

Cataract & Refractive Surgery TODAY

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Endothelial Protection in Cataract Surgery



**The State of the Art in Ophthalmic
Viscosurgical Devices**

OVDs: An Undervalued Asset in Cataract Surgery

BY IQBAL IKE K. AHMED, MD

Although now used so routinely that they are taken for granted, ophthalmic viscosurgical devices (OVDs) are probably one of ocular surgery's most significant innovations. Since the agents were first introduced in the 1970s, OVDs have evolved to serve two primary purposes: (1) to protect the inner structures of the eye; and (2) to maintain intraocular space during surgery. Until recently, however, no single OVD formula could serve both functions. Initial attempts at producing a device with equally effective dispersive and cohesive properties resulted in agents whose risks outweighed their benefits. Then, Alcon Laboratories, Inc. (Fort Worth, TX), developed DuoVisc, a combination of two viscoelastics that capitalized on their respective dispersive and cohesive properties.

DuoVisc

I have used DuoVisc routinely in cataract surgery for the past 7 years with great success. The name refers to the combined use of ProVisc viscoelastic preparation and Viscoat viscoelastic solution (both from Alcon Laboratories, Inc.). ProVisc contains hyaluronic acid that makes it cohesive, and Viscoat is a compound of hyaluronic acid and chondroitin sulfate, which give it dispersive properties. Until now, no single, easy-to-use agent provided optimal working space and corneal protection; it was worth the effort of using two separate vials and injections. I prefer DuoVisc during my preferred high-flow phaco techniques for complicated cases, because I often need Viscoat's dispersive quality for coating the cornea and sequestering areas of the eye, while ProVisc helps me maintain space.

DisCoVisc

DisCoVisc (Alcon Laboratories, Inc.) creates a new category within OVDs called *viscodispersive*—a cross between dispersive and cohesive viscoelastics. I have begun using this agent in cataract surgery to see if it is possible for one agent to effectively provide both desired properties. So far, my experience indicates that DisCoVisc has hit the sweet spot in terms of cohesive/dispersive behavior.

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The ingredient that gives DisCoVisc its unique features is chondroitin sulfate. Although this compound is also present in Viscoat, in DisCoVisc, its ratio with hyaluronic sulfate provides space maintenance that is on par with cohesive viscoelastics. More beneficially, chondroitin sulfate generates a triple-negative charge that enhances DisCoVisc's attraction to intraocular structures and thus provides, in my opinion, the ideal viscosity, coating, and corneal protection. Unlike other dispersives, DisCoVisc is easy to remove from the eye.

CORNEAL PROTECTION IS KEY

Cataract patients today expect immediate optimal results, and to satisfy them, we find ourselves routinely using surgical techniques we used to reserve for complex cases. I feel that corneal protection is critical when we use advanced surgical techniques, particularly when we are operating on compromised eyes. Having used nearly every OVD currently on the market, I feel that none are comparable in terms of endothelial coating and corneal protection to those that contain chondroitin sulfate.

In the following pages, two noted surgeons describe how the newest OVDs help them mitigate challenging cataract surgeries. Their examples underscore the importance of these surgical devices to successful outcomes. ■

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OVDs With Chondroitin Sulfate for Challenging Cases

The right OVD can protect intraocular structures and facilitate surgery in vulnerable eyes.

BY JOHNNY L. GAYTON, MD

I prefer viscoelastics that contain chondroitin sulfate. I believe this ingredient provides added protection for the corneal endothelium compared with the use of sodium hyaluronate alone. The following three scenarios describe how ophthalmic viscosurgical devices (OVDs) containing both chondroitin sulfate and sodium hyaluronate assist me in safely performing surgical maneuvers during challenging cataract cases.

FLOPPY IRIDES

Therapeutic and Manual Aids

Ophthalmic surgeons are increasingly encountering the intraoperative challenges created by intraoperative floppy iris syndrome (IFIS). In fact, I recently operated on seven eyes in 1 day that were affected by IFIS. Because this condition may cause the iris to constrict fairly quickly after its initial dilation, surgeons should work efficiently with as little iris manipulation as possible.

