Supplement to

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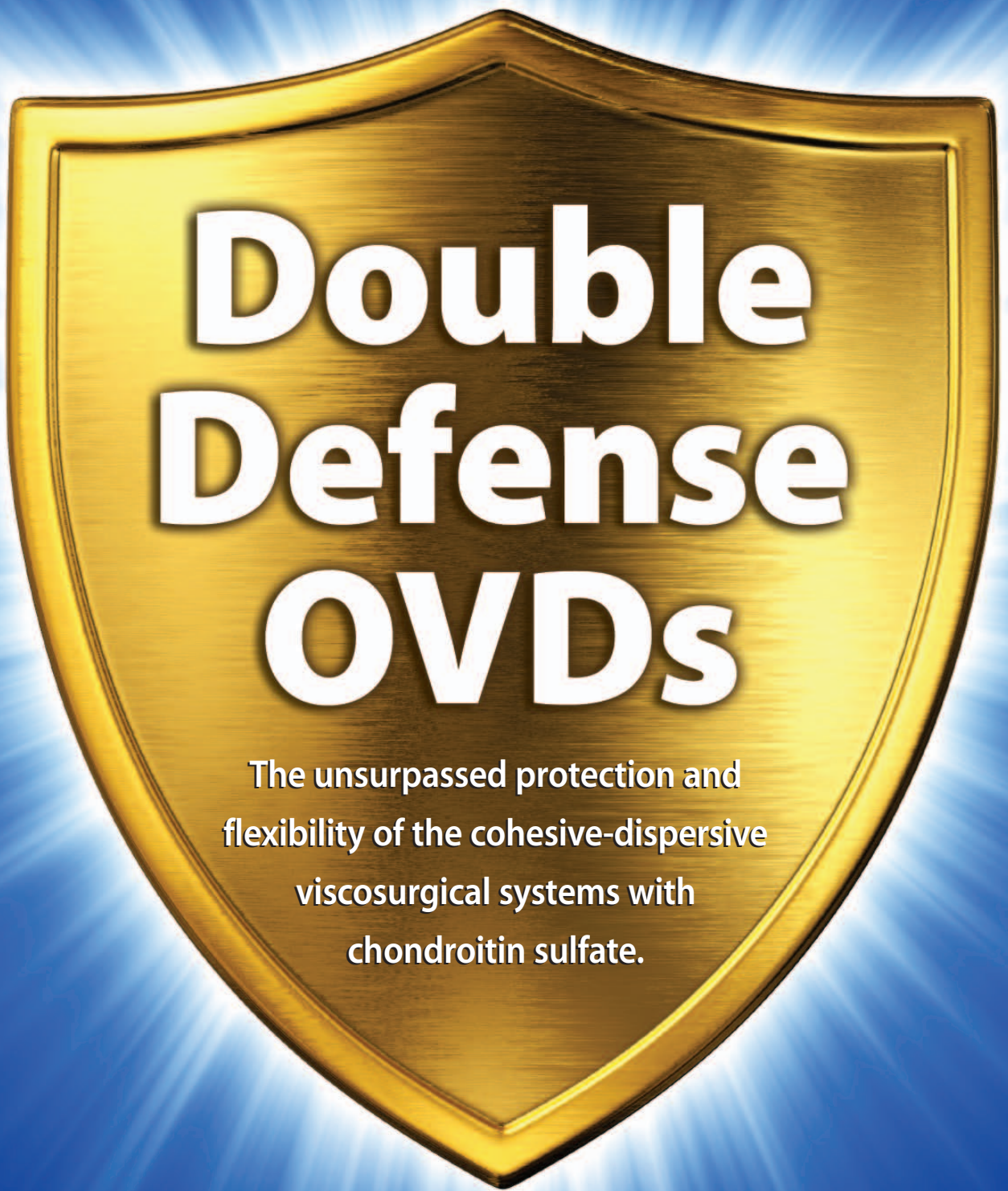
Cataract & Refractive Surgery TODAY



