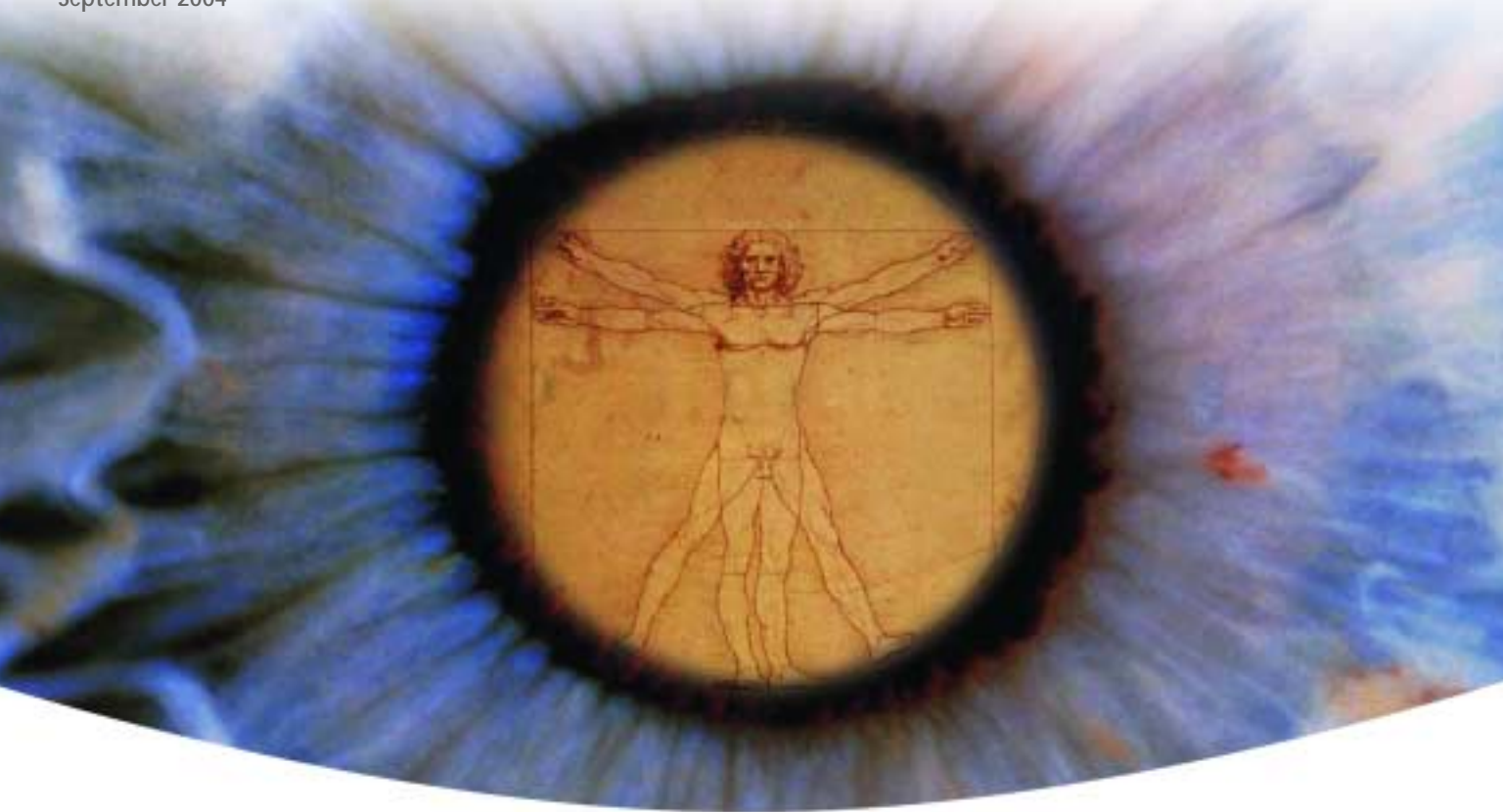


Supplement to

# Cataract & Refractive Surgery TODAY

September 2004



# Cataract Innovators

S y m p o s i u m

The best of the sessions.

