AT-OVDs: The Best of Both Worlds

Advanced-technology OVDs combine beneficial properties of cohesives and dispersives.

BY HONG KYUN KIM, MD, PhD, AND TESS HUYNH, MD

This article is the third in a series that highlights the utility and versatility of advanced-technology OVDs (AT-OVDs) in cataract surgery. Here, Hong Kyun Kim, MD, PhD, of Daegu, South Korea, and Tess Huynh, MBBS, FRANZCO, of Liverpool, Australia, discuss which AT-OVDs they prefer in particular surgical situations, and why. ▶ *To watch related videos, visit Eyetube.net and enter the keyword "Discovisc" in the search bar.*

HONG KYUN KIM, MD, PhD

Arshinoff devised a system of OVD classification that initially divided ophthalmic viscosurgical devices (OVDs) into higher-viscous cohesive agents and lower-viscous dispersive agents based on their physicochemical and rheological properties.[1] Cohesive OVDs are made of hyaluronic acid, while dispersive OVDs are usually composed of chondroitin sulfate and hyaluronic acid.

Ever since hyaluronic acid 1% was first used in OVDs, they have become an important surgical device for protecting the corneal endothelium and maintaining adequate space during cataract surgery.[2] Hyaluronic acid has a high viscosity with a high molecular weight. Generally, it has excellent characteristics for creating space in the eye and providing a stable surgical environment. Also, cohesive OVDs that contain hyaluronic acid are easier to remove at the end of surgery than dispersive agents. Because phacoemulsification is usually performed under high fluidic turbulence, however, the ability of cohesive OVDs to maintain space and protect the corneal endothelium is quite limited due to rapid removal.

Dispersive OVDs containing mixtures of chondroitin sulfate and hyaluronic acid have a lower viscosity and are molecularly attracted to intraocular tissues with lower surface tension and lower pseudoplasticity. Thus, dispersive OVDs have the optimal characteristics for protecting the corneal endothelium during phacoemulsification. Several studies have demonstrated the protective effect of VISCOAT OVD (Alcon Laboratories, Inc.).[3-5] However, by itself, VISCOAT OVD is not good at creating space in the eye and is not easily removed from the anterior chamber. Arshinoff's soft shell technique,[6] which combines use of a cohesive and a dispersive OVD to take advantage of the benefits of each, has been shown to be highly efficacious for maintaining the anterior chamber with the cohesive layer and protecting the corneal endothelium with the dispersive layer. Subsequently, Alcon Laboratories, Inc., created the DuoVisc viscoelastic system, which contains this ideal combination.

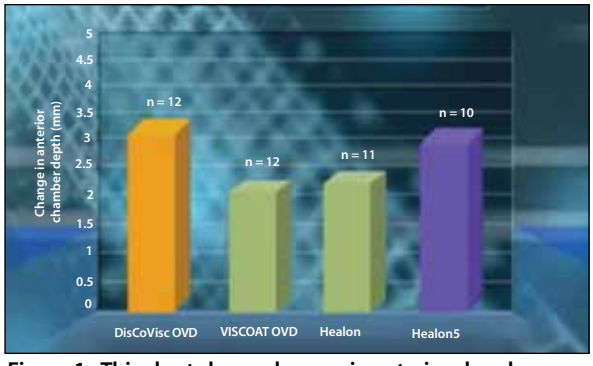

Figure 1. This chart shows changes in anterior chamber depth (ACD) as measured with immersion A-scan after OVD instillation. DisCoVisc OVD and Healon5 showed a greater difference in ACD after their injections. VISCOAT OVD and Healon showed lower changes in the ACD.