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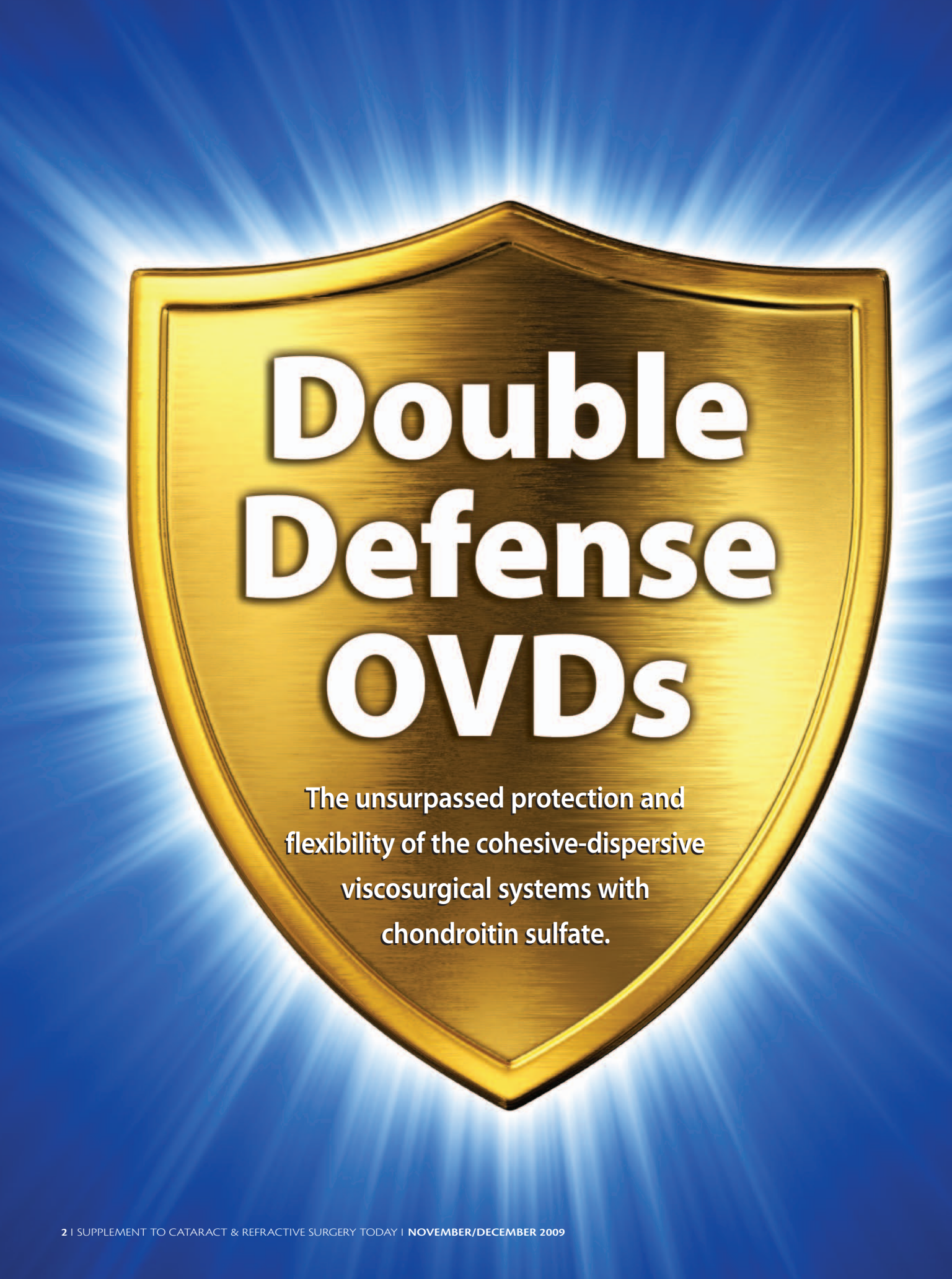
Double
Defense
OVDs
The unsurpassed protection and flexibility of the cohesive-dispersive viscosurgical systems with chondroitin sulfate.

PARTICIPANTS

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CONTENTS

Dr. Modi: This roundtable discussion focuses on the latest research on ophthalmic viscosurgical devices (OVDs) as they relate to cellular protection during cataract surgery. By way of introduction, my name is Satish Modi, MD. I am an assistant clinical professor of ophthalmology at Albert Einstein College of Medicine, which is in the Bronx, New York. I am also Medical Director of the SEETA Eye Clinic in Poughkeepsie, New York, by Vassar College. I specialize in cataract surgery and refractive surgery.

Dr. Miller: My name is Kevin Miller, MD. I am a professor of clinical ophthalmology at the UCLA Jules Stein Eye Institute in Los Angeles. My practice is largely focused on, but not limited to, cataract and refractive surgery with an emphasis on combined refractive cataract surgery.

Dr. Jones: My name is Jason Jones, MD, and I am Medical Director and President of Jones Eye Clinic in Iowa. My practice is largely devoted to cataract surgery and incorporates premium IOL technology.

CHANGES IN CATARACT SURGICAL STRATEGIES

Dr. Modi: What are some of the key changes you see in cataract surgery today, and how do you see these changes affecting your choice of an ophthalmic viscosurgical device (OVD) or devices during your surgeries?

Dr. Miller: A couple of changes are taking place. The agents we use have not changed much; we are still limited to hyaluronic acid, chondroitin sulfate, and hydroxypropylmethylcellulose (HPMC). However, our use of various combinations of these agents has changed. We are now seeing more dual viscoelastic systems, like DuoVisc (Alcon Laboratories, Inc., Fort Worth, TX). Also, there are new crossover products that have both dispersive and cohesive viscoelastic properties in the same vial. Further, manufacturers are beginning to add more volume per syringe, as surgeons frequently run out of viscoelastic during surgery on highly myopic and other difficult eyes.

> "Patients make judgments about their outcomes very soon after surgery, even as soon as day 1."
> —Jason Jones, MD

Dr. Jones: I think the main issue driving a lot of these developments is our patients' increasing expectations. Even monofocal patients have expectations nowadays that we have not seen before. Patients make judgments about their outcomes very soon after surgery, even as soon as day 1.

Dr. Modi: I could not agree more. We are victims of our own success. Our patients expect good results; even a slight subconjunctival hemorrhage upsets them. Overall, premium IOL patients are very similar to LASIK refractive patients, and we cannot give them a "wow factor" on day 1 if they have cloudy corneas. The key is protecting the cornea throughout the surgery so that the patient emerges with a crystal-clear cornea (Figure 1). If we can protect the cornea, premium lenses can do their job and we can deliver great vision on the first postoperative day.

