop

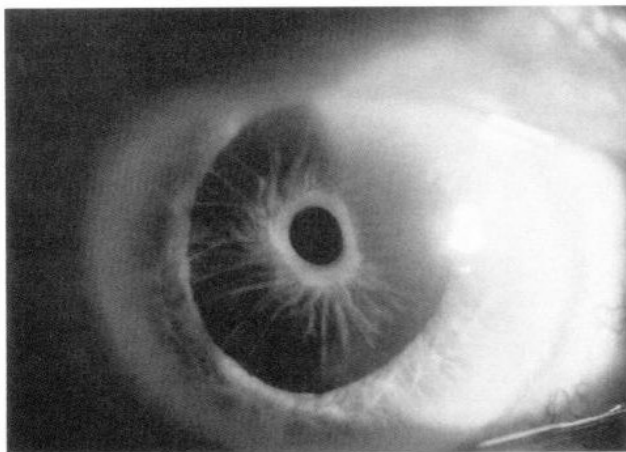


Figure 2. (Gallagher) Slitlamp photograph of purse-string closure of the capsulorhexis.

CCS, may not be necessary in cases of mild to moderate zonular laxity. Currently, the U.S. Food and Drug Administration (FDA) has not approved the endocapsular tension ring.

Several reports state that PMMA haptics maintain the capsulorhexis diameter more effectively than polypropylene haptics.<sup>2,3,19</sup> Although this study suggests that the PMMA haptics of the SI-40NB IOL are not significantly better than the polypropylene haptics of the SI-30NB IOL at preventing clinically significant fibrosis, we did not attempt to quantify the capsulorhexis diameter in all cases.

As others have suggested,<sup>8,10,28</sup> IOL composition is likely to affect fibrosis and postoperative capsulorhexis diameter. Nevertheless, especially in the presence of compromised zonules, the underlying ocular condition may present a risk of CCS independent of IOL composition. In case studies, CCS has been associated with a variety of IOL types, including single-piece PMMA models.<sup>2,7,14,15,17,33,34</sup> However, as in our study, nearly all the reported cases involve a preoperative condition that has been linked to the complication.

The fellow eyes in 2 cases in our study, although not statistically independent and therefore not considered in the analysis, also required an anterior capsulotomy in a similar postoperative time course. The patient in Case 1 had preoperative pseudoexfoliation syndrome in both eyes and received SI-30NB IOLs bilaterally; he required an anterior capsulotomy at 71 days in the first eye and

50 days in the second. The patient in Case 5 also had preoperative pseudoexfoliation syndrome in both eyes but received SI-40NB IOLs bilaterally. He required an anterior capsulotomy at 120 days and 71 days, respectively. In each patient, the surgeon attempted to increase the diameter of the second capsulorhexis to at least 6.0 mm. However, this measure did not prevent the development of CCS.

Five of the 6 cases involved preoperative zonular laxity from pseudoexfoliation syndrome or preoperative ocular trauma. Case 3 is the only one without an obvious preoperative disposition toward anterior capsule fibrosis and may represent a fibrotic response that is different from that in the other eyes. This patient did not notice a decrease in vision until almost 5 months after surgery, whereas 4 of the other 5 cases noted a decrease within 3 months. Additionally, the eye in Case 3 did not demonstrate the purse-string closure of the anterior capsule observed in the other cases. Instead, the fibrosis progressed in 1 direction, across the pupil from the inferonasal capsulorhexis margin toward the superotemporal margin. This eye demonstrated an intraocular pressure (IOP) of 40 mm Hg on the first day after IOL implantation. The patient was treated with timolol (Timoptic-XE®) for 2 days, and subsequent IOP measurements were below 20 mm Hg without medication. It is not known whether the postoperative IOP triggered the fibrosis by generating an unnoticed inflammatory response. If such a response compromised the BAB, the aqueous may have been exposed to cytokines that stimulated LEC activity, leading to the fibrosis along the inferonasal ridge. This mechanism has been suspected as the cause of both anterior and posterior capsulorhexis contraction in eyes with destabilized BABs and may differ from the mechanism that causes CCS in cases of zonular weakness.<sup>12,35,36</sup>

All our CCS cases were treated successfully with an Nd:YAG capsulotomy that prevented recurrent closure of the capsulorhexis. Although the patients are doing well, we continue to follow them closely, as the long-term complications of anterior radial capsulotomy with 3-piece foldable IOLs are not known. An Nd:YAG anterior capsulotomy must be performed with caution in cases involving plate-haptic silicone IOLs, which depend on an intact continuous capsulorhexis rim.<sup>5</sup> Plate-haptic silicone IOLs have been reported to dislocate

within 1 month of an Nd:YAG anterior capsulotomy for CCS.<sup>34</sup>

In summary, this study suggests that the PMMA haptics of the SI-40NB IOL do not reduce the risk of CCS in eyes with compromised zonules significantly better than the polypropylene haptics of the SI-30NB IOL. Considering the recent FDA approval of multifocal IOLs and their increasing popularity, it should be noted that with the exception of the anterior surface of the optics, the SI-40NB is identical to the AMO Array® SA-40N IOL. Apart from haptic composition, many factors, including IOL optic composition, optic dimensions, haptic dimensions, intraoperative capsulorhexis diameter, and the use of a capsular tension ring, may influence the final postoperative diameter of the capsulorhexis. However, the relationship between these factors and advanced fibrosis in the form of CCS is unknown. We recommend that eyes with apparent or suspected zonular compromise be followed closely in the postoperative period to minimize the consequences of anterior capsule fibrosis.

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*Accepted for publication August 2, 1999.*

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*Presented in part at the annual meeting of the Association for Research in Vision and Ophthalmology, Fort Lauderdale, Florida, USA, May 1997.*

*None of the authors has a financial interest in any product mentioned.*

*David C. Musch, PhD, provided statistical advice.*