

# Prospective Multicenter Evaluation of Cataract Surgery in Patients Taking Tamsulosin (Flomax)

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**Purpose:** Intraoperative floppy iris syndrome (IFIS) caused by systemic  $\alpha$ -blockers has been associated with an increased risk of cataract surgical complications when the surgeon was unaware of the medication history and did not anticipate its occurrence. This study was undertaken to evaluate the surgical outcomes and rate of complications when the ophthalmologist knew the patient was taking tamsulosin (Flomax, Boehringer-Ingelheim Pharmaceuticals, Ridgefield, CT) and used 1 of several strategies to manage IFIS.

**Design:** Prospective multicenter nonrandomized observational series.

**Participants:** A total of 167 consecutive eyes in 135 patients taking tamsulosin and undergoing cataract surgery.

**Methods:** Phacoemulsification was performed in conjunction with at least 1 of 4 different IFIS management strategies, namely, topical atropine preoperatively, iris retractors, pupil expansion ring, or use of viscoadaptive ophthalmic viscosurgical device with reduced fluidic parameters.

**Main Outcome Measures:** Severity of IFIS, incidence of operative or postoperative complications, and final visual acuity.

**Results:** The IFIS severity was rated as mild in 17%, moderate in 30%, and severe in 43% of the study eyes. No IFIS was noted in 10% of the eyes. The rate of posterior capsule rupture and vitreous loss was 0.6% (1/167; 95% confidence interval, 0%–1.8%). Ninety-five percent of eyes achieved a best-corrected visual acuity of at least 20/40.

**Conclusion:** When experienced surgeons could anticipate IFIS and employ compensatory surgical techniques, the complication rate from cataract surgery was low and the visual outcomes were excellent in eyes of patients with a history of tamsulosin use. *Ophthalmology* 2007;114:957–964 © 2007 by the American Academy of Ophthalmology.

Tamsulosin (Flomax, Boehringer-Ingelheim Pharmaceuticals, Ridgefield, CT) is 1 of several systemic  $\alpha$ -1 adrenergic antagonists used to treat the lower urinary tract symptoms of benign prostatic hyperplasia. Other medications in this group include terazosin (Hytrin; Abbott Laboratories, Abbott Park, IL), doxazosin (Cardura; Pfizer, New York, NY), and alfuzosin (Uroxatral; Sanofi-Aventis, Bridgewater, NJ). These drugs improve urinary outflow by relaxing the smooth muscle in the prostate and bladder neck.

Intraoperative floppy iris syndrome (IFIS) associated with the use of tamsulosin was first described in 2005.<sup>1</sup> This

association has been confirmed by several additional published studies.<sup>2–5</sup> Characteristics of this new small pupil syndrome include poor preoperative pupil dilation and intraoperative iris billowing, iris prolapse, and progressive pupillary miosis. Intraoperative floppy iris syndrome may occur in patients taking other  $\alpha$ -blockers as well.<sup>2,6–10</sup> Subsequent retrospective studies have confirmed Chang and Campbell's original observation of an increased rate of complications in eyes with IFIS, such as iris trauma, posterior capsule rupture, and vitreous loss.<sup>2</sup> Unfortunately, stopping systemic  $\alpha$ -blockers preoperatively does not reliably prevent IFIS.<sup>1,2,5</sup> In addition, 2 of the most popular techniques for small pupil management—partial thickness sphincterotomies and mechanical pupil stretching—are ineffective for IFIS and indeed may exacerbate it.<sup>1</sup> For this reason, a number of alternative methods for managing the pupil in IFIS have been described.<sup>1,2,11–17</sup>

Because of the increased difficulty of performing phacoemulsification in eyes with IFIS, valid concerns have been raised about the safety of prescribing  $\alpha$ -blockers such as tamsulosin in patients with developing cataracts. Retrospective studies to date have only determined the rate of surgical complications when, before the recognition of this syndrome, surgeons did not anticipate IFIS or understand its

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pathophysiology.<sup>1,2</sup> What is not known is the risk of surgical complications when the ophthalmologist, forewarned by a history of  $\alpha$ -blocker use, anticipates IFIS and employs alternative methods of small pupil management. A prospective multicenter trial was organized to assess the surgical outcomes and complication rates in a consecutive series of cataract patients taking tamsulosin.

## Patients and Methods

All eligible cataract patients taking tamsulosin were consecutively enrolled at 1 of 10 study sites in the United States. All of the investigators were highly experienced cataract surgeons; their names and practice locations are listed under Tamsulosin Study Group in the Appendix. Institutional review board approval was obtained, as was written informed patient consent. Male or female patients undergoing cataract surgery who were taking tamsulosin were eligible. Patients were excluded if there was any history of iridocyclitis, iris neovascularization, or prior iris surgery. Patients with traumatic cataracts, zonular dialysis, or cataracts associated with ocular disease (e.g., uveitis) were also excluded.