Next, Alcon Laboratories, Inc., introduced DisCoVisc OVD, which combines a medium-weight and medium-strength hyaluronic acid with chondroitin sulfate. DisCoVisc OVD has the dispersive characteristics of chondroitin sulfate, but it maintains space in the eye like a traditional cohesive product.[7] Due to its rheological properties, DisCoVisc OVD is a powerful space maintainer, yet functions as a retentive endothelial protector during phacoemulsification. At the end of surgery, DisCoVisc OVD exits the eye much more easily than other dispersive OVDs.[8]

Clinical Test

In a small, experimental laboratory study, my colleagues and I compared the behavior of four types of OVDs: cohesive Healon (Abbott Medical Optics Inc.), dispersive VISCOAT OVD, viscoadaptive Healon5 (Abbott Medical Optics Inc.), and viscodispersive DisCoVisc OVD in a standard porcine cataract surgical model. These data are currently unpublished; however, my colleagues and I are planning a larger study based on the preliminary findings, the results of which will be submitted for publication at a later date.

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Figure 2. VISCOAT and DisCoVisc OVDs provided better retention than Healon and Healon5. Thus, we concluded that VISCOAT and DisCoVisc OVDs better protect the corneal endothelium from ultrasonic energy.

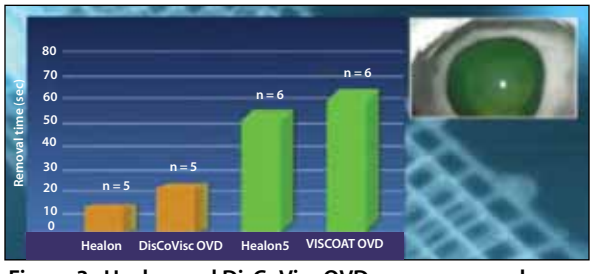

Figure 3. Healon and DisCoVisc OVDs were removed quicker than VISCOAT OVD or Healon5.

Space Creating Ability

To compare the space-creating and space-maintaining ability of each OVD, we measured the changes in the anterior chamber depth (ACD) at three time points using immersion A-scan. We recorded the ACD preoperatively and after making the corneal and sideport incisions. We injected each OVD into the anterior chamber through the sideport incision until we observed the outflow of OVD. Then we repeated the A-scan and recorded the results. The difference between each measurement of the ACD reflects the space-creating ability of the OVD. A larger difference in the pre- and post-injection measurements meant better space-creating ability (Figure 1).

When we operate on a patient with a shallow anterior chamber or positive lenticular pressure, such as those with an intumescent cataract, the space-creating ability of a cohesive OVD was very important for preventing unwanted radial capsular tearing. According to the results of our study, DisCoVisc and Healon5 OVDs would be very useful in such cases.

After my colleagues and I measured the ACD a second time, we refilled the anterior chamber with each OVD and performed a continuous curvilinear capsulorhexis in the standard manner. Once the capsulorhexis was completed, we measured the ACD again. The difference between the pre- and post-capsulorhexis measurements reflected the amount of outflow of OVD during this step. The smaller the difference, the safer the capsulorhexis can be performed, especially in eyes with a shallow anterior chamber. According to our results, DisCoVisc OVD showed the least change in ACD. Healon5 was second place, followed by Healon and VISCOAT OVD.

OVD Retention

To protect the corneal endothelium during phacoemulsification, the retention of OVD is very important. Bissen-Miyajima reported in vitro behavior of OVDs during phacoemulsification.[9] My colleagues and I modified some aspects of the experiment to achieve results for the OVDs on trial. We performed the capsulorhexis and hydrodissection with the aid of methylcellulose. After completing hydrodissection, we removed the remaining methylcellulose and refilled the anterior chamber with the fluorescein-stained OVD on trial. Then we measured the retention time, defined as the time from the beginning of phacoemulsification to completion of the OVD's aspiration (Figure 2).

Removal Time

Some kinds of OVD are easily removed, but some OVDs resist aspiration. Figure 3 shows the removal time of OVDs, which is defined as the time from the start of OVD aspiration to the time it is fully aspirated. After implanting an IOL, the ease with which we were able to remove the OVDs minimized the risk of leaving any material behind.