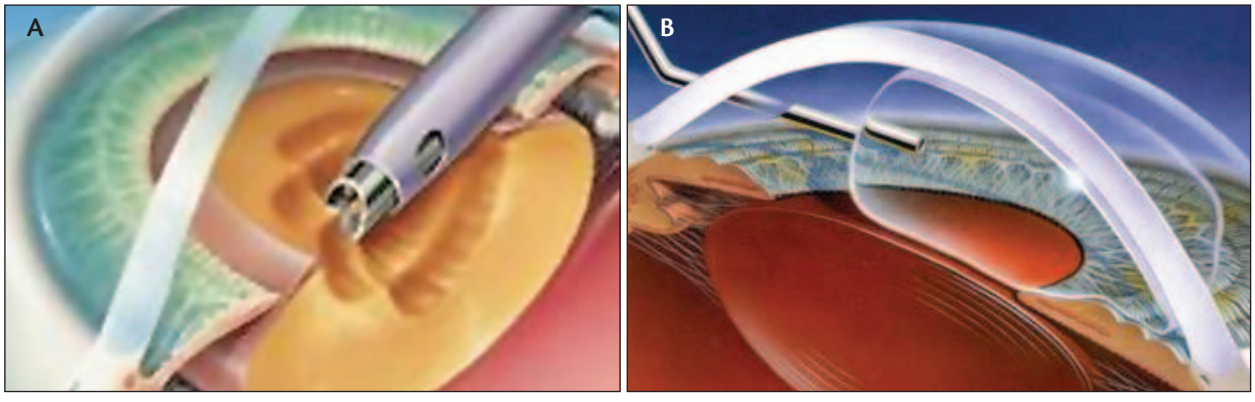

Figure 1. It has been demonstrated that phacoemulsification can damage the endothelium (A).[1] A retained OVD provides a barrier to protect the thin layer of mucinous material where the endothelium intersects with the aqueous (B).[2]

(1. Holst A, Rolfsen W, Svensson B, et al. Formation of free radicals during phacoemulsification. *Curr Eye Res.* 1993;12:359-365.
2. Kim EK, Cristol SM, Kang SJ, et al. Viscoelastic protection from endothelial damage by air bubbles. *J Cataract Refract Surg.* 2002;28:1047-1053.)

Dr. Miller: I agree. I have told my residents for years that a subconjunctival hemorrhage is a big deal. How the eye looks postoperatively is almost as important to the patient as how the eye sees. We want atraumatic surgery at every level; we do not want to pinch the conjunctiva or ding the endothelium. Using viscoelastic agents with dispersive properties produces clearer corneas on day 1, even though they take slightly longer to remove at the end of the case.

SURGICAL TECHNIQUES WITH OVDs

Dr. Modi: Let's talk about some of the latest surgical techniques, such as microincisions, viscodissection, and intraocular protection. What do you think about viscodissection of the cortex and the nucleus? How can we protect the posterior capsule?

> "If we can protect the cornea, premium lenses can do their job and we can deliver great vision on the first postoperative day."
> —Satish Modi, MD

Dr. Miller: Because we are using much smaller incisions, we are not running as much fluid through the eye during cataract surgery as we used to. This is particularly true if we use the OZil Torsional ultrasound technology (Alcon Laboratories, Inc.). One downside of having less fluid in the eye, however, is a somewhat greater difficulty removing the viscoelastic agent. When I first transitioned to OZil, I also switched from Healon GV (Abbott Medical Optics Inc., Santa Ana, CA) to DisCoVisc (Alcon Laboratories, Inc.). I noticed more nuclear fragments in the anterior chamber on the first postoperative day. Lens fragments were trapped in the sulcus because the INFINITI system's aspiration flow did not completely evacuate the dispersive OVD. So, I now recommend that surgeons who are transitioning to smaller incisions (2.2 to 2.4 mm from 2.7 or 2.8 mm) spend more time at the end of surgery irrigating fluid through the eye to clear the OVD and any hidden, trapped lens fragments.

I am not a big fan of viscodissection, and I do not like to waste OVD. I may use viscolevitation (*see the sidebar,* Viscolevitation and Viscoelevation) if necessary, such as if a brunescent cataract evolves after phacoemulsification into a concave posterior leathery plate that adheres to the capsule. Viscolevitation will allow me to lift the fragment so I can pursue it with the OZil tip. For posterior polar cataracts, I perform hydrodelineation rather than viscodissection.

VISCOLEVITATION AND VISCOELEVATION

Viscolevitation refers to using an OVD to hold cataract fragments in place and keep them from falling back in the eye. *Viscoelevation* is the act of instilling an OVD beneath nuclear fragments to raise them into the pupillary space so that the surgeon may have easier and safer access them with the phaco needle, away from the vitreous gel.

Dr. Jones: Viscodissection is not a routine part of my technique, either. There are certain indications for using a viscoelastic agent in the capsular bag in the presence of nuclear material, such as loose zonules and difficulty rotating the lens within the bag. The OVD acts more like a tamponading agent in that situation. I believe in hydrodissection more as a routine part of my procedure. I think certain components of viscodissection are helpful in preventing capsular rupture, which may be a bigger issue with particular techniques. I prefer quick chopping or vertical chopping, because I am able to visualize all of the instruments completely throughout the surgery, which reassures me that I will not damage the posterior capsule during the procedure.

> "A dispersive OVD is an indispensable tool for viscoelevation."
> —Jason Jones, MD

Dr. Modi: I agree. I do not use viscodissection routinely. Having said that, cost is always an issue. Often, I can complete an entire case, even a complicated one, with one ampoule of DisCoVisc, which I think is phenomenal. I would not waste it trying to create space between the posterior capsule and the epinucleus or the nucleus. Secondly, if I use a small incision, I can keep the OZil handpiece in the center of the pupil and pull nuclear pieces to it. That capability in itself protects the posterior capsule.