Produced under an  
educational grant from  
 Bausch & Lomb  
UNIVERSITY

# Cataract Innovators

## Symposium

*Cataract & Refractive Surgery Today* is pleased to present this retrospective of the Cataract Innovators Symposium, sponsored by Bausch & Lomb University on March 26 through 28, 2004. The symposium was organized by Rosa Braga-Mele, MD, of Toronto and featured presentations on important cataract surgery topics given by notable surgeons and researchers. The following pages contain reprints of three sessions of the symposium—Advanced Surgical Techniques, Advances in IOL Technology, and Phacoeficiency—as well as the presentation of one new session, Refractive Cataract Surgery. This final compendium combines these educational presentations into one constructive feature of insights on topics ranging from ASC ownership to bioptics. A treasure of pearls from some of ophthalmology's most forward-thinkers!

### CONTENTS

#### ADVANCED SURGICAL TECHNIQUES

**Moderator: Richard L. Lindstrom, MD**

Featured Presentations

- 3 Phacodynamics and Fluidic Fundamentals**  
By Barry S. Seibel, MD

- 5 Quick Chop Tips and Tricks**  
By Rosa Braga-Mele, MD, FRCSC

- 6 Phaco Flip Tips and Tricks**  
By Uday Devgan, MD, FACS

Panel Discussion

- 7 Microincisional Cataract Surgery: Pearls for Making the Transition**  
By Mark Packer, MD; Richard L. Lindstrom, MD; Rosa Braga-Mele, MD, FRCSC; and I. Howard Fine, MD

#### ADVANCES IN IOL TECHNOLOGY

**Moderator: I. Howard Fine, MD**

Featured Presentations

- 11 IOL Materials and Edge Designs**  
By Thomas W. Samuelson, MD

- 14 IOL Insertion: SofPort Planar Delivery System**  
By Louis "Skip" D. Nichamin, MD

- 15 Upcoming IOL Technology: Multifocal, Accommodative, and Small-Incision**  
By Richard L. Lindstrom, MD

#### PHACOEFFICIENCY

**Moderator: Uday Devgan, MD, FACS**

Featured Presentation

- 19 The Habits of a Highly Efficient ASC: OR Logistics**  
By Paul S. Koch, MD

#### 24 Question & Answer

With Uday Devgan, MD, FACS; Paul S. Koch, MD; Richard L. Lindstrom, MD; Larry E. Patterson, MD

#### REFRACTIVE CATARACT SURGERY

**Moderator: Louis "Skip" D. Nichamin, MD**

Featured Presentations

- 27 Limbal Relaxing Incisions**  
By Louis "Skip" D. Nichamin, MD

- 30 Bioptics in Conjunction With Cataract Surgery**  
By Stephen G. Slade, MD, FACS

- 31 Refractive Presbyopic Lens Exchange**  
By I. Howard Fine, MD

The material contained in this publication is being provided to you for educational purposes. The material expresses the opinions and personal experiences of the authors only.