Study Conclusions

In our experiment, my colleagues and I confirmed the variable performance of OVDs based on their composition. All of the OVDs have a unique character and special purpose. For example, the dispersive VISCOAT OVD demonstrated a strong coating ability, whereas cohesive OVDs exited the eye easily after surgery.

The results of this study suggest that the choice of an OVD for cataract surgery can be customized to the needs of the case. Challenging cases, such as those with a shallow anterior chamber, a high lenticular pressure, or a very low endothelial cell capacity, will benefit from customizing the type of OVD to the patient's condition. Routine cataract surgeries, however, are suitable for the viscodispersive properties of the DisCoVisc OVD. Although I select an OVD based on the eye's condition, my first choice of OVD in routine cases is DisCoVisc OVD. It is helpful in most cases, and I feel comfortable that the postoperative results will be great.

CLINICAL CASES

Case 1

A 73-year-old man with uveitic glaucoma presented to our clinic for cataract surgery. He had 20/10 UCVA in

the right eye and 20/1000 in the left eye. The nuclear density of his left lens was grade 4 by NOCS II classification. Considering his remnant endothelial cell capacity, I chose to use DisCoVisc OVD. On the first postoperative day, his left eye recovered 20/20 visual acuity. At 1 month, when I compared the serial specular microscopic examination to the preoperative test, the cell density coefficient of variation and hexagonality had not changed.

Even very weak ultrasonic energy can be very dangerous for eyes with very low corneal endothelial cellular reserve like this one. In such cases, the dispersive characteristic of DisCoVisc OVD is very helpful.[10,11]

Case 2

A 48-year-old male presented with a complicated intumescent cataract in his right eye. Due to swelling of the lens, the anterior chamber was very shallow, and so I decided to use DisCoVisc OVD for its space-creating ability. Because of the high lenticular pressure, if I did not use a powerful space creator, we would not have been able to control for capsulorhexis tearing. Because the eye had a fibrotic plaque on the posterior capsule, I made a posterior capsulorhexis with the aid of DisCoVisc OVD.

DisCoVisc OVD has very unique and helpful characteristics for cataract surgery. I usually use this combination agent in most of my cataract surgery cases. ■

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As a corneal surgeon, I want to do all I can to protect the corneal endothelium whenever I operate. The low molecular weight and short molecular chain of VISCOAT OVD make it a dispersive viscoelastic. In contrast, DisCoVisc OVD has a zero-shear viscosity that places it in a new class of OVD (viscodispersive), because it features properties of both dispersive and cohesive agents. This advanced-technology (AT) OVD has been shown to have better retention than other OVDs during phacoemulsification,[8,12] thereby resulting in better protection of the corneal endothelium.

I continue to use VISCOAT and DisCoVisc OVDs when operating on dense cataracts, because I want corneal protection as well as the availability of a cohesive OVD to assist me through a difficult or complicated cataract extraction, where I may need to tamponade the vitreous or iris. I may even need to add extra endothelial protection with a dispersive OVD if the surgery is taking longer than expected.

A number of recent papers have compared VISCOAT OVD and DisCoVisc OVD to other OVDs on the market.[13-15] Apart from the physical protection these agents provide, they also offer inhibitory effects on the formation of free radicals in the eye during surgery, which is another way they protect the endothelium.[10,11]

CLINICAL CASE

A 57-year-old male presented with an intumescent cataract in his right eye and a traumatic cataract in the left eye. His preoperative visual acuities were hand motions OD and 20/100 (Snellen Chart) OS. I removed the right cataract successfully with my routine phaco-chop technique using trypan blue dye and DuoVisc OVD containing VISCOAT and PROVISC OVDs. I then implanted an Acrysof IQ Toric lens (Alcon Laboratories, Inc.), after which the patient saw 20/20 on the first postoperative day. The left eye, however, was a lot more challenging due to two clock hours of zonular dehiscence and vitreous in the anterior chamber. I ensured a generous endothelial coating of VISCOAT OVD throughout the procedure. I also placed a capsular tension ring and performed an anterior vitrectomy. I used three sutures to close the 2.2-mm wound. The two side-port incisions I made for the anterior vitrectomy also served to address the eye's pre-existing corneal astigmatism. The patient saw 20/40 on day 1 and 20/25 after I removed his sutures at 1 week. ■

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DUOVISC® Viscoelastic System
DUOVISC® Viscoelastic System is designed to give two viscoelastic materials with different physico-chemical properties that can be used differently and/or sequentially to perform specific tasks during a cataract procedure. DUOVISC® Viscoelastic System consists of VISCOAT® Ophthalmic Viscosurgical Device and PROVISC® Ophthalmic Viscosurgical Device.

CAUTION: Federal law restricts this device to sale by or on the order of a physician.

Viscoat ® OVD (Sodium Chondroitin Sulfate – Sodium Hyaluronate) Ophthalmic Viscosurgical Device

Indications : Viscoat® OVD is indicated for use as an ophthalmic surgical aid in anterior segment procedures including cataract extraction and intraocular lens (IOL) implantation. Viscoat maintains a deep anterior chamber during anterior segment surgeries, enhances visualization during the surgical procedure, and protects the corneal endothelium and other ocular tissues. The viscoelasticity of the solution maintains the normal position of the vitreous face and prevents formation of a flat chamber during surgery.

Warnings: Failure to follow assembly instructions or use of an alternate cannula may result in cannula detachment and potential patient injury.

Precautions : Precautions are limited to those normally associated with the surgical procedure being performed. Although sodium hyaluronate and sodium chondroitin sulfate are highly purified biological polymers, the physician should be aware of the potential allergic risks inherent in the use of any biological material.

Adverse Reactions: Viscoat® OVD has been extremely well tolerated in human and animal studies. A transient rise in intraocular pressure in the early postoperative period may be expected due to the presence of sodium hyaluronate, which has been shown to effect such a rise. It is therefore recommended that Viscoat be removed from the anterior chamber by thorough irrigation and/or aspiration at the end of surgery to minimize postoperative IOP increases. Do not overfill anterior chamber.

ATTENTION: Reference the Physician Labeling/ Directions for Use for a complete listing of indications, warnings and precautions.

ProVisc® OVD (Sodium Hyaluronate) Ophthalmic Viscosurgical Device
Indications : ProVisc® OVD is indicated for use as an ophthalmic surgical aid in the anterior segment during cataract extraction and intraocular lens (IOL) implantation. Ophthalmic viscoelastics serve to maintain a deep anterior chamber during anterior segment surgery allowing reduced trauma to the corneal endothelium and surrounding ocular tissues. They help push back the vitreous face and prevent formation of a flat chamber during surgery.

Precautions : Postoperative increases in intraocular pressure have been reported with sodium hyaluronate products. The IOP should be carefully monitored and appropriate therapy instituted if significant increases should occur. It is recommended that ProVisc® OVD be removed by irrigation and/or aspiration at the close of surgery. Do not overfill anterior chamber. Although sodium hyaluronate is a highly purified biological polymer, the physician should be aware of the potential allergic risks inherent in the use of any biological material; care should be used in patients with hypersensitivity to any components in this material. Cannula assembly instructions should be followed to prevent patient injury.

Adverse Reactions: Postoperative inflammatory reactions such as hypopyon and iritis have been reported with the use of ophthalmic viscoelastics, as well as incidents of corneal edema, corneal decompensation, and a transient rise in intraocular pressure.

ATTENTION: Reference the Physician Labeling/ Directions for Use for a complete listing of indications, warnings and precautions.

DisCoVisc® Ophthalmic Viscosurgical Device
DisCoVisc® Ophthalmic Viscosurgical Device (Sodium Chondroitin Sulfate – Sodium Hyaluronate).

Description: DisCoVisc® Ophthalmic Viscosurgical Device has an intermediate cohesive/dispersive index (CDI) and can best be described as the first viscous dispersive viscoelastic and is optimized for the entire surgical procedure.

Indications: DisCoVisc® Ophthalmic Viscosurgical Device is indicated for use during surgery in the anterior segment of the eye. It is designed to create and maintain space, to protect the corneal endothelium and other intraocular tissues and to manipulate tissues during surgery. It may also be used to coat intraocular lenses and instruments during cataract extraction and IOL insertion.

Warnings: Failure to follow assembly instructions or use of an alternate cannula may result in cannula detachment and potential patient injury.

Precautions: Precautions are limited to those normally associated with the surgical procedure being performed. Although sodium hyaluronate and sodium chondroitin sulfate are highly purified biological polymers, the physician should be aware of the potential allergic risks inherent in the use of any biological material.

Adverse Reactions: DisCoVisc® Ophthalmic Viscosurgical Device was very well tolerated in nonclinical and clinical studies. A transient rise in intraocular pressure in the early postoperative period may be expected due to the presence of sodium hyaluronate, which has been shown to effect such a rise. It is therefore recommended that DisCoVisc® Ophthalmic Viscosurgical Device be removed from the anterior chamber by thorough irrigation and/or aspiration at the end of surgery to minimize postoperative IOP increases. Do not overfill anterior chamber.

ATTENTI ON: Reference the Physician Labeling/Directions for Use for a complete listing of indications, warnings and precautions.

CAUTION: Federal (USA) law restricts this device to the sale by, or on the order of, a physician.

AcrySof® IQ Toric Intraocular Lenses – Physician Brief Statement
CAUTION: Federal (USA) law restricts this device to the sale by or on the order of a physician.

INDICATIONS: The AcrySof® IQ Toric posterior chamber intraocular lenses are intended for primary implantation in the capsular bag of the eye for visual correction of aphakia and pre-existing corneal astigmatism secondary to removal of a cataractous lens in adult patients with or without presbyopia, who desire improved uncorrected distance vision, reduction of residual refractive cylinder and increased spectacle independence for distance vision.

WARNING/PRECAUTION: Careful preoperative evaluation and sound clinical judgment should be used by the surgeon to decide the risk/benefit ratio before implanting a lens in a patient with any of the conditions described in the Directions for Use labeling. Toric IOLs should not be implanted if the posterior capsule is ruptured, if the zonules are damaged, or if a primary posterior capsulotomy is planned. Rotation can reduce astigmatic correction; if necessary lens repositioning should occur as early as possible prior to lens encapsulation. All viscoelastics should be removed from both the anterior and posterior sides of the lens; residual viscoelastics may allow the lens to rotate.

Optical theory suggests that high astigmatic patients (i.e. > 2.5 D) may experience spatial distortions. Possible toric IOL related factors may include residual cylindrical error or axis misalignments. Prior to surgery, physicians should provide prospective patients with a copy of the Patient Information Brochure available from Alcon for this product informing them of possible risks and benefits associated with the AcrySof® IQ Toric Cylinder Power IOLs.

Studies have shown that color vision discrimination is not adversely affected in individuals with the AcrySof® Natural IOL and normal color vision. The effect on vision of the AcrySof® Natural IOL in subjects with hereditary color vision defects and acquired color vision defects secondary to ocular disease (e.g., glaucoma, diabetic retinopathy, chronic uveitis, and other retinal or optic nerve diseases) has not been studied. Do not resterilize; do not store over 45° C; use only sterile irrigating solutions such as BSS® or BSS PLUS® Sterile Intraocular Irrigating Solutions.

ATTENTION: Reference the Directions for Use labeling for a complete listing of indications, warnings and precautions.