I also agree with Dr. Miller about avoiding hydrodissection with a posterior polar cataract. I would only hydrodelineate to free up the endonucleus. In some cases of weak zonules, I would use the viscoelastic to open up or protect the capsular bag. I was privileged to watch Dr. Jones present

a case at the 2008 AAO annual meeting in which he had the entire nucleus and endonucleus in the capsular bag, and then he went right through the posterior capsule (*view the video on Eyetube.net at* http://www.eyetube.net/videos/default.asp?lopipo).[1] He used a dispersive viscoelastic to tamponade the rupture and extract the cataract masterfully. Would you please comment on that case, Dr. Jones?

Dr. Jones: A dispersive OVD is preferable to use with an open capsule or potential vitreous presentation, because it will protect against vitreous prolapse, evenly coat the intraocular structures, and provide extra protection for the iris and any residual capsule present. It allows you to viscoelevate material anteriorly, which is what happened during this particular case. A dispersive OVD is an indispensable tool for viscoelevation. Additionally, the 27-gauge visco cannula is quite useful for manipulating material in the anterior chamber to your advantage.

Dr. Modi: How did you change your flow settings for that case after you noticed the tear in the capsule?

Dr. Jones: The first step is to recognize the problem and then to keep your instrument in the incision. Keep the irrigation flowing, and have your technician lower the bottle as you are injecting viscoelastic agent into the rent in the posterior capsule. It is crucial that you keep the phaco tip within the anterior chamber during this step, because it will prevent vitreous from herniating forward. Then, once the anterior chamber is filled with viscoelastic (Figure 2), remove the phaco tip and reassess the situation. Use more viscoelastic to elevate the lens material if necessary. I had a fair amount of endonucleus still in the capsular bag, but it did not go through the posterior capsule. I was able to elevate the endonucleus to the iris plane, and then I approached this nuclear remnant with a lower flow setting and bottle height. I was able to remove most of it with the torsional ultrasound. I mechanically debrided the few remaining parts, and then I began a bimanual anterior vitrectomy that removed all the cortical material. As I changed my bimanual hand pieces, just like we would at the initial presentation of a capsular rupture, I tamponaded the vitreous and refilled the space before I removed the irrigation line. I was able to access all the cortical material, and then I successfully implanted a lens with an optic capture technique.

> "A cohesive agent cannot protect the cornea against turbulent flow—a dispersive is required."
> —Kevin Miller, MD

ENDOTHELIAL PROTECTION

Dr. Modi: It seems like every male in my area is on Flomax (tamsulosin; Ingelheim Pharmaceuticals, Inc., Ridgefield, CT) or saw palmetto. My staff and I now always ask a male cataract patient about any history of Flomax usage, past or present. I do not like using iris hooks for floppy irides, because they increase my incidence of cystoid macular edema. I will use DisCoVisc instead to keep the pupil open. Sometimes, when trying to thin the posterior plate, I am not able to crack the nucleus or raise it to the pupillary plane, and then I will use DisCoVisc to viscofracture and viscoelevate these elements of endonucleus. Then, I am able to phacoemulsify them safely.

Multiple studies have investigated endothelial cell damage during the phaco procedure. Please comment on the protective benefits of today's OVDs.

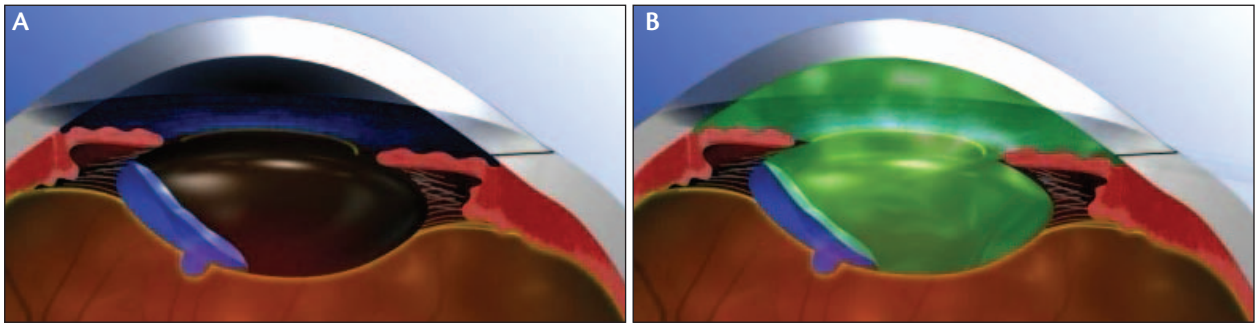

Figure 2. If the posterior capsule ruptures (A), filling the anterior chamber with OVD (B) will maintain the capsule's shape and prevent vitreous from herniating forward as you extract the phaco tip.

Dr. Miller: Today's OVDs are really yesterday's OVDs repackaged; there has not been a major change in the agents we use. The average phaco surgeon in the United States probably emulsifies nuclear material above the pupillary plane, where endothelial cell protection matters. We all know that cohesive agents leave the eye within a minute or two after beginning phacoemulsification (Figure 3). So, if the surgeon does not have a dispersive agent in the eye, the endothelium will suffer cellular damage (Figure 4). Furthermore, I believe that turbulence and fluid flow are much more traumatic to the endothelium than phaco power and heat. Although surgeons occasionally encounter problems with phaco burns and phaco energy, turbulence and fluid flow are ever-present, and we need to protect corneas against these forces. A cohesive agent cannot protect the cornea against turbulent flow—a dispersive is required. A dispersive OVD is mandatory to achieve good results on the first postoperative day with modern phaco techniques (Table 1).