Intraocularly, I have found that DisCoVisc (Alcon Laboratories, Inc., Fort Worth, TX) addresses two challenges posed by IFIS. First, it effectively tamponades and stabilizes the iris, thanks to its concentration of hyaluronic acid. In fact, one may use this OVD to viscodilate a poorly dilated pupil. This stabilizing property also allows me to easily insert a Malyugin Ring (MicroSurgical Technology Inc., Redmond, WA) if needed, thereby protecting the endothelium and iris. The chondroitin sulfate in DisCoVisc provides valuable extra protection for the corneal endothelium

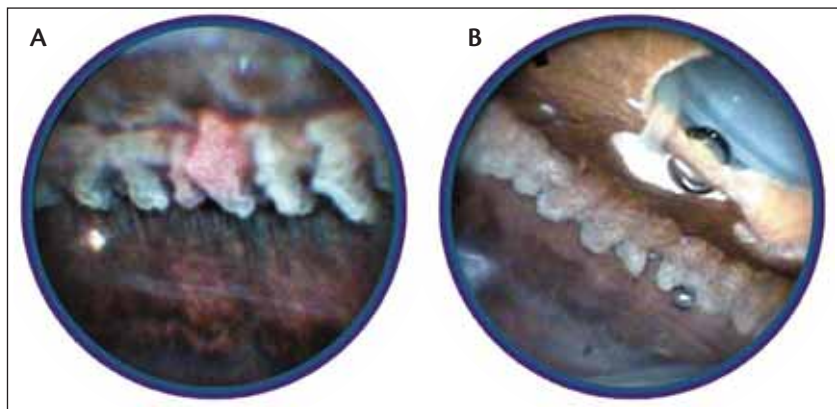


Figure 1. These images demonstrate the excellent intraoperative view that the right OVD can provide when used prior to performing ECP. The first image shows the ciliary processes in an aphakic patient (A), and the second is a view of the posterior surface of the iris with a peripheral iridectomy and a lens haptic in the sulcus (B).

during the case, and the OVD is relatively easy to remove at the end of the surgery. This combination of DisCoVisc and the Malyugin Ring makes the cataract procedure in the IFIS patient much safer and significantly reduces the operative time of the procedure. This enables us to easily schedule patients that may have IFIS, for we do not have to allow extra time for the procedure.

Surgical Course

I employ a few management strategies when operating on eyes with IFIS. Preoperatively, my technician treats the ocular surface with a sterile pledget that has been soaked in a cocktail of anesthetic, antibiotic, dilating agent, and NSAID. When the patient enters the OR, he receives a small amount of intravenous sedation, and we prepare the eye with a solution of 50% betadine. If the pupil does not dilate well, or I note signs of IFIS, I will inject 1% unpreserved lidocaine or

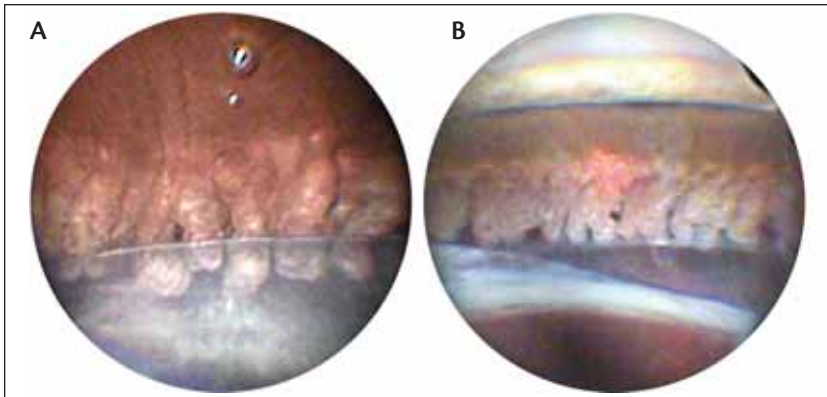


Figure 2. These images show the ciliary processes prior to deepening the posterior chamber with an OVD (A) and the ciliary processes over a PCIOL after deepening the chamber (B).

Epi-Shugarcaine (see sidebar, *Epi-Shugarcaine*, p. 5) through the 2.2-mm surgical wound prior to instilling the OVD. I then make the sideport incision. I inject the DisCoVisc through the primary wound with the tip of the cannula placed in the center of the pupil, just anterior to the lens capsule. This viscodilates the pupil and creates a space for easy insertion of the Malyugin Ring, if needed. Although the ring is usually inserted prior to making the capsulorhexis, it may be used at any point during the procedure. For instance, I have introduced the ring after removing the cataract to accurately position a toric lens.

“The chondroitin sulfate gives the OVD stronger binding affinity, which aids in its retention as a protective coating over the endothelium.”

After performing the capsulorhexis, I hydrodissect with 1% unpreserved lidocaine injected through a Chang cannula (Katena Products, Inc., Denville, NJ, or Mastel Precision, Inc., Rapid City, SD). Then, I remove the nucleus using the INTREPID upgrade on the INFINITI Vision System with OZil Torsional ultrasound (Alcon Laboratories, Inc.). The INTREPID permits a 2.2-mm incision and dampens surge, greatly reducing the risk of damaging the capsule and iris. Additionally, the INFINITI system allows the surgeon to program a setting with lower flow rates for IFIS

eyes, which helps the OVD stay in the eye and decreases the iris' movement.