# Advanced Surgical Techniques

**MODERATOR: RICHARD L. LINDSTROM, MD**

**PHACODYNAMICS AND FLUIDIC FUNDAMENTALS**

**BARRY S. SEIBEL, MD**

**QUICK CHOP TIPS AND TRICKS**

**ROSA BRAGA-MELE, MD, FRCSC**

**PHACO FLIP TIPS AND TRICKS**

**UDAY DEVGAN, MD, FACS**

**PANEL DISCUSSION: MICROINCISIONAL CATARACT SURGERY: PEARLS FOR MAKING THE TRANSITION**

**MARK PACKER, MD; RICHARD L. LINDSTROM, MD; ROSA BRAGA-MELE, MD, FRCSC; AND I. HOWARD FINE, MD**

## PHACODYNAMICS AND FLUIDIC FUNDAMENTALS

**Barry S. Seibel, MD**

Ultrasound power modulations such as burst and pulse modes allow us to utilize fluidics as a dominant force in phacoemulsification surgery. The basics of fluidics comprise three things: (1) flow, as in aspiration outflow and CCs per minute, which attracts material to the aspiration port; (2) vacuum, in mm Hg, which grips material to the aspiration port; and (3) bottle height, which provides adequate infusion pressure to maintain chamber stability. These components combine differently depending on the type of machine we use and what kind of priority it has. Several different technologies are available, including a diaphragm pump, a scroll pump, and a peristaltic pump. Based on the type of pump the machine uses and the activity at the aspiration ports, we can monitor what is happening in surgery.

## A FLOW-PRIORITY PUMP

A flow-priority pump tells the phaco machine how much flow to produce. Setting the flow rate with this pump determines how strongly the tip attracts material (assuming that the aspiration port is not occluded). Without occlusion, setting the vacuum limit has no effect. This is the case with a peristaltic pump, such as is used by the Legacy (Alcon Laboratories, Inc., Fort Worth, TX), the Infiniti (Alcon Laboratories, Inc.), and the Sovereign (Advanced Medical Optics, Inc., Santa Ana, CA) phaco systems. If the tip is occluded, adjusting the flow will control rise time but not the attraction of material (which is already on the tip). Vacuum builds quickly with occlusion, and changing the vacuum limit changes the applied vacuum forces and therefore the grip.

## A VACUUM-PRIORITY PUMP

If the machine uses a vacuum-priority pump, such as a ven-

turi pump, then we control commanded vacuum rather than a vacuum limit. In other words, the machine will produce the actual, live vacuum level that is commanded. If the tip is not occluded, then changing the vacuum has the clinical effect of proportionately changing the aspiration outflow rate; contrast this with the lack of any clinical effect when changing the vacuum limit with an unoccluded aspiration port and a flow pump. Changing the flow with the vacuum-priority pump changes the attraction of material to the phaco tip. With an occluded aspiration port, changing the vacuum level proportionately affects the grip of the occluding fragment with a vacuum-priority pump, just as it does with a flow-priority pump. We must clinically define our surgical goals and be aware of the type of phaco machine we are using in order to logically input surgical parameters. For example, if we want to attract a fragment to the phaco tip, then we work with flow. If we want a stronger current to pull material more forcibly to the unoccluded tip, then we increase the flow rate, either directly by changing the flow rate with a flow pump or indirectly by changing the commanded vacuum with a vacuum pump.

To phacoaspirate a nuclear fragment, we use a combination of fluidics and ultrasound. Because ultrasound repels material and fluidics overcomes that repulsive action, we set flow and vacuum together to balance the forces. Lens chatter indicates that we either lack enough fluid for attracting material or that we have too much ultrasound; we can try to reduce the ultrasound to minimize lens chatter.

Consider that your surgical goal is to grip the fragment, chop it into smaller pieces, and manipulate it. Let's say that you dislodge the fragment as you begin to chop it, because you lack sufficient grip. Because you know that grip equates to vacuum, your instinct may be to raise the vacuum to increase grip. However, increasing the vacuum's preset limit would have no effect when using a flow pump. We must completely occlude the aspiration port, regardless of pump type, to effectively transfer vacuum and grip the occluded fragment. If the vacuum is already built up to the preset limit, the aspiration port is completely occluded, and vacuum is the only relevant parameter, then it makes sense to raise the vacuum limit even further if grip is still insufficient. Flow rate is irrelevant when the aspiration port is completely occluded because there is no flow; however, flow rate does affect the rise time of vacuum buildup.