Dr. Jones: Do you use DisCoVisc or DuoVisc?

Dr. Miller: As I mentioned, I converted from Healon GV to DisCoVisc as my agent of choice. Honestly, there was a learning curve in the first month, because I spent more time chasing after the OVD. DisCoVisc fractures, unlike Healon GV. I persisted in using it, however, because my patients' corneas looked so good on day 1. With Healon GV, the corneas looked great 80% of the time, and 20% of the time I thought I could have done better. With DisCoVisc, I am happy with my 1-day postoperative corneas 90% to 95% of the time.

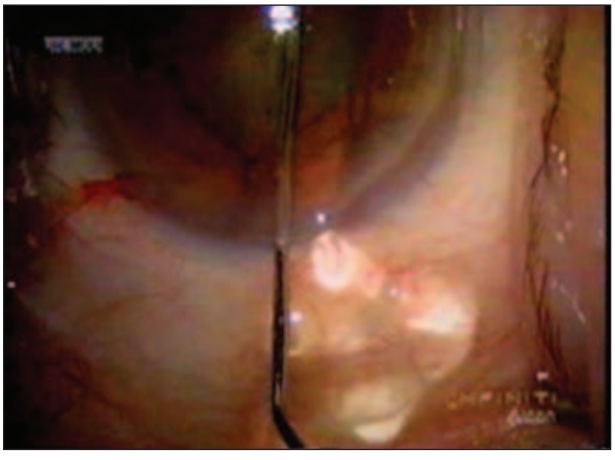

Figure 3. A cohesive OVD exits the eye under slight pressure from the instrumentation.

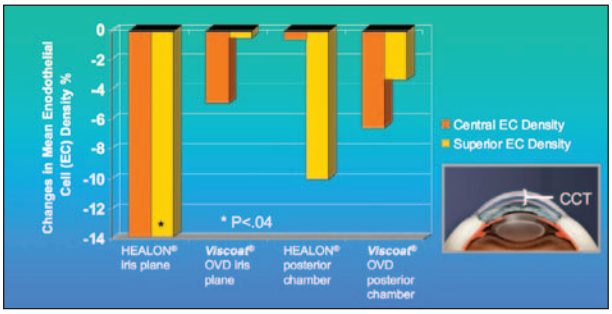

Figure 4. After 16 weeks, the eyes that had received Viscoat OVD at the iris plane had significantly less superior endothelial cell loss than the eyes that had received Healon.[1]
(1. Koch DD, Liu JF, Glasser DB, et al. A comparison of corneal endothelial changes after use of HEALON or Viscoat during phacoemulsification. *Am J Ophthalmol.* 1993;115(2):188-201.)

QUALITIES OF VARIOUS OVDs

Dr. Modi: How do the protective qualities of various OVDs differ?

Dr. Jones: I agree that a dispersive agent is necessary for the reasons Dr. Miller mentioned. Turbulence and fluid flow are a major factor in corneal edema and endothelial damage, and a dispersive agent stays in the eye better. OVDs with chondroitin sulfate have an extra negative charge, which provides an added layer of protection that other dispersive agents cannot achieve.[2] I think chondroitin sulfate is a key component in how DisCoVisc and Viscoat in the DuoVisc package afford such a high level of protection. I think DuoVisc is an excellent product, and it is my viscoelastic agent of choice. Provisc evacuates the eye a little more readily than DisCoVisc, in my opinion.

Dr. Miller: To remove DisCoVisc, I advance the phaco tip beneath the IOL and into the sulcus, and I keep the tip there and chase after the OVD wherever I find it. I sometimes let the infusion pressure go to zero, and the forward vitreous movement will burp out the OVD in the sulcus. I will even re-enter the eye if I see DisCoVisc oozing around the pupil after I pull the I/A tip out of the eye. In short, I keep aspirating until the OVD is gone. My major reason for not using DuoVisc is that pure Viscoat can trap bubbles, although this may be a lesser issue or even a nonissue with today's new phaco technologies, like torsional ultrasound.

Dr. Modi: I started using Viscoat when I learned how to do phacoemulsification, and I still think it is a superb agent for protecting the corneal endothelium. Sometimes it would take me 1 to 1.5 minutes to get it out of the eye,

however, and I could still have pressure spikes of 45 mm Hg the next day that required me to burp the wound. A few years later, when I tried using DuoVisc, which combines Viscoat with the cohesive property of Provisc, it took me only 11 seconds to extract the Provisc completely without any postoperative IOP spikes. By comparison, Healon5 (Abbott Medical Optics Inc.) took me approximately 50 seconds to remove.

Later, I was one of the clinical investigators on the FDA's phase 3 study that brought DisCoVisc to market, and I have used DisCoVisc in almost all my cases since, because it is a more cohesive dispersive agent. I can remove DisCoVisc in 12 to 13 seconds, a speed that is similar to that observed in a recently published Japanese study.[3] I empty the anterior chamber, go to foot position zero, push the IOL up with the I/A tip, and keep the tip behind the implant with its opening facing me (turning the tip 45° either way can capture the posterior capsule, especially with a pseudoexfoliative case). I have had no pressure spikes with DisCoVisc, and as I said, I can complete an entire case, even a complicated one, with one ampoule. Furthermore, if I am using DuoVisc, I make sure to tell my technicians to use Viscoat (not Provisc) to load the Monarch cartridge (Alcon Laboratories, Inc.) to insert the lens, because it is so lubricious.