All patients were dilated preoperatively with topical 2.5% phenylephrine and either 1% tropicamide or 1% cyclopentylate (at the surgeon's discretion). In all cases, cataract surgery was performed using a temporal clear corneal or scleral pocket small incision, capsulorhexis, phacoemulsification, and foldable lens implantation. Either topical or regional injection anesthetic was used. The surgeons were asked to use 1 of 4 methods for managing the pupil—iris retractors, a pupil expansion ring, viscoadaptive ophthalmic viscosurgical device (OVD; Healon 5, Advanced Medical Optics, Santa Ana, CA) with low fluidic parameters, or preoperative topical atropine. The choice of technique was left entirely to the surgeon's discretion, and a second strategy could be used if the primary method alone was ineffective. For example, the surgeon could insert iris retractors if the pupil constricted despite preoperative atropine or the use of Healon 5. When selected as the primary method, 1% atropine was administered topically thrice daily for 1 to 2 days before surgery. The Healon 5 method mandated the use of low infusion, low aspiration flow rate and vacuum parameters (vacuum < 200–250 mmHg and aspiration flow rate < 25 cc/min) to delay its evacuation from the eye.

During cataract surgery, pupil size was measured with calipers at the following times: (1) At the start of surgery (after administration of all topical dilating agents); (2) after hydrodissection; (3) at the conclusion of phacoemulsification; (4) after aspiration of the cortex; and (5) at the conclusion of surgery before any miotics were administered. The severity of IFIS was assessed during evacuation of the OVD with the irrigation–aspiration handpiece, and after the removal of any mechanical dilating devices. Intraoperative iris behavior was graded as follows: no IFIS (stable normal iris with no significant miosis), mild IFIS (slightly noticeable floppy iris, minor or no miosis, and no tendency of iris prolapse), moderate IFIS (floppy iris, significant miosis, and small tendency for iris prolapse), and severe IFIS (floppy iris, significant miosis, and strong tendency for iris prolapse). Significant miosis was defined as  $\geq 3$ -mm decrease in pupil diameter if mechanical iris devices were used or  $\geq 2$ -mm decrease in pupil diameter if no iris devices were used. All operative complications were recorded including but not limited to torn capsulorhexis, torn posterior capsule, vitreous loss, iris tears, iridodialysis, and hyphema.

All postoperative complications were recorded, including but not limited to persistent uveitis, persistent intraocular pressure (IOP) rise (defined as requiring new or additional glaucoma medication by 1 month postoperatively), and clinical cystoid macular

edema. Any iris abnormality such as pupil distortion, posterior synechiae, iridodialysis, iris stromal tears, transillumination defects, or permanent mydriasis was noted. Pupil size and best-corrected visual acuity at the final postoperative visit (minimum 1 month) were also recorded.

## Statistical Analysis

The point and 95% confidence interval (95% CI) estimation for the surgical complication rate were determined. The Mann–Whitney test (between 2 groups) and Kruskal–Wallis test (among  $\geq 3$  groups) were performed to assess if the eye color or stopping tamsulosin before the surgery made a difference in IFIS severity and if the IFIS severity score differed among the treatment groups. Independent-samples *t* test was used to evaluate whether stopping tamsulosin made a difference in pupil size at the start of surgery and whether the change in pupil size from the start to the conclusion of surgery was different in the atropine and Healon 5 groups. All statistical tests were done using the SPSS program (SPSS Inc., Chicago, IL), and a probability of less than 5% ( $P < 0.05$ ) was considered statistically significant.

## Results

### Patient Characteristics

Between March and September 2005, 167 consecutive eyes in 135 patients taking tamsulosin were enrolled at the 10 study sites. All of the patients were male, and 15% of the surgeries were in diabetic patients. Pseudoexfoliation was present in 6% of the eyes. The iris color was blue in 49% of the eyes, brown in 36% of the eyes, and blue-green in 15% of the eyes. Preoperatively, the nuclear density was graded as being 1 to 2+ in 65% and 3 to 4+ in 35% of the eyes. Topical 1% cyclopentylate was used in 32% of cases, with the remainder receiving 1% tropicamide. Topical anesthesia was used in 75% of the cataract operations, and regional injection anesthesia in 25%. All cases were done with coaxial phacoemulsification. Phaco chop was used in 91% of the surgeries, and some form of divide-and-conquer was used in the remaining 9%. All patients completed the minimum 1-month follow-up.

### Surgical Techniques

Cataract operations were performed by 1 of 15 surgeons at the 10 study sites. The IFIS management strategy used to complete each of the 167 operations is shown in Table 1.

