

Small Pupils

The causes of miosis and the challenges it poses.

BY KEVIN M. MILLER, MD

This general overview of the management of a small pupil touches on the causes of miosis, cosmetic issues, and the techniques for management. Although intended primarily for cataract surgeons, this information should benefit any surgeon who needs to improve visualization through the pupil.

CONDITIONS THAT RESULT IN SMALL PUPILS

Pupils may be physiologically small, or their reduced diameter may be associated with various disease states. Pseudoexfoliation (PXF) syndrome occurs in older individuals among many different ethnic groups, not just fair-skinned people of Scandinavian or Russian heritage. PXF may be associated with secondary open-angle glaucoma and zonular laxity. Sphincter hypertrophy from previous or concurrent miotic glaucoma therapy (pilocarpine, eserine) may make some pupils permanently small. The accumulation of glycogen in the iris pigment epithelium can hinder dilation in diabetics. Furthermore, posterior synechiae and fibrotic pupillary bands may develop after trauma or bouts of uveitis. Systemic alpha antagonist therapy to treat prostatic hypertrophy or urinary retention may cause intraoperative floppy iris syndrome (IFIS) and pupillary miosis. Last, multiple previous eye surgeries may impede subsequent dilation.

Whatever the cause, eyes with a small pupil represent a surgical challenge.

COSMETIC ISSUES

I find many patients to be concerned about the postoperative appearance of their eyes, even late in life. The day after surgery, some patients are more worried about ocular cosmesis than how they see. Those with light blue or blue-green irides may be sensitive to any disparity in their pupils' size, position, or shape. I have noticed this tendency even in patients with partial or complete aniridia who enroll in my aniridia implant trials. I therefore urge surgeons to make every effort to minimize long-term changes to the appearance of patients' pupils.

Certain techniques for managing the pupil should be abandoned, because they have a deleterious effect on cosmesis and the blood/aqueous barrier. They include keyhole iridectomies and multiple sphincterotomies.^{1,2}

CURRENT TECHNIQUES

Procedures Used Singly or in Combination

I use many techniques, either alone or in combination, to manage small pupils. My approach is somewhat of a stepladder, and I do not always touch every rung before moving on to the next.

Pharmacologic Dilation

Most ophthalmologists instill dilating agents before cataract or posterior segment surgery. Common mydriatic agents include tropicamide, cyclopentolate, and phenylephrine. An increasing number of ophthalmologists, however, take patients to the OR without dilating their pupils. After establishing a paracentesis, these surgeons inject nonpreserved 1% lidocaine, which paralyzes the nerves in the iris, resulting in modest dilation.

If the lidocaine or mydriatic drops are insufficient, it is a simple matter to apply more dilating drops just before or during surgery. I typically administer tropicamide and phenylephrine in the preoperative area. I will add cyclopentolate in the OR if I need a larger pupil. I almost never use homatropine or atropine because of their long duration.

In my experience, intracameral 1:3,000 epinephrine is tremendously helpful in eyes with IFIS I perform the injection over the iris just after administering lidocaine and just before injecting the viscoelastic. Epinephrine tends to stiffen the iris during surgery.

Some surgeons believe that nonsteroidal anti-inflammatory agents administered preoperatively improve the duration and quality of intraoperative mydriasis. The drugs have been found to prevent intraoperative miosis but do not affect dilation.³ I do not find them very helpful.

Viscomydriasis

Surgeons can use highly cohesive ophthalmic viscosurgical devices to manipulate the pupil intraoperatively.

These agents include Healon GV and Healon5 (Abbott Medical Optics Inc., Santa Ana, CA) and DisCoVisc (Alcon Laboratories, Inc., Fort Worth, TX). It is important to avoid overfilling the eye with Healon5.⁴

Working Through a Small Pupil

Each surgeon has a different comfort level for working through small pupils. I generally prefer a pupil that is at least 2 mm in diameter. Some surgeons can work with smaller pupils, but most require greater dilation. It is important to avoid phaco trauma to the pupil when adjunctive dilating techniques are not used.