### THE IMPORTANCE OF A VACUUM SEAL

To achieve effective occlusion, the bevel must remain parallel to the surface of the material, whether using a 0° or a 45° tip. Past advice about 0° tips' occluding more easily is inaccurate; the important point is to make those surfaces parallel. Without grip, vacuum (using a vacuum pump such as a venturi) produces flow. Because a vacuum seal is critical to achieving control, I suggest using high-vacuum maneuvers such as phaco chop. The goal is to achieve a tight vacuum seal, center the most homogeneous portion of the nucleus, and adequately bury the tip. Attempting to transition to

Sculpt	
■ Peri:	20 cc/min flow, 50mm Hg vac limit
■ Venturi:	50mm Hg commanded vacuum
■ bottle height:	75cm
Chop	
■ Peri:	30cc/min flow, 160-300mm Hg vac limit
■ Venturi:	160-300mm Hg commanded vac
■ bottle height:	110cm

Figure 1. Suggested parameter ranges for sculpting and chopping techniques.

high-vacuum techniques such as chopping may induce problems with inadequate grip, often because the tip is too anterior. Soft peripheral material will preferentially aspirate under high vacuum mode or high ultrasound power.

Using too much ultrasound power for too long for a particular nuclear density can erode the vacuum seal around the phaco tip. Viewing the aspiration port through the microscope will show the presence of any miscalculations, such as an abrupt aspiration around the phaco tip during vacuum mode.

### PHACO NEEDLES

Phaco needles may clinically impact both your technique and the technology. Microincisional-sized needles hold the promise of allowing smaller-incision surgery, and they offer more fluidic resistance, which promotes chamber stability by limiting how quickly fluid egresses from the chamber. The problem, however, is that a smaller surface area at the tip equals less grip for a given amount of vacuum. Therefore, I prefer hybrid phaco tips, because they have a small internal lumen shaft diameter that provides fluidic resistance and chamber stability but also a larger distal opening.

### MAXIMIZING PHACO CHOP

The original phaco chop technique was somewhat difficult to reproduce because it used a large chopper and could be ergonomically awkward. Paul Koch, MD, introduced vacuum power to the technique, which allows us to grip and centrally displace the heminucleus (Figure 1). This approach facilitates inserting the chopper into the periphery. Make sure you are in position 2 when gripping with the chopper; if the needle vibrates in position 3, your grip will be ineffective, and a vibrating needle may pull out of the nuclear material rather than pull the fragment with it.

### POSTOCCLUSION SURGE

Using a high vacuum level can induce postocclusion surge. Initiating a high-vacuum technique once you have achieved occlusion can build up vacuum forces between the occlusion and the pump and pull compliance out of the system.

*Compliance* is a change in volume over a change in pressure. With high-vacuum maneuvers, once postocclusion surge or compliance builds up in the system, the outflow rate will momentarily increase. If it rises enough, the chamber may dimple or even collapse as the fluid and pressure equalize.

Combat postocclusion surge by first increasing the bottle height if you notice any dimpling or chamber instability. Second, consider whether the vacuum level is too high for that particular case or machine setup. In this scenario, flow matters less than vacuum forces, which determine how much the tubing deforms and how much compliance pulls out. Use a more resistant needle, either a microflow or similar needle, or a smaller aspiration line tubing (although, this type of tubing is more likely to clog, whereas resistance at the point of the phaco needle vibrates the needle ultrasonically and reduces this likelihood).

### FOOT PEDAL CONTROL

Dual-linear foot pedal control has revolutionized our level of finesse and control when performing cataract surgery, particularly with high-vacuum techniques. The standard foot pedal has positions 0, 1, 2, and 3, with fluidics within range 2 and ultrasound within range 3. This setup has two important liabilities. First, having both fluidics and ultrasound within one range of travel limits this range for each, thus limiting control sensitivity. For instance, even with linear control of fluidics in position 2 of 0 to 300 mm Hg of vacuum, entering into position 3 (ultrasound) locks you into using the highest level of fluidics. Even if you adjust to a light linear control of ultrasound, you retain the high level of vacuum, which may be inappropriate for the surgical step you are entering. The dual-linear foot pedal overcomes these liabilities by separating the pedal movement into two planes of travel. The pedal still has an up and down (pitch) motion, as well as a side-to-side (yaw) component that separates fluidics and ultrasound. More importantly, dual-linear control allows you to simultaneously and independently adjust both the fluidics and ultrasound parameters.