When mechanical devices (either iris retractors or pupil expansion rings) were used, no additional methods were needed. Patients receiving a pupil expansion ring had an average preoperative pupil diameter of  $4.3 \pm 1.2$  mm, and patients receiving iris retractors had an average preoperative pupil diameter of  $5.8 \pm 1.0$  mm (Table 1). In the 103 cases where the Healon 5 was used, 95% (98/103) did

Table 1. Intraoperative Floppy Iris Syndrome Management Strategy by Percentage of Cases Completed and Mean Starting Pupil Diameter (PD)

Patient Treatment Group	% Cases Completed	Preoperative Mean PD (mm)
Healon 5	60 (n = 101)	6.6 $\pm$ 1.2
Iris retractors	31 (n = 51)	5.8 $\pm$ 1.0
Pupil expansion ring	4 (n = 7)	4.3 $\pm$ 1.3
Topical atropine	5 (n = 8)	7.2 $\pm$ 0.9

Table 2. Intraoperative Pupil Diameter Change in the Atropine-only Group (n = 8)\*

Mean Preoperative Pupil Diameter = 7.2 mm	Mean Decrease in Pupil Diameter (mm)
After hydrodissection	0.1±0.5
After nuclear removal	0.4±1.3
After cortex removal	0.6±1.4
Conclusion of surgery	0.9±1.6

\*In 9 of 17 eyes in which atropine was administered, a second strategy was used by the surgeon to assist in managing the intraoperative floppy iris syndrome.

not require any other supplemental pupil expansion method. In the 5 remaining Healon 5 cases, the additional use of iris retractors or pupil expansion rings became necessary to manage the iris.

Preoperative topical atropine was used in 19 eyes. This alone permitted completion of surgery in 8 eyes. In the remaining 11 eyes, supplemental strategies were necessary to manage the iris, meaning that the majority of cases (11/19; 58%) could not be completed with topical atropine alone. Of the original 19 eyes in the atropine group, the Healon 5 method was used in 2 eyes, and iris retractors were used in 9 eyes.

For obvious reasons, there was no intraoperative decrease in pupil diameter during the period that either iris retractors or pupil expansion rings were in place. When preoperative topical atropine was used as the sole iris management strategy (n = 8), the average preoperative pupil diameter was 7.2±0.9 mm (Table 1). Compared to its preoperative size the pupil diameter decreased by an average of 0.9±1.6 mm by the conclusion of surgery (Table 2). When the Healon 5 method was used as the sole management strategy (n = 97), the average preoperative pupil diameter was 6.6±1.2 mm (Table 1). Compared with its preoperative size the pupil diameter decreased by an average of 1.9±1.2 mm by the conclusion of surgery (Table 3).

The presence and severity of IFIS was graded at the conclusion of surgery while the OVD was being aspirated (Table 4). No IFIS was noted in 10% of eyes, and moderate to severe IFIS was present in 73% of eyes. Intraoperative floppy iris syndrome severity scores did not differ according to eye color (Kruskal–Wallis test, chi-square test [2] = 0.67; P = 0.72). However, when the 4 different treatment groups were compared, IFIS severity was higher in the eyes in which iris retractors and pupil expansion rings were used compared to the Healon 5 group (P<0.01). There was no statistical correlation between preoperative pupil size and IFIS severity score (Spearman’s rank correlation coefficient = -0.001; P=0.99).

Tamsulosin was stopped preoperatively in 32 eyes (19%). Depending on the surgeon and the patient, the duration of preoperative cessation varied from 1 to 8 weeks. Overall, this did not

Table 3. Intraoperative Pupil Diameter Change in the Healon 5 Group (n = 101)\*

Mean Preoperative Pupil Diameter = 6.6 mm	Mean Decrease in Pupil Diameter (mm)
After hydrodissection	0.8±1.0
After nuclear removal	1.5±0.9
After cortex removal	1.8±0.9
Conclusion of surgery	1.9±1.2

\*In an additional 4 eyes treated with Healon 5, the surgeon used a second strategy to help manage the intraoperative floppy iris syndrome.

Table 4. Intraoperative Floppy Iris Syndrome (IFIS) Severity (Surgeon Rating)

IFIS Severity	% of Cases
No IFIS	10
Mild	17
Moderate	30
Severe	43

result in any difference in IFIS severity (Mann–Whitney test, z = 1.14; P = 0.26). The effect of stopping tamsulosin on IFIS severity scores was separately evaluated in both the atropine and the Healon 5 subgroups. Stopping tamsulosin did not reduce the IFIS severity score in either subgroup. However, stopping tamsulosin did result in a larger pupil size at the beginning of surgery (mean pupil diameter 6.9±1.5 mm in stopped cases vs 6.0±1.2 mm in nonstopped cases; P<0.001).

### Surgical Outcomes

Posterior capsule rupture and vitreous loss occurred in 1 eye (1/167, incidence 0.6%; 95% CI: 0%–1.8%). This patient achieved a final best-corrected visual acuity of 20/20. One patient developed clinical cystoid macular edema (0.6%; 95% CI: 0%–1.8%). After treatment with a periocular steroid injection, the vision improved from 20/160 to 20/20.

On the first postoperative day, 22% of the eyes had IOP >24 mmHg, and in 14 % the IOP was >29 mmHg. There were no cases of persistent IOP elevation requiring new or additional topical medication. Mild to moderate iris transillumination defects were noted in 16% (27/167; 95% CI, 11%–22%) of the eyes. There were no cases of peaked or distorted pupils, iridodialysis, or permanent mydriasis.

Best-corrected visual acuity of at least 20/40 was achieved in 95% of the eyes enrolled. Of the 9 eyes (5%) that did not achieve this level of vision, the cause was deemed to be amblyopia in 1 case, an epiretinal membrane in 2 eyes, and age-related macular degeneration in the remaining 5 eyes.

### Discussion

Intraoperative floppy iris syndrome is most commonly caused by systemic α<sub>1</sub>-adrenergic antagonists, such as tamsulosin.<sup>1–5</sup> In our study of tamsulosin patients presenting for cataract surgery, IFIS was diagnosed in 90% of the eyes enrolled. Among currently prescribed α<sub>1</sub>-antagonists, tamsulosin is the only drug that is selective for the α<sub>1A</sub>-receptor subtype.<sup>18,19</sup> This is the predominant α<sub>1</sub>-receptor subtype present in both the prostate and iris dilator smooth muscle.<sup>19–21</sup> Because of this receptor subtype specificity, tamsulosin is more uroselective and less likely to cause postural hypotension.<sup>18</sup> For this reason, it is the most commonly prescribed medication for benign prostatic hyperplasia.

Intraoperative floppy iris syndrome can occur in patients taking nonselective α<sub>1</sub>-antagonists as well.<sup>2,7–9</sup> These drugs include terazosin, doxazosin, and alfuzosin. In our experience, in comparison with tamsulosin, IFIS is less common and less severe in patients taking nonselective α-adrenergic medications.<sup>1,4,22,23</sup> For example, in 1 large retrospective chart review of 1298 cataract patients, 5% of patients were

taking systemic  $\alpha$ -blockers at the time of surgery. Tamsulosin accounted for only 26% of the  $\alpha$ -blockers used, but 71% of the cases with intraoperative iris prolapse (Radomski SB, Srinivasan S, Chung S, et al. Intraoperative iris prolapse during cataract surgery in men using alpha-blockers for lower urinary tract symptoms due to benign prostatic hypertrophy. Paper presented at: American Urological Association Annual Meeting, May 20–26, 2006, Atlanta, Georgia). Another prospective study of 1786 patients showed that only 1 of 51 patients taking other  $\alpha_1$ -antagonists had IFIS, compared with 57% of patients taking tamsulosin.<sup>4</sup> One explanation might be that tamsulosin, in comparison with the nonspecific  $\alpha$ -blockers, demonstrates significantly greater affinity for the  $\alpha_{1A}$  receptor subtype.<sup>22–25</sup> A greater and more prolonged blockade of the iris  $\alpha_{1A}$  receptors might be more likely to cause the loss of iris dilator smooth muscle tone that characterizes IFIS. Although no histologic dilator muscle changes have been noted in tamsulosin patients, this loss of tone can persist for several years after cessation of the drug (Destafeno JJ, Kim T. The effect of alpha1-adrenergic receptor antagonist tamsulosin on iris smooth dilator muscle anatomy. Poster presented at: AAO Annual Meeting, November 11–14, 2006, Las Vegas, Nevada). Intraoperative floppy iris syndrome has also been associated with other drugs possessing  $\alpha$ -antagonist effects.<sup>2,26</sup> Although all of the subjects taking tamsulosin in our study were male,  $\alpha_1$ -blockers are also prescribed for urinary retention or hypertension in women, and IFIS can therefore arise in either gender.<sup>1,2,27</sup>

Intraoperative floppy iris syndrome frequently manifests a triad of intraoperative signs: billowing and floppiness of the iris in response to normal irrigation currents, a strong propensity for the iris to prolapse, and progressive intraoperative miosis.<sup>1</sup> Although most IFIS pupils dilate poorly preoperatively, some dilate normally.<sup>1,5</sup> Before the first report of its association with tamsulosin, cataract surgeons had no way to anticipate when IFIS might occur. In the absence of this knowledge, IFIS could produce surgical complications in several ways. Sudden iris prolapse and miosis after hydrodissection or upon initiating phaco are certainly not expected in eyes with well-dilated pupils. Neither is such iris behavior expected after partial thickness sphincterotomies and mechanical pupil stretching for a small pupil. Unfortunately, these popular small pupil management techniques are ineffective for IFIS and may worsen the iris problems.<sup>1</sup> Finally, when confronted with unexpected intraoperative miosis, placement of mechanical devices, such as iris retractors or a pupil expansion ring, is much more difficult after the capsulotomy and hydrodissection have been performed.

Not surprisingly, unexpected iris prolapse and intraoperative miosis increase the rate of surgical complications. Such problems include iris trauma, iris aspiration by the phaco or irrigation-aspiration tip, iridodialysis, hyphema, posterior capsule rupture, zonular dialysis, and vitreous loss.<sup>1,2,28</sup> We previously reported a 12% rate of posterior capsule rupture and vitreous loss in a retrospective series of IFIS cases.<sup>1</sup> Furthermore, there were 4 tamsulosin patients included in the retrospective and prospective arms of the study who had previously undergone cataract surgery else-

where in their contralateral nonstudy eye. Posterior capsule rupture and vitreous loss had occurred in 2 of these 4 contralateral nonstudy eyes.

Since the initial published description of IFIS, other retrospective studies have documented a higher rate of posterior capsule rupture associated with unrecognized tamsulosin use. Nguyen et al<sup>2</sup> reported a 7% rate of posterior capsule rupture among >600 cases of IFIS retrospectively reported in a national survey conducted in the United Kingdom. Another surgeon reviewed the charts of every case of posterior capsule rupture in his practice from 2000 to 2004, before the first report of IFIS. Of the 5 patients who had experienced this complication, 4 were taking tamsulosin at the time of their surgery (Richard Beller, MD, personal communication, 2005). At the Massachusetts Eye and Ear Infirmary, a review of resident cataract surgery on patients taking tamsulosin from 2001 to 2006 showed a statistically significant increase in posterior capsule rupture (22%) when compared to age-matched controls (Joseph P, Kim JY, Henderson BA, Cremers SL. Intraoperative floppy iris syndrome associated with tamsulosin in a residents' cataract outcomes database. Poster presented at: ARVO, April 30–May 4, 2006, Fort Lauderdale, Florida). A separate retrospective review of the resident cataract database was undertaken for the 2-year period immediately before the first description of IFIS. The database included seven instances where systemic  $\alpha$ -blockers were recorded in the patient's medical history. A review of these 7 charts revealed that vitreous loss had occurred in 71% (5/7) of the eyes, suggesting a higher complication rate when IFIS was neither anticipated or recognized (Bonnie An Henderson, MD, personal communication, 2005).

Our original study reported that IFIS could surprisingly occur more than 1 year after cessation of tamsulosin.<sup>1</sup> Similar reports have appeared in the literature, and surgeons participating in the current trial have observed cases of IFIS occurring from 3 to 5 years after stopping the drug.<sup>2,27</sup> In a recent study, tamsulosin was detectable in the aqueous humor of 3 of 5 patients who discontinued the drug for 7 to 28 days before cataract surgery, suggesting a very prolonged drug-receptor binding time.<sup>5</sup> In the current study, surgeons were given the option of stopping tamsulosin preoperatively, which they did in 19% of the surgeries. This resulted in a larger mean preoperative pupil diameter, but was not associated with an improvement in reported IFIS severity scores. Although this was not a randomized comparison, it is clear that stopping tamsulosin preoperatively does not reliably prevent IFIS or reduce its severity.

Another question is how quickly IFIS can occur after initiation of systemic  $\alpha$ -blockers. There are several reports suggesting that IFIS can occur within weeks of starting tamsulosin.<sup>2,27</sup> In 1 interesting anecdotal case, a patient with no prior history of tamsulosin underwent unremarkable cataract surgery in the first eye, only to manifest severe IFIS in the second eye 1 month later. Further questioning revealed that he had been started on tamsulosin 2 weeks before the second eye surgery (Marc Daniels, MD, personal communication, 2005).

A number of approaches have been proposed to manage the iris in IFIS. These include pharmacologic approaches,

the use of highly viscous or viscoadaptive OVDs, and placement of mechanical dilating devices.<sup>1,2,11–17</sup> We believe that certain general surgical principles should be universally applied. These include the careful construction of appropriately sized incisions, use of very gentle hydrodissection, lowering the irrigation inflow rate if possible, and directing irrigation currents away from the pupillary margin. Partial thickness sphincterotomies and mechanical pupil stretching should be avoided.<sup>1</sup>

Several adjunctive pharmacologic approaches to managing IFIS have been described. As noted, simply stopping tamsulosin preoperatively is of unpredictable and questionable value. Preoperative atropine drops (e.g., 1% thrice daily for 1–2 days preoperatively) maximizes cycloplegia, and was first suggested by one of our investigators, Sam Masket, MD. Because of the risk of acute urinary retention, systemic  $\alpha$ -blockers should not be stopped altogether if atropine is employed. Off-label intracameral injection of  $\alpha_1$ -agonist drugs such as phenylephrine and epinephrine directly stimulates the iris dilator smooth muscle receptors.<sup>2,12,13,16,17</sup> In addition to dilating the pupil, these mydriatics may improve iris rigidity by increasing dilator smooth muscle tone. To buffer the pH, it is important to avoid preserved solutions and to use a diluted mixture, for example, 1:1000 bisulfite-free epinephrine mixed 1:3 with BSS or BSS Plus (Alcon, Fort Worth, TX).<sup>13</sup>