Divide-and-conquer or vertical chop are the safest fragmenting techniques in eyes with small pupils, because they permit good visualization of the central nucleus.⁵

Pupillary Stretching

Pupillary stretching techniques are helpful for physiologically small pupils, those with fibrotic rings or bands, and those associated with posterior synechiae. This technique should be avoided with IFIS.

The simplest approach for pupillary stretching involves two Kuglen or iris color button hooks. The pupil is stretched horizontally from limbus to limbus and held in that position for a few seconds. Then, it is stretched vertically from limbus to limbus and held there for another few seconds. After withdrawing the hooks, the surgeon injects additional viscoelastic to complete the stretch. One-handed pupil dilators are also available.⁶⁻⁸

For surgeons comfortable with sleeveless bimanual phacoemulsification, an irrigating iris retractor is another option.⁹

Pupillary Expansion Rings

A number of devices can be inserted and removed during surgery to facilitate intraoperative mydriasis. These include the injectable Perfect Pupil (Milvella Ltd., Sydney, Australia; distributed in the United States by Ambler Surgical Corp., Exton, PA), Graether 2000 (EagleVision, Memphis, TN), Morcher Pupil Dilator (Morcher GmbH, Stuttgart Germany; distributed in the United States by FCI Ophthalmics, Marshfield Hills, MA), and the Malyugin Ring (MicroSurgical Technology, Redmond, WA). My favorite at this time is the 6-mm Malyugin Ring, which is made from 5-0 polypropylene. There is also a 7-mm device. The Malyugin Ring comes with an injector for easy insertion and removal. Care should be taken not to remove the device before its disinsertion from the iris.^{10,11}

Iris hooks

Inserted through paracentesis incisions, polymethylmethacrylate, polypropylene, and nylon iris hooks can

be used to engage the pupillary margin. I find them most useful in eyes with segmental miosis or concurrent zonular laxity. Placing a hook beneath the incision can help to protect the iris from unintended phaco trauma. Hooks can also be used to stabilize the capsulorhexis while surgeons enlarge the pupil. It is important to avoid overstretching the pupil.¹²⁻¹⁸

SITUATIONS THAT OFTEN REQUIRE THE MANAGEMENT OF A SMALL PUPIL

Physiologically Small Pupils

My approach to pupils that are physiologically small is to use a combination of topical and intracameral pharmacological mydriasis, viscomydriasis, and a slow and controlled surgical technique. I add pupillary stretching as needed.

PXF Syndrome

Pupils with PXF syndrome are often miotic. I find that they seldom respond well to pharmacologic agents or viscomydriasis. My favorite approach for these eyes is pupillary stretching. PXF irises often have a small fibrotic pupillary ring that binds the pupil down and that may break if stretched. Occasionally, a PXF iris will become floppy, so it is important not to overly stretch it.¹⁹

Miotic Glaucoma Therapy

Patients who are or have been on miotic therapy often have hypertrophic pupillary sphincter muscles. Like strong rubber bands, these smooth muscles can be stretched, but they snap back when released. I find pupillary expansion devices to be ideal for this situation. Viscomydriasis is also sometimes helpful.

Diabetes Mellitus

It is rare to find a diabetic pupil that will not dilate to at least 3 mm after the instillation of mydriatic agents. Diabetic pupils also respond well to viscomydriasis. When these measures fail, mechanical stretching is often helpful. The irises of diabetic eyes often behave like those with PXF or prior uveitis.²⁰

Posterior Synechiae and/or Fibrotic Pupillary Bands

The first step is to break posterior synechiae with a cyclodialysis spatula or viscoelastic cannula. Injecting additional viscoelastic usually enlarges these pupils enough to allow surgery to proceed. If not, pupillary stretching should break the fibrotic pupillary band to widen the pupil further.

Systemic Alpha Antagonist Therapy

Tamsulosin is the alpha-receptor blocker with the most profound effect on the pupil dilator muscle. It has a pro-

pensity to inhibit pupillary dilation and cause the iris to become floppy intraoperatively. I find the intracameral injection of 1:3,000 epinephrine to be very helpful for stiffening these irises. Viscomydriasis can also be useful. Pupillary expansion devices such as the Malyugin Ring are ideal for managing small pupils in this setting. Mechanical pupillary stretching should be avoided.²¹

Multiple Previous Operations

In eyes that have undergone multiple previous surgeries, the pupil often dilates poorly for subsequent operations. I generally prefer to work through the small pupil in these eyes. If necessary, however, I will stretch the pupil.