After I remove the cataract, I instill DisCoVisc again before implanting the IOL. I remove the Malyugin Ring after positioning the lens and prior to removing the DisCoVisc. The OVD's presence in the chamber makes this extraction easy and atraumatic. Finally, I evacuate the DisCoVisc and pressurize the eye with a solution composed of BSS Plus (Alcon Laboratories, Inc.) and a small amount of amikacin and vancomycin.

FUCHS' DYSTROPHY

In an eye with Fuchs' dystrophy, I sometimes use the cannula of a syringe that contains the dispersive OVD Viscoat (Alcon Laboratories, Inc.) as my second instrument. I inject small amounts of the OVD into the anterior chamber during phacoemulsification to help protect the fragile cornea endothelium. The chondroitin sulfate gives the OVD stronger binding affinity, which aids in its retention as a protective

EXTRACTING DisCoVisc FROM A VULNERABLE EYE

Eyes that are compromised by IFIS or Fuchs' dystrophy are sensitive to aspiration. Rapid removal of the OVD at the end of cataract surgery can increase endothelial cell loss, decenter or displace IOLs, and traumatize the iris. In standard cataract surgery, I aspirate the OVD with 500 to 600 mm Hg of vacuum. In eyes with IFIS or in which I have implanted a toric IOL, I increase the aspiration slowly while watching the iris and/or lens' position. This slow aspiration allows the haptics to expand fully into the capsular fornices, thus minimizing rotation during implantation. It takes several seconds to evacuate most of the OVD, and in vulnerable eyes, I feel it is better to leave a small amount of OVD than to significantly traumatize the intraocular structures by aggressively attempting to evacuate it completely.

coating over the endothelium. Especially in eyes with a shallow chamber and/or a dense nucleus, this extra coating over the endothelial cells can decrease the incidence and duration of postoperative corneal edema. Using Viscoat for intraocular surgery can prevent or delay some Fuchs' patients' need for a corneal transplant by decreasing endothelial cell loss.

Instead of aggressively removing the Viscoat at the end of the case and risking damage to the endothelium, I will gently aspirate the Viscoat without attempting to remove all of it from the endothelial surface. I reform the anterior chamber with BSS Plus, which provides extra protection to the corneal endothelium. I then treat the patient's possible IOP rise prophylactically with a drop each of Combigan (Allergan, Inc., Irvine, CA) and Travatan Z (Alcon Laboratories, Inc.). A few hours after surgery, a staff member calls the patient and inquires if he is experiencing a headache and/or significant nausea. If the patient has either of these symptoms, we ask him to return to the clinic so we can check his IOP and manually decompress the anterior chamber if necessary.

“Agents containing chondroitin sulfate are my OVDs of choice.”

**DisCoVisc IN ECP
OVD of Choice**

I have converted to using the viscodispersive DisCoVisc in all my endolaser cyclophotocoagulation surgeries for several reasons. First, in addition to containing chondroitin sulfate, DisCoVisc stabilizes the iris and viscodilates the pupil. Second, this agent creates a clear stable space between the posterior surface of the iris and the anterior capsule of the lens in which to ablate the ciliary epithelium (Figures 1 and 2). A third, yet important benefit of DisCoVisc is that it does not absorb the laser's emitted wavelength and thus allows me to use relatively low energy, reducing the likelihood of causing heat-related injury to the ocular tissues.

Following the endolaser cyclophotocoagulation procedure, I evacuate the viscoelastic as thoroughly as possible. Because glaucoma patients are predisposed to postoperative IOP spikes, we have them return to our office for an IOP check within 3 hours of the procedure. Unlike some OVDs, DisCoVisc is easy to remove from the laser probe, allowing the expensive probes to be reused more times.

EPI-SHUGARCAINE

Epi-Shugarcaine is one of the many contributions to ophthalmology made by the late Joel Shugar, MD, of Perry, Florida. This neutral-pH mixture provides intracameral anesthesia as well as increased iris tone and pupillary dilation. It is made by mixing the following agents:

- 9 mL fortified balanced salt solution (BSS Plus; Alcon Laboratories, Inc.)
- 4 mL bisulfite-free 1:1000 epinephrine
- 3 mL nonpreserved lidocaine 4% (Hospira, Inc., Lake Forest, IL)

The final mixture comprises 1:4,000 epinephrine and 0.75% lidocaine. The surgeon instills a small amount, 0.25 to 0.5 mL, into the anterior chamber at the beginning of a surgical case. This is a nonpreserved mixture and should be refrigerated, and any amount left over should be discarded at the end of the day (or sooner if it takes on a reddish/brown color). Epi-Shugarcaine is effective for most cases of IFIS and poorly dilating pupils, particularly when supplemented with additional epi-Shugarcaine intraoperatively.