The second problem with the standard phaco foot pedal is having to maintain a high level of vacuum throughout the procedure. If we need a high vacuum level for gripping, we must contend with its potential for destabilizing the chamber, even while phacoaspirating the fragment.

### CONCLUSION

Phacodynamics allow you to use your intuition and experience to simplify the extraordinary complexity of cataract surgery. The science provides a framework of reasoning with which to approach future surgeries and technologies based on fundamental knowledge of the basic principles by which they function.

### QUICK CHOP TIPS AND TRICKS

Rosa Braga-Mele, MD, FRCSC

I will discuss the quick chop technique used in phacoemulsification. I believe that quick chop holds certain chopping advantages over the divide-and-conquer technique, including decreased phaco power and a shorter procedure.

Quick chop favors mechanical forces versus ultrasound power to remove the nucleus. In addition, studies<sup>1</sup> have shown that both horizontal and vertical chop techniques impart less stress to the zonules and therefore are superior phacoemulsification techniques, specifically in small-pupil pseudoexfoliation cases. Vertical chop allows you to work centrally without having to go underneath the iris or into a dangerous zone with either the chopping instrument or the phaco tip. This technique also permits supracapsular emulsification.

### FOR BEGINNERS

If you have not previously performed a chopping technique, I suggest beginning with stop-and-chop. This approach creates an initial groove in the nucleus that allows more initial control of the chopping technique. Hydrodelineation and hydrodissection are very important steps with a chopping technique. Make sure that the nucleus is mobile as you create an epinuclear shell, which will be your safety zone during the procedure. It is important to keep the phaco tip deep and proximal within the nucleus; thus, you must expose more of the tip's sleeve at this point in the procedure. You may wish to use a capsular dye to show the location of the capsular edges for your first few cases. Quick chop does not move the tip back and forth as does divide-and-conquer, so there is less risk of the occlusion holes' entering the wound. By working centrally with the phaco tip, you can expose more of it and thereby avoid disengaging the nucleus from the tip with the phaco sleeve. Patient selection is also important when learning the chopping technique. For your first few cases, I suggest a small, firm endonucleus because they are the easiest to manipulate.

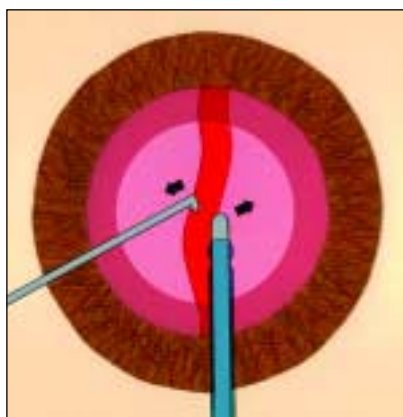


Figure 2. Chop in half by bringing the chopper to the left and slightly down while moving the phaco needle to the right and up slightly. Propagate the cleavage plane laterally and through the posterior plate.

### MAXIMIZING TECHNIQUE AND TECHNOLOGY

I use a 30°, beveled phaco needle that I keep at 0° and turn to facilitate occlusion. This maneuver reduces the amount of work necessary with the needle. I begin with a bevel-down position to achieve 0° occlusion on the top of the nucleus. Then, I retract the silicone sleeve to allow maximization and deeper purchase.

The chopping technique involves two motions: (1) pushing down and to the left with the chopper and (2) pulling up and to the right with the phaco tip to create two halves (Figure 2). Achieving this requires good occlusion, so keep both hands moving simultaneously. It is

important to propagate the cleavage plane laterally and posteriorly through the posterior plate. Failing to cut through the plate will create what I call a *flower petal effect* of the nucleus in which nuclear fragments will float up, still attached to the posterior plate, that you will be unable to break. Finally, rotate the nucleus and repeat the technique for each segment.