BENEFITS OF CHONDROITIN SULFATE

Dr. Modi: Let's discuss why OVDs with chondroitin sulfate provide better endothelial protection than agents that lack it. Recent studies have shown that it is not really the phaco power or the flow and high shear forces that damage endothelial cells; it is the formation of free radicals in the eye.[4] In fact, Endre Balazs, MD, from Hungary, who was inducted recently into the Ophthalmology Hall of Fame, produced seminal work on viscoelastics that changed the way we perform cataract surgery forevermore and improved patients' results immeasurably.[5] Dr. Balazs started his work with the hyaluronic acid in Healon and then went on to study chondroitin sulfate.[6] Also, Abhay R. Vasavada, MD, from India, presented a study at the 2009 ASCRS meeting that showed that, depending on the amount of irrigation flow in the eye and the duration of the phaco tip in the eye, using hyaluronic acid 3% almost doubles the amount of endothelium apoptosis compared to adding chondroitin sulfate with either DisCoVisc or Viscoat.[7]

Dr. Miller: Looking back on the history of phacoemulsification, I think four inventions will stand out as seminal. The first is the invention of phacoemulsification by Charles Kelman, MD. Second, without question, is the development of viscoelastic agents. Third is the capsulorrhexis technique,

TABLE 1. PRE- VS POSTOPERATIVE CHANGES IN CCT[1]

	DuoVisc				Healon		
Exam	No. of Eyes	Mean CCT (µm)	CCT Increase (%)	**Exam**	No. of Eyes	Mean CCT (µm)	CCT Increase (%)
Preop	32	547	NA	**Preop**	29	552	NA
Postop 1d	32	618	13.2	**Postop 1d**	29	665	20.3
Postop 1wk	32	609	11.3	**Postop 1wk**	29	644	16.5
Postop 1mo	32	586	7.1	**Postop 1mo**	29	610	10.5
Postop 6mo	32	557	1.8	**Postop 6mo**	29	588	6.5

Figure 4. The group treated with DuoVisc OVD showed smaller increases in CCT at all time points measured compared with the group treated with sodium hyaluronate alone. Poyer et al[2] speculate that Viscoat OVD 's protective effect is a result of its coating properties.

(1. Tarnawska D, Wylegala E. Effectiveness of the soft-shell technique in patients with Fuchs' endothelial dystrophy. *J Cataract Refract Surg.* 2007;33:1907-1912.
2. Poyer JF, Chan KY, Arshinoff SA. New method to measure the retention of viscoelastic agents on a rabbit corneal endothelial cell line after irrigation and aspiration. *J Cataract Refract Surg.* 1998;24:84-90.)

and fourth is foldable IOL implants. All of these inventions or advances were critical to getting us where we are today. Concerning viscoelastics, all the formulations have their place, but the combination of chondroitin sulfate and hyaluronic acid, with their unique properties, is very helpful in cataract surgery. I almost wish that the word *dispersive* had not taken hold to that type of product so quickly; I prefer the term *adhesive*. I teach residents to think of these agents as adhesives, because they adhere to tissues such as the iris and the endothelium and so are difficult to remove. It is the adhesive characteristic that provides the endothelial protection on which we rely.

Dr. Jones: Without the OVDs we have today, we would not be able to deliver the results that we can. The dispersive products in particular are crucial to achieving the outcomes our patients expect. Knowing about the history of phacoemulsification and viscoelastics helps us appreciate that chondroitin sulfate is still the key ingredient in corneal preservative media. Chondroitin sulfate's role in facilitating corneal transplants is particularly noteworthy.

Dr. Modi: Have either of you felt that chondroitin sulfate reduces the clarity of the OVD?

Dr. Miller: I have not seen chondroitin sulfate cloud an OVD. The only drawback I have observed with a mixture of chondroitin sulfate/hyaluronic acid is its tendency to trap air bubbles.

> "Chondroitin sulfate is still the key ingredient in corneal preservative media. Chondroitin sulfate's role in facilitating corneal transplants is particularly noteworthy."
> —Jason Jones, MD

Dr. Jones: Storing the vials of DuoVisc and Viscoat upright according to the arrows on the package reduces the chance of bubbles forming, as does carefully filling the hub of the cannula with balanced salt solution. I have not experienced a problem with seeing through Viscoat at all. I think surgeons can cloud any viscoelastic agent by failing to form a bolus of the agent across from the incision through which they start surgery. The bolus creates a smooth dome of viscoelastic to fill the anterior chamber (or wherever you are trying to achieve space).

Dr. Miller: I have many surgical pearls that I try to convey to first-year residents, some of which are related to injecting the viscoelastic. It is important to take the cannula across the anterior chamber and inject from the opposite side, so as to back-fill the anterior chamber. Too often, because of the position of the eyelid or the lid speculum, surgeons want to start injecting the OVD after barely entering the paracentesis. Of course, the agent will begin to fill the anterior chamber, but then the aqueous will become trapped and the IOP will rise, because a dispersive OVD retains everything in the eye. At some point, the pressure will rise enough that even a dispersive agent will exit, and then suddenly it will run out, leaving aqueous in the eye.