Of the many available OVDs, the Healon 5 excels in its viscomydriatic ability and is uniquely able to block the iris from prolapsing to the incisions (Fig 1).<sup>1</sup> Two of the authors (RHO, DDK) were the earliest advocates of this technique. However, low aspiration flow and vacuum settings (e.g.,  $\leq 25$  cc/min;  $\leq 200$ – $250$  mmHg) should be used to allow the Healon 5 to remain in the anterior chamber for as long as possible. As the pupil constricts during phaco, Healon 5 can be repeatedly reinjected. Compared to using mechanical expansion devices, the Healon 5 method is more dependent upon proper phaco technique and fluidic parameters. Other OVDs can be used together in combination with Healon 5.<sup>11</sup>

Devices that mechanically dilate the pupil and restrain it from prolapsing include iris retractors and pupil expansion rings.<sup>29,30</sup> Both the 5S Pupil Ring (Morcher GmbH, Stuttgart, Germany; distributed by FCI Ophthalmics, Marshfield Hills, MA) and the Perfect Pupil (Milvella Ltd, Sydney, Australia) are grooved polymethyl methacrylate rings that are threaded along the pupillary margin using a metal injector (Fig 2).<sup>31</sup> A disposable plastic injector is used to insert the Graether silicone pupil expansion ring (Eagle Vision, Inc, Memphis, TN).<sup>32</sup> All of these rings are more difficult to position if the pupil is  $< 4$  mm wide, or if the anterior chamber is shallow. An excessively large pupil diameter (e.g.,  $\geq 7$  mm) may prevent the rings from engaging the pupillary margin. A foldable metal expansion device has been developed as well (Malyugin BE, Russian solution to small-pupil phaco and tamsulosin floppy-iris syndrome. Video presented at: ASCRS Annual Symposium, March 2006, San Francisco, CA).

We recommend positioning iris retractors in a diamond configuration (Fig 3).<sup>33</sup> The subincisional retractor is inserted through a separate paracentesis track that is beneath and separate from the phaco incision. This retractor maxi-

mizes exposure immediately in front of the phaco tip, and pulls the iris posteriorly away from it. Disposable retractors are manufactured with 6-0 nylon (available from Alcon); autoclavable retractors are made of 4-0 polypropylene (Katena Products, Inc, Denville, NJ, and FCI Ophthalmics). Because the pupillary margin is typically elastic, iris retractors are much less likely to induce sphincter tears in IFIS compared to when the pupil is fibrotic (e.g., chronic miotic use or posterior synechiae). Like pupil expansion rings, iris retractors are much easier to insert before initiation of the capsulorhexis. Should iris retractors need to be inserted after the capsulotomy and hydrodissection, it is useful to lift the pupil margin with a manipulating hook or with Healon 5 to avoid engaging the capsulorhexis edge.

In our experience and that of others, there is a wide range of IFIS severity, which varies between different patients, and even between different eyes in the same patient.<sup>2–4,22,27</sup> We propose that IFIS can be categorized as mild (good dilation; some iris floppiness without prolapse or constriction), moderate (some tendency for iris prolapse and constriction of a moderately dilated pupil), or severe (classic triad often accompanied by poor preoperative dilation). Of course, some criteria such as floppiness are subjective, which may lead to interobserver grading variability. Unfortunately, there is no reliable way to predict the severity of IFIS in advance. Poor preoperative dilation usually forewarns severe IFIS. Billowing of the iris during initial injections of fluids into the anterior chamber also suggests that IFIS will ensue. Although IFIS was not present in 10% of eyes in this study, moderate to severe IFIS was present in 73% of all eyes (Table 4). In a much smaller prospective study of 17 eyes in patients taking tamsulosin, 35% (6/17) had no IFIS, compared with 47% (8/17) who rated moderate to severe IFIS.<sup>3</sup>

Because of this individual variability, it is difficult to conclude whether 1 IFIS management technique is superior to another. Given the potentially higher risk of complications in tamsulosin eyes, surgeons participating in this study were given full discretion and flexibility in their choice of surgical techniques. As a nonrandomized observational trial, we did not seek to determine whether 1 method of iris management was safer than another. We also allowed surgeons to use multiple techniques if a single method alone was not sufficiently safe. Indeed, pharmacologic approaches and the use of a high viscosity OVD and mechanical devices constitute complementary strategies that can be used either alone or in combination.

In our series, the most common iris management technique employed was the Healon 5 method (60%), followed by iris retractors (31%; Table 1). The majority of eye surgeons responding to a recent nationwide questionnaire in the United Kingdom also preferred these 2 techniques.<sup>2</sup> In this poll, 61% of surgeons preferred iris retractors and 27% preferred Healon 5 with low flow for IFIS cases. An audience response poll conducted at a United States cataract complications symposium revealed that 46% of the respondents listed iris retractors and 35% listed Healon 5 as their preferred technique for managing IFIS (Spotlight on Cataracts Symposium, American Academy of Ophthalmology Annual Meeting, 2005, Chicago, IL). Among mechanical

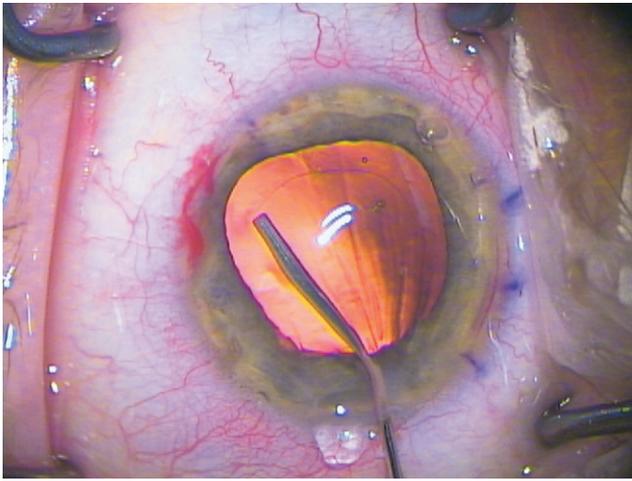


Figure 1. Viscomydriasis using Healon 5 injection.

devices used in the present study, iris retractors were preferred over pupil expansion rings by a 6:1 margin.

Although Bendel and Phillips<sup>15</sup> reported that topical atropine alone was sufficient for managing IFIS in 81% of their 16 tamsulosin cases, this was not true in our study. Although topical atropine generally produced the largest preoperative pupils (mean diameter, 7.2 mm), 58% of the 19 eyes receiving preoperative atropine required additional measures such as iris retractors to manage the iris. Of those eyes in which atropine alone successfully managed the iris, the average decrease in pupil diameter was only 0.9 mm by the conclusion of surgery (Table 2). The success of intracameral mydriatic drugs, such as phenylephrine and epinephrine, as pharmacologic adjuncts for IFIS management was not reported until after the current study had been initiated.<sup>12,13</sup> Therefore, intracameral mydriatics were not a treatment option under this protocol.

For Healon 5 cases, the average preoperative pupil diameter was slightly smaller (mean, 6.6 mm) when compared with the atropine group (Table 1). However, 95% of these cases were completed without any need for adjunctive me-

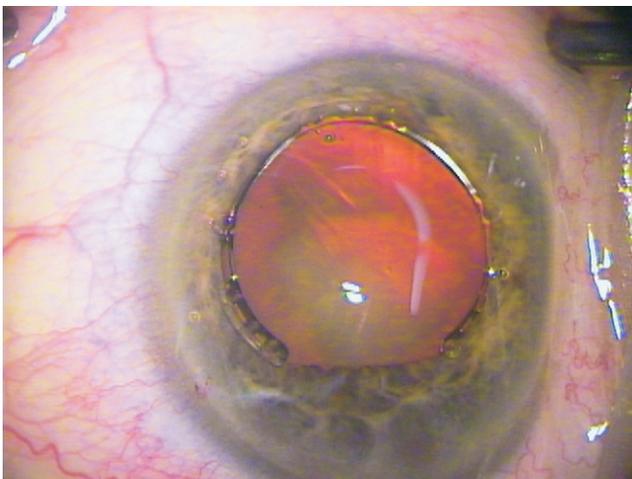


Figure 2. Morcher 5S pupil expansion ring.

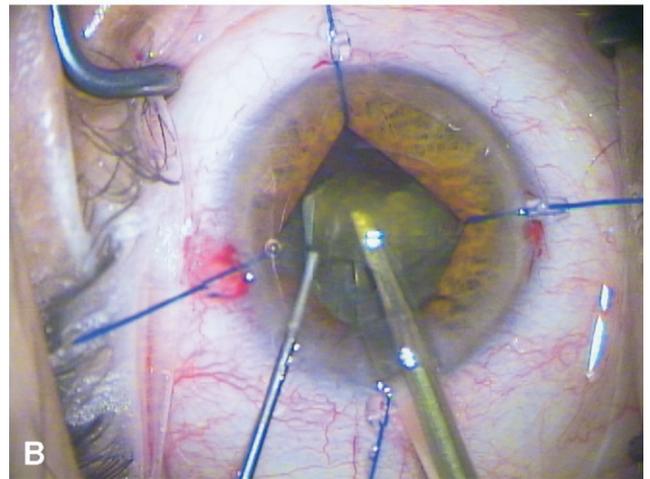
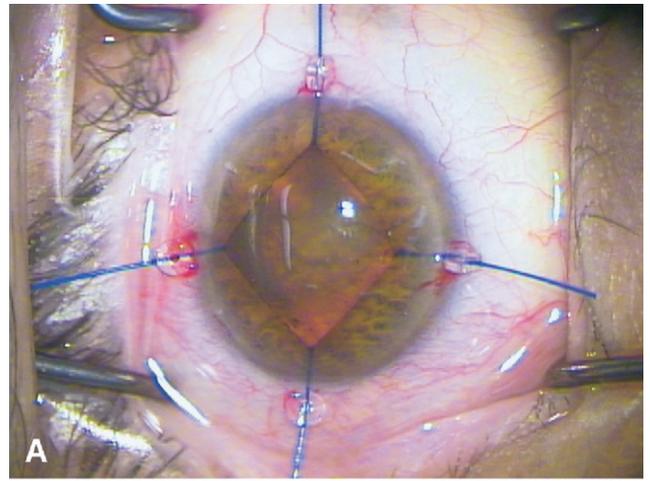


Figure 3. A, 4-0 polypropylene iris retractors in a diamond configuration. B, A subincisional retractor is placed through a separate tunnel beneath the phaco incision.

chanical devices. This was presumably due to the fact that additional injections of Healon 5 could be used to reexpand the pupil when necessary. Mechanical dilating devices tended to be used in patients with smaller preoperative pupil diameters (mean 5.8 mm for iris retractors and 4.3 mm for pupil expansion rings) and with more severe degrees of IFIS (Table 1). Their use prevented pupil constriction until removal of the devices at the conclusion of surgery.

In this prospective multicenter study involving multiple surgeons, the rate of posterior capsule rupture and vitreous loss was very low (0.6%). This compares favorably with the 0.2% to 4.5% incidence of vitreous loss reported in other large cataract study populations (Table 5).<sup>34-46</sup> In the most recently reported retrospective study, Ang and Whyte<sup>46</sup> found a 1.7% rate of posterior capsule rupture and a 1.1% rate of vitreous loss in a series of >2700 phacoemulsification procedures. As in our study, patients with traumatic cataracts or any zonular dehiscence were excluded from their analysis.

The most common complication in our series was the occurrence of mild to moderate iris transillumination de-

Table 5. Published Vitreous Loss Rates, 1997 to 2006

Author	Published	% Vitreous Loss	Study Size
Chitkara <sup>34</sup>	1997	4.0	1552
Corey <sup>35*</sup>	1998	1.8	396
Desai <sup>36</sup>	1999	4.4	18 454
Martin <sup>37</sup>	2000	1.3	3000
Lundstrom <sup>38</sup>	2001	2.2	2731
Ionides <sup>39</sup>	2001	2.9	1420
Gimbel <sup>40</sup>	2001	0.2	18 470
Blomquist <sup>41*</sup>	2002	4.5	1400
Tan <sup>42</sup>	2002	3.6	2538
Chan <sup>43</sup>	2003	1.1	8230
Androudi <sup>44</sup>	2004	4.0	543
Hyams <sup>45</sup>	2005	2.0	1364
Ang <sup>46</sup>	2006	1.1	2727

\*Resident surgeons.

fects (16%). These were usually caused by intraoperative iris prolapse and were asymptomatic. There were no instances of permanent mydriasis, iridodialysis, iatrogenic pupillary deformities, or prolonged postoperative iritis or IOP elevation. The incidence of early postoperative clinical cystoid macular edema was also low (0.6%).

Overall surgical outcomes were excellent with 95% of eyes achieving at least 20/40 best-corrected Snellen visual acuity at 1 month. This percentage approached 100% if eyes with preexisting maculopathy were excluded. It should be emphasized that the all of the ophthalmologists participating in this study were experienced cataract surgeons. Phacoemulsification in eyes with IFIS is generally more difficult, and surgeons should still approach these cases with caution. Whether the complication rate would have been higher in the hands of less experienced surgeons was not answered by this study.

Because systemic  $\alpha_1$ -antagonists are the most popular pharmacologic treatment for benign prostatic hyperplasia, one must address the question of whether these drugs are safe to use in the cataract population. In previously reported retrospective studies, the surgeons would have had no way to foresee the occurrence of IFIS.<sup>1,2</sup> Being able to elicit a history of tamsulosin or other  $\alpha_1$ -blocker use now enables cataract surgeons to anticipate IFIS and to employ alternative methods of small pupil management before initiating the capsulorhexis. Educating patients, their ophthalmologists, and their prescribing doctors about IFIS is paramount for this reason. This prompted the American Society of Cataract and Refractive Surgery to issue a global advisory alert regarding tamsulosin in January 2005. The United States Food and Drug Administration also instituted a labeling change warning about  $\alpha$ -blockers and cataract surgery in 2005. Finally, the American Society of Cataract and Refractive Surgery, the American Academy of Ophthalmology, and the American Urological Association issued a joint press release in 2006 highlighting the need for patients taking systemic  $\alpha$ -blockers to inform their ophthalmologist before cataract surgery.

In conclusion, retrospective studies have shown that when the surgeon does not anticipate or recognize tamsulosin-

associated IFIS, the rate of posterior capsule rupture and vitreous loss is significantly increased. However, when experienced surgeons are forewarned by a history of tamsulosin use and employ appropriate operative strategies to manage the iris, the complication rate is low and the success rate is excellent. We do not believe that patients should discontinue or avoid systemic  $\alpha$ -blockers, such as tamsulosin, as long as they inform their ophthalmologist of this medication history before having eye surgery.

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