CONCLUSION

Whatever the cause of the intraoperative miosis, one or more of the techniques and/or devices described in this article can be applied to handle any situation that arises. It is important to minimize trauma to the iris sphincter, disruption of the blood-aqueous barrier, and changes to the cosmetic appearance of the eye. My patients appreciate me the most when their eyes see well and look normal after surgery. ■

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1. Cole MD, Brown R, Ridgway AE. Role of sphincterotomy in extracapsular cataract surgery. *Br J Ophthalmol.* 1986;70:692-695.
2. Fine IH. Pupilloplasty for small pupil phacoemulsification. *J Cataract Refract Surg.* 1994;20:192-196.
3. Solomon KD, Turkalj JW, Whiteside SB, Stewart JA, Apple DJ. Topical 0.5% ketorolac vs 0.03% flurbiprofen for inhibition of miosis during cataract surgery. *Arch Ophthalmol.* 1997;115:1119-22.
4. Bissen-Miyajima H. Ophthalmic viscosurgical devices. *Curr Opin Ophthalmol.* 2008;19:50-54.
5. Lee EJ, Lee JH, Hyon JY, et al. A case of cataract surgery without pupillary device in the eye with iridoschisis. *Korean J Ophthalmol.* 2008;22:58-62.
6. Shepherd DM. The pupil stretch technique for miotic pupils in cataract surgery. *Ophthalmic Surg.* 1993;24:851-852.
7. Miller KM, Keener GT Jr. Stretch pupilloplasty for small pupil phacoemulsification. *Am J Ophthalmol.* 1994;15:117:107-108.
8. Dinsmore SC. Modified stretch technique for small pupil phacoemulsification with topical anesthesia. *J Cataract Refract Surg.* 1996;22:27-30.
9. B'hm P, Horvath J, Zahorcova M. Irrigating iris retractor for complicated cataract surgery. *J Cataract Refract Surg.* 2009;35:419-421.
10. Kershner RM. Management of the small pupil for clear corneal cataract surgery. *J Cataract Refract Surg.* 2002;28:1826-1831.
11. Malyugin B. Small pupil phaco surgery: a new technique. *Ann Ophthalmol (Skokie).* 2007;39:185-193.
12. Mackool RJ. Small pupil enlargement during cataract extraction; a new method. *J Cataract Refract Surg.* 1992;18:523-526.
13. De Juan E Jr, Hickingbotham D. Flexible iris retractor. *Am J Ophthalmol.* 1991;111:776-777.
14. Nichamin LD. Enlarging the pupil for cataract extraction using flexible nylon iris retractors. *J Cataract Refract Surg.* 1993;19:793-796.
15. Oetting TA, Omphroy LC. Modified technique using iris retractors in clear corneal cataract surgery. *J Cataract Refract Surg.* 2002;28:596-598.
16. Tognetto D, Agolini G, Grandi G, Ravalico G. Iris alteration using mechanical iris retractors. *J Cataract Refract Surg.* 2001;27:1703-1705.
17. Nov3k J. Flexible iris hooks for phacoemulsification. *J Cataract Refract Surg.* 1997;23:828-831.
18. Masket S. Avoiding complications associated with iris retractor use in small pupil cataract extraction. *J Cataract Refract Surg.* 1996;22:168-171.
19. Akman A, Yilmaz G, Oto S, Akova YA. Comparison of various pupil dilatation methods for phacoemulsification in eyes with a small pupil secondary to pseudoexfoliation. *Ophthalmology.* 2004;111:1693-1698.
20. Zaczek A, Zetterstr'm C. Cataract surgery and pupil size in patients with diabetes mellitus. *Acta Ophthalmol Scand.* 1997;75:429-432.
21. Chang DF. Use of Malyugin pupil expansion device for intraoperative floppy-iris syndrome: results in 30 consecutive cases. *J Cataract Refract Surg.* 2008;34:835-841.