> "DisCoVisc was nearly named ClearVisc, principally because it is such an incredibly clear agent that you cannot see it in the eye."
> —Satish Modi, MD

The second pearl I convey to residents, which relates more to cohesive agents, is to be aware of what is happening to the subincisional iris during hydrodissection. With a high-viscosity agent (ie, Healon GV or Healon5), if you do not closely watch the subincisional cortex while you inject balanced salt solution and watch the fluid wave go around the lens, the iris may expel through the phaco incision. If it mounds up toward the incision, halt the hydrodissection, decompress the eye slightly, extract the hydrodissection cannula, and let the viscoelastic agent that is beneath the iris redistribute before continuing. The worst thing that can happen in modern-day phaco surgery is to have a knuckle of iris prolapse from the eye. That is often the beginning of a cosmetic and functional disaster. That situation is more likely to occur with a highly cohesive viscoelastic. So, I instruct residents always to watch the fluid wave with one eye and the subincisional iris with the other eye, and if it starts to come up, stop. You cannot proceed to phacoemulsification until you have cleared some of the OVD from beneath the iris. You can go back and hydrodissect more later if needed.

Dr. Modi: I have seen residents do the same thing. They start injecting DisCoVisc into the center of the anterior chamber, and then they have this linguini-like mass in the middle of the chamber that reduces visibility. Also, after

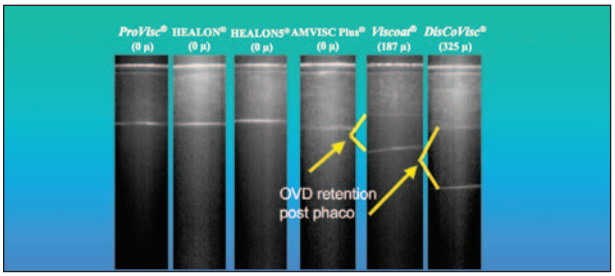

Figure 5. This image shows a quantitative assessment of OVDs containing chondroitin sulfate versus those containing hyaluronate using in vivo confocal microscopy.[9] The viscous-dispersive OVD provided the greatest residual thickness after phacoemulsification. There is less endothelial cell damage after phacoemulsification when the OVD is retained.

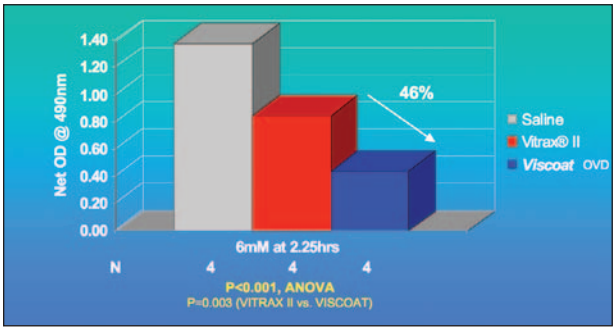

Figure 6. This graph summarizes endothelial toxicity after exposure to hydrogen peroxide. The OVD with chondroitin sulfate significantly lowered the amount of damage from free radicals compared to the OVD with hyaluronic acid only.[11]

making the capsulorrhexis and before hydrodissecting, you need to empty the chamber a little bit. I instruct residents to use the hub of the needle or dissection cannula to press on the posterior lip of the incision, remove a little bit of the OVD, create space, and then start hydrodissection and hydrodelamination. Incidentally, DisCoVisc was nearly named ClearVisc, principally because it is such an incredibly clear agent that you cannot see it in the eye.

I think we need to protect the endothelium from three primary factors. The first is potential damage from the ultrasound handpiece. Aust et al showed at the 2008 ESCRS meeting that switching from longitudinal to OZil Torsional ultrasound markedly reduces the amount of free radicals released in the eye and therefore minimizes damage.[8] The second issue is retention of the OVD with the high-shear flow rates common with traditional phacoemulsification. The third issue is the reduction of free radicals in the eye.

Dr. Jones: Researchers at the University of Texas conducted a confocal microscopy study that demonstrated that the products that contain chondroitin sulfate are better retained under simulations of flow (Figure 5).[9] This finding shows how chondroitin sulfate, with a second negative charge, imparts a retentive nature to viscoelastic products on which cataract surgeons rely to resist flow and shear rates. It underscores how much protection you can expect from these products versus hyaluronic products that do not contain chondroitin sulfate.

OVD PROTECTION AGAINST FREE RADICALS

Dr. Modi: Geffen et al, published a study[10] in the December 2008 issue of the *Journal of Cataract and Refractive Surgery* that attributed cell apoptosis to the generation of free radicals in the eye. How does one reduce free radicals in the eye? We know that switching from longitudinal to OZil Torsional ultrasound accomplishes this goal, but what part does OVD usage play in preventing the formation of free radicals in the eye?

Dr. Miller: Free radical formation in cataract surgery is a relatively new concept. Dr. Vasavada has shown that compared to hyaluronic acid, only products containing chondroitin sulfate significantly reduced the amount of free-radical production and free-radical cell damage (Figure 6).[7,11] Furthermore, my colleague, Young Keun Han, MD, recently finished a series of experiments that verified that OZil produces significantly less heat than longitudinal phacoemulsification.[12] Heat can damage the endothelium, and certainly it can burn a corneal incision if it gets above a threshold of about 50º C.

Nevertheless, I think more work needs to be done regarding the use of OVDs in minimizing these potentially damaging molecules.

Dr. Jones: I think this is an exciting area of research that can help us deliver the best outcomes. Right now, I do not think we have the final answer regarding how OVDs protect the eye from free radicals.

HEALON D AND VITRAX

Dr. Modi: Have either of you doctors used Healon D, and what are your thoughts about it? Is it really a dispersive OVD?

Dr. Jones: I personally have not had any experience yet with Healon D, although I believe it will be interesting to try

it and see how it compares to my previous experience using Vitrax (Abbott Medical Optics, Inc.). From what I understand, Healon D is essentially a rebranding of Vitrax. In my experience, Vitrax was somewhat retentive, more so than other hyaluronic-containing products, but its adhesive properties were not equal to Viscoat.

Dr. Modi: Yes, the US FDA's premarket approval database lists Healon D as a rebranding of Vitrax.[13]

Dr. Miller: I had the opportunity to use Vitrax many years ago, and I thought its coating properties were adequate. I remember it coming out of the eye a little more easily than Viscoat. I did not find it to be particularly advantageous over Viscoat, and so I never adopted it. It is unfortunate for AMO that they had to recall the product just after it was launched. I do hope to try it when it is back on the market.

Dr. Modi: Did either of you observe any corneal edema when using Vitrax?

Dr. Jones: When I used Vitrax and compared it side-by-side with Viscoat using the same phaco fluidics, the only difference I noted was clearer corneas with Viscoat over Vitrax.

SUMMARY

Dr. Miller: The field of OVDs is ripe for innovation. It has been stagnant for a little too long, and there are a number of improvements I think cataract surgeons would like to see. One is an OVD that you can leave in the eye without having to worry about IOP spikes. Secondly, I think we need new products. Prior to the introduction of the two long-chain molecules we currently have, the idea of coating the endothelium was not even a thought. I think if we can get more molecules onto the market, we will see even more applications.

Dr. Modi: In summary, I want to thank both Dr. Miller and Dr. Jones for their insights into this intriguing subject. We must deliver the outcomes our patients expect on the first postoperative day. We're practicing astigmatically neutral surgery with small, square incisions. Using OZil Torsional ultrasound is another component of safer surgery, because it reduces flow rate and thermal energy in the eye and thereby decreases the generation of free radicals in the eye. The second part of safer surgery is the judicious use of appropriate OVDs. Both DuoVisc and DisCoVisc contain chondroitin sulfate in addition to hyaluronic acid, and this attribute allows for wonderful retention in the eye and protects the endothelium until the end of the case. It absorbs free radicals and thereby reduces apoptosis of the endothelial cells. Of no less importance, it provides a very clear cornea for wonderful patient outcomes on day 1.

1. Modi S, Jones J. Pupil protection, yours and the patient's. Video presented at the Alcon booth Speakers Forum, AAO annual meeting; November 10, 2008; Atlanta, GA.
2. Poyer JF, Chan KY, Arshinoff SA. New method to measure the retention of viscoelastic agents on a rabbit corneal endothelial cell line after irrigation and aspiration. *J Cataract Refract Surg.* 1998;24(1):84-90.
3. Bissen-Miyajima H. In vitro behavior of ophthalmic viscosurgical devices during phacoemulsification. *J Cataract Refract Surg.* 2006;32(6):1026-1031.
4. Augustin AJ, Dick HB. Oxidative tissue damage after phacoemulsification: influence of ophthalmic viscosurgical devices. *J Cataract Refract Surg.* 2004;30(2):424-427.
5. Balazs EA, Denlinger JL. Clinical uses of hyaluronan. *Ciba Found Symp.* 1989;143:265-75; discussion 275-280, 281-285.
6. Balazs EA. Hyaluronan as an ophthalmic viscoelastic device. *Curr Pharm Biotechnol.* 2008;9(4):236-238.
7. Praveen MR, Koul A, Vasavada AR, et al. DisCoVisc versus the soft-shell technique using Viscoat and Provisc in phacoemulsification: randomized clinical trial. *J Cataract Refract Surg.* 2008;34(7):1145-1151.
8. Aust S, Gardner J, Humbert J. Free radicals generated from different technologies during phacoemulsification. Paper presented at: The ESCRS annual meeting; September 16, 2008; Berlin, Germany.
9. Petroll WM, Jafari M, Lane SS, et al. Quantitative assessment of ophthalmic viscosurgical device retention using in vivo confocal microscopy. *J Cataract Refract Surg.* 2005;31(12):2363-2368.
10. Geffen N, Topaz M, Kredy-Farhan L, et al. Phacoemulsification-induced injury in corneal endothelial cells mediated by apoptosis: in vitro model. *J Cataract Refract Surg.* 2008;34(12):2146-2152.
11. Vasavada A, Ong M, Cordova D, Hartzer M. Protective effect of ophthalmic viscosurgical devices (OVDs) against hydrogen peroxide-induced oxidative damage to corneal endothelial cells: an in-vitro model. Paper presented at: The ASCRS Symposium on Cataract, IOL and Refractive Surgery; April 7, 2009; San Francisco, CA. 2008;34(7):1145-1151.
12. Miller K, Han YK. Heat production in longitudinal versus torsional phacoemulsification. *J Cataract Refract Surg.* Accepted for publication.
13. Healon D Pre-market approval. The Food and Drug Administration Web site. http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMA/PMA.cfm?ID=5999. Accessed August 18, 2009.

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