IN CLOSING

Agents containing chondroitin sulfate are my OVDs of choice. I prefer using DuoVisc, a combination of dispersive Viscoat and cohesive ProVisc, for my standard cataract procedures. For specific situations, I will use Viscoat alone or DisCoVisc, depending on the surgery. The added protection of the chondroitin sulfate for the corneal endothelium makes these agents preferable over other OVDs that contain sodium hyaluronate alone. ■

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OVD Performance in Cataract Surgery

A comparison study showed favorable results for OVDs containing chondroitin sulfate.

BY FERNANDO AGUILERA, MD

Colleagues and I at the Instituto de Ojos in Mexicali, Mexico, conducted a prospective study of the performance of multiple ophthalmic viscosurgical devices (OVDs) during uneventful phaco surgery. Our goal was to compare the clinical results and machine parameters between various OVD products in cataract surgery.

PARAMETERS

Our study included 216 eyes (176 cataract patients) randomized equally between five OVD products: DisCoVisc (Alcon Laboratories, Inc., Fort Worth, TX) for the viscodispersive category, Biovisc (Sophia Laboratories S.A., Guadalajara, Mexico) and Amvisc Plus (Bausch & Lomb, Rochester, NY) for the cohesive category, DuoVisc (Alcon Laboratories, Inc.) for a combination product, and Healon5 (Advanced Medical Optics, Inc., Santa Ana, CA) for a viscoadaptive agent (Figure 1).

Each OVD has a slightly different chemical composition. DisCoVisc contains sodium hyaluronate and chondroitin sulfate. DuoVisc is a combination of dispersive Viscoat and cohesive ProVisc. Amvisc Plus, Healon5, and Biovisc are all made of sodium hyaluronate.

In addition to OVD performance, we also measured the cumulative delivered energy (CDE) and the amount of balanced salt solution (BSS; Alcon Laboratories, Inc.) used in three phases of the surgery

(phacoemulsification, I/A of the cortex, and during the aspiration of viscoelastic after the IOL's implantation). To measure the BSS, we attached an electrical scale to the bottle that we hung from the extension pole of the INFINITI machine (Alcon Laboratories, Inc.). Each mL of the BSS solution was equal to 1 gram of difference on the scale.

SURGICAL COURSE

After a complete preoperative evaluation, each patient underwent uneventful cataract surgery by the same surgeon. He used a microcoaxial technique with the OZil Torsional ultrasound technology (Alcon Laboratories, Inc.) on the INFINITI Vision System. For phacoemulsification, the surgeon used a combination of torsional and longitudinal ultrasound in burst mode. The blended mode of phaco energy consisted in conventional phaco at 20% power in panel mode for

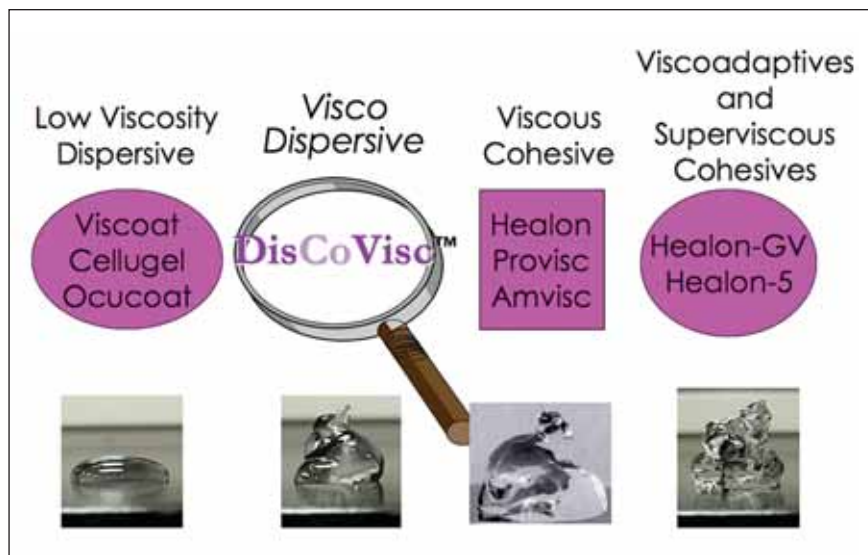


Figure 1. One can see physical differences between dispersive and cohesive OVDs.