Once I complete chopping the nucleus, I evacuate the pie-shaped segments using high vacuum. I prefer burst mode because I find it increases the followability and purchase of the fragments. When moving each piece, it is critical to keep your second instrument behind the phaco needle to protect the capsule throughout the procedure.

The size of the pie-shaped segments will obviously vary according to the nuclear density. Create smaller segments to extract denser nuclei, especially depending on the size of the capsulorhexis. You can always chop a fragment a second time if it is too large to easily evacuate. Occasionally, the nucleus has a thick epinuclear plate, and if you cannot propagate the separation down and through, you may be able to maneuver the needle up and behind the pie-shaped segment in order to pull behind it with the chopper and break it off the posterior plate.

### SYSTEM PREFERENCES

The Millennium Phaco System (Bausch & Lomb, Rochester, NY) offers dual-linear control with which you can increase the vacuum power after achieving purchase. The comparable setting on either the Alcon Laboratories, Inc. (Fort Worth, TX), or Advanced Medical Optics, Inc., phaco systems is occlusion mode. However, this mode is panel preset on these machines with a defined lower and upper limit and therefore has no median vacuum setting. The dual-linear control of the Millennium system allows you to work within a range of vacuum settings and to reduce vacuum once occlusion begins to break. It is important to place the chopping instrument in front and to the side of the needle so as to not break occlusion.

After the initial chop, I bring the segment to the center of the pupil and use burst mode power modulations to increase the followability for that nuclear segment. I do not need to move from my central location.

### IN CLOSING

I believe chopping truly allows better purchase on the nuclear material and creates a safer procedure. By using a 0° bevel configuration approach, you do not have to bore through the material as much as you would with a 30° bevel on an upright position, and the sharp edge of the phaco tip stays far from the capsule, over to the side. Understanding followability, burst mode, and how to turn the bevel to achieve maximal occlusion will benefit your phaco technique so that you can execute a central and safe procedure.

1. DeBry P, Olson RJ, Crandall AS. Comparison of energy required for phaco-chop and divide and conquer phacoemulsification. *J Cataract Refract Surg.* 1998;24:689-692.

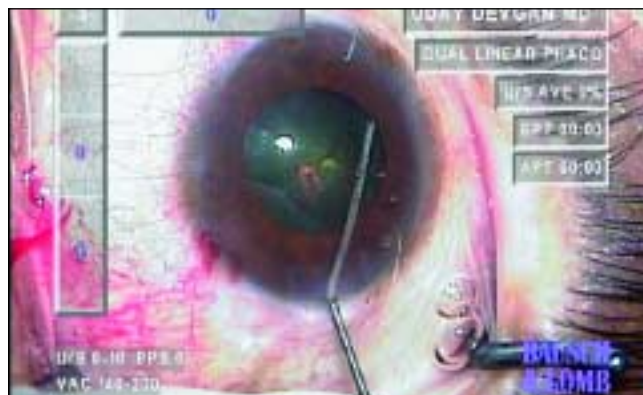


Figure 3. The basic phaco flip technique.

### PHACO FLIP TIPS AND TRICKS

Uday Devgan, MD, FACS

I have amassed excellent cataract techniques from my teachers and mentors in ophthalmology, and I will discuss how I incorporate these techniques into my own practice. First, however, I will share one technological innovation that has helped me surgically: I placed a flat-panel TV monitor on top of my Millennium Phaco System so that, when I operate, the technician and I can see exactly where we are in the procedure.

### PHACO FLIP PROS AND CONS

In basic phaco flip, I use gentle hydrodissection to prolapse part of the nucleus out of the capsular bag. I then perform a quick flipping maneuver by depressing the nuclear half that remains in the bag (Figure 3). The force vectors are those of flipping and not pushing. The advantages of this technique are that it (1) is very quick, (2) is less stressful to the zonules, (3) maintains a safe distance from the posterior capsule, and (4) is effective for softer nuclei and small pupils. In the case of a small pupil, for instance, I will hydrodissect the nucleus in order to partially pop it out of the capsular bag. Once it has prolapsed, I will flