Cataract Surgery in Small Pupils: Choosing the Appropriate Tool

Mechanical devices, ophthalmic viscosurgical devices, and phaco settings play a role in the management of these cases.

BY AHMED ASSAF, MD, FRCS(Ed)

Poorly dilating or nondilating small pupils can be a challenge for cataract surgeons. A small pupil can impede visualization and make placing instruments into the eye more difficult. Indeed, intraoperative pupillary miosis has been demonstrated to be a risk factor for conversion of phacoemulsification to extracapsular cataract extraction, with consequent lengthening of surgical time.

Performing capsulorrhexis, hydrodissection, and phacoemulsification becomes more difficult in these eyes because visualization is poor, making surgical management more complicated. The heightened level of difficulty can lead to an increased risk of iris sphincter tear, bleeding, iris emulsification, ruptured posterior capsule, and loss of the nucleus. These complications can potentially result in a postoperative irregular and atonic pupil, inducing photophobia and patient discomfort.

The challenges posed by small pupils are compounded in patients with dense cataracts in whom a thick lens, shallow anterior chamber, and potentially prolonged phacoemulsification time markedly increase the risk for corneal endothelial decompensation. Therefore, the use of specific surgical techniques and tools is often necessary in eyes with small pupils in order to minimize the risk of complications and, consequently, of unsuccessful outcomes.

Numerous techniques to enlarge intraoperative pupil size have been devised, such as the use of mechanical devices. These devices have been well described by multiple authors, so, while this article briefly reviews the uses of some of these tools, it also presents my own preferences for surgical management of small pupils with a different type of device—an ophthalmic viscosurgical device (OVD).

CAUSES OF SMALL PUPILS

Iris sphincter sclerosis may be present in patients undergoing cataract surgery. This condition can be caused by aging, synechiae, previous trauma or surgery.
In diabetes, chronic syphilis, iridoschisis, uveitis, chronic miotic therapy, or pseudoexfoliation. Furthermore, it has been demonstrated that constriction of the pupil during cataract surgery is more pronounced in eyes of patients with diabetes compared with controls.8

Intraoperative floppy iris syndrome (IFIS) is another cause of miosis.9 IFIS is characterized by a flaccid iris, which undulates in response to ordinary intraocular fluid currents, with a tendency to prolapse toward the area of surgery, and may result in damage to the iris by intraocular instruments.9 This phenomenon is observed after systemic intake of alpha-blockers for the treatment of benign prostatic hyperplasia.9 Other medications such as oxycodone or acetaminophen combinations,10 brimonidine tartrate,11 and clonidine12 can also induce significant levels of miosis and therefore complicate cataract removal. In any of these cases, special measures should be considered for the surgical procedure in order to avoid complicated surgery with potential for subsequent adverse events.

SURGICAL PROTOCOL

My protocol for managing small pupils during phacoemulsification is to use intracameral preservative-free phenylephrine when the pupil is 5.0 mm or more in diameter. It has been demonstrated that intracameral phenylephrine reduces the risk of a small pupil occurring during cataract surgery, providing a longer duration of mydriasis.13 Furthermore, intracameral use of this type of mydriatic is not associated with an increased risk of systemic or ophthalmic complications postoperatively.14

For pupils of less than 5.0 mm, I use a combination of intracameral preservative-free phenylephrine, OVD (Healon5; Abbott Medical Optics Inc.), and low flow and vacuum settings for phacoemulsification. This technique, which is based on the creation of a deep central space...
and the use of a low aspiration flow rate with appropriate vacuum, has been shown to be successful for small pupil cataract surgery, with minimal or no pupil-widening maneuvers needed and restoration of the preoperative pupil configuration.15

My decision to use Healon5 is based on the special physical and rheological characteristics of this OVD (Table 1). Healon5 is a viscoadaptive OVD; it behaves as a cohesive or dispersive agent, depending on the applied shear force. This adaptive behavior maximizes control throughout surgery. Healon5 possesses the highest zero-shear viscosity of any OVD due to its combination of molecular weight and sodium hyaluronate concentration, which allows maintenance of anterior chamber volume during surgery.16 Likewise, it provides outstanding endothelial protection because it acts like a dispersive agent at high flow rates during phacoemulsification, as demonstrated by Holzer et al.16

In small-pupil cataract surgery, I prefer to use Healon5 rather than mechanical devices because it is more economical, less time-consuming, and performs multiple functions. The OVD can be used to dilate the pupil mechanically by pushing the iris away peripherally and to simultaneously maintain pupil dilation during rhexis formation (Figure 1). The OVD keeps the iris flat against the anterior lens capsule, preventing prolapse through the main incision during rhexis formation. Healon5 also provides excellent control during rhexis formation and prevents extension into the periphery. The space-creating and maintaining feature of this OVD is especially useful if there is an associated shallow anterior chamber. Additionally, it can be used to fill the capsular bag prior to IOL injection (Figure 2).

One of the practical advantages of the use of Healon5 in small-pupil cataract surgery is that no mechanical damage is induced to the pupillary sphincter, as might occur with mechanical devices. Therefore, the pupil remains functionally and morphologically intact, as in its preoperative status. I often notice a slight enlargement of the pupil postoperatively when I use mechanical devices due to disruption of the pupillary sphincter. Figure 3A shows the postoperative pupil after phacoemulsification with iris retractors in a patient with a narrow pupil. Figure 3B shows the contralateral eye of the same patient on the first postoperative day after phacoemulsification with Healon5. This OVD-filled pupil looks more morphologically and physiologically normal compared with the pupil in Figure 3A.

**A ROLE FOR DEVICES**

The use of mechanical devices for pupil enlargement, such as the Malyugin Ring (MicroSurgical Technology) and iris retractors, has a place in my practice. I use these devices exclusively in eyes with extremely narrow pupils with patches of iris atrophy. The Malyugin Ring, for example, is useful in patients with IFIS. The device is available in two ring sizes, 6.25-mm and 7.00-mm, and is easy to implant via its dedicated implantation system. The Malyugin Ring is renowned for its short learning curve.

Iris retractors are also rewarding tools for managing narrow pupils during phacoemulsification. I prefer the reusable version (K4970; Katena Products, Inc.) and have found that placement of three or four hooks is sufficient. In some cases, iris retractors cause tenting of the iris toward the cornea and may be responsible for damage during the entry of the phaco needle into the anterior chamber. In order to prevent this, I always push the iris backward to clear the pathway for the phaco needle through the main incision (Figure 4).

**TABLE 1. CHARACTERISTICS OF HEALON5**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity</td>
<td>7,000,000 mPas</td>
</tr>
<tr>
<td>Molecular weight</td>
<td>4,000,000 daltons</td>
</tr>
<tr>
<td>Concentration</td>
<td>2.3% NaHa, latex-free</td>
</tr>
<tr>
<td>Size</td>
<td>0.6 mL</td>
</tr>
<tr>
<td>Classification</td>
<td>Viscoadaptive</td>
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PEARLS FOR OVD USE
Based on my experience, the following pearls enable successful use of Healon5 in small-pupil cataract surgery.

No. 1: Use the ultimate soft shell technique described by Steve Arshinoff, MD. This involves an injection of balanced saline solution below Healon5 on the anterior capsule prior to rhexis formation, which facilitates the performance of a curvilinear capsulorhexis while Healon5 fills the anterior chamber.

No. 2: Use low–flow-rate phaco. This reduces turbulence and prevents excessive OVD washout from the anterior chamber.

No. 3: Reinject OVD when needed. Additional injections can be administered to maintain adequate pupil size for safe nucleus disassembly and cortical clean-up.

No. 4: Use the quick-chop technique. This technique can be completed with the Neuhann vertical chopper (Geuder AG) for nucleus disassembly of hard nuclei (N2 or more on the Lens Opacities Classification System III).

No. 5: Perform multiple hydrodelineation rings for soft cataracts. This helps to delineate and emulsify small nuclei.

No. 6: Use a 21-gauge phaco tip with Ultra Sleeve (Abbott Medical Optics Inc.). This provides better maneuverability compared with 20- or 19-gauge phaco tips.

No. 7: Limit the size of the main incision to 2.2 mm. A small incision helps to keep the OVD inside the anterior chamber while performing the rhexis.

No. 8: Use small amounts of a viscodispersive agent. Healon Endocoat (Abbott Medical Optics Inc.) or Viscoat (Alcon) can be injected at the main incision to prevent excessive escape of Healon5 during the phaco procedure.

CONCLUSION
Adequate tools are available for safe surgical management of eyes with small pupils undergoing phacoemulsification cataract surgery. Surgeons can manage phacoemulsification in eyes with small pupils not only by using mechanical devices for pupil enlargement but also with the help of appropriate OVDs and phaco settings.

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