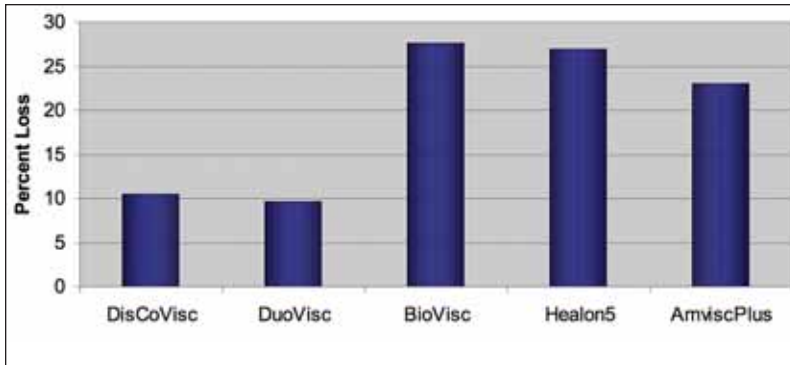


Figure 2. This table shows the pre- and 2-month postoperative percentage of loss in endothelial cell counts.

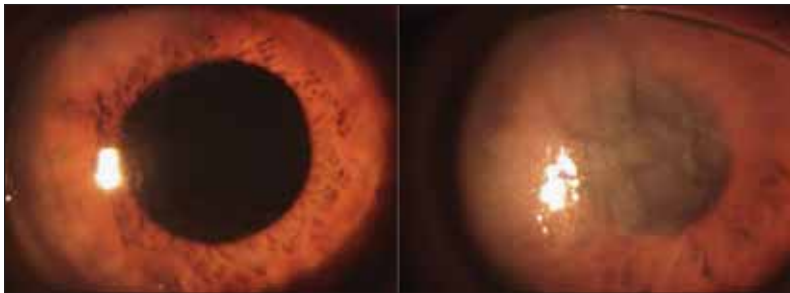


Figure 3. Grade 4 cataracts in two eyes of the same patient. The first received an OVD with chondroitin sulfate (A), and the second received a cohesive OVD (B).

5 milliseconds, followed by a burst of 70 milliseconds of torsional phaco at 100% power in linear mode.

POSTOPERATIVE DATA

We followed each patient for at least 2 months postoperatively, and we compiled the data from the day 1, 7, 30, and day 60 visits.

We evaluated the OVDs' intraoperative performance by five subjective metrics: ease of injection, visibility, pupil manipulation, maintenance of the anterior chamber, IOL implantation, and ease of removal after the implantation. We found that the viscoelastics containing chondroitin sulfate, DuoVisc and DisCoVisc, performed the best over OVDs containing only sodium hyaluronate. Objectively, the former had the lowest associated epithelial cell loss and corneal edema (Figure 2). The cohesive viscoelastics, such as BioVisc, showed the worst endothelial cell loss and corneal edema as well as the most inflammation on the first postoperative day. DuoVisc had the least endothelial cell loss, followed by DisCoVisc, Healon5, Amvisc Plus, and BioVisc with the most. There was also a statistically significant difference in the endothelial cell loss

between the dispersive OVDs, DisCoVisc and DuoVisc, versus the cohesive ones, Amvisc Plus and BioVisc. Also, endothelial cell loss seemed to correlate with the amount of solution used (> 100 mL) and especially with the amount of ultrasound energy used (CDE > 10).

CONCLUSIONS

According to our statistical analysis, OVDs containing chondroitin sulfate such as DisCoVisc and DuoVisc are the best viscoelastics for corneal protection on the market right now (Figure 3). Cohesive OVDs were related to greater endothelial cell loss in harder cataracts and should not be used in grades 4 and above (in the worst case, we found a 49% endothelial cell count loss). In fact, we have ceased using cohesive OVDs in our study in grade 4 cataracts for this reason. By comparison, the normal rate of endothelial cell loss in cataract surgery is approximately 11%; that is what we found

in the chondroitin sulfate OVD's group. For cataracts of grades 1 to 4 (LOCS III classification), we recommend DisCoVisc because of its overall performance in all the stages of surgery. For very hard cataracts, however, surgeons need the added protection of DuoVisc, using Viscoat for the ultrasound phase of the surgery.

We also found that the OVDs containing chondroitin sulfate are more apt to remain in the cornea during surgery. We attribute this characteristic to the chemical and physical characteristics of these compounds, which create a triple-negative charge that adheres to the positive charges of the endothelial cells. Also, these molecules' smaller chain size makes them more difficult to be aspirated during the surgery. If the OVD fractures during surgery, it remains attached to the endothelium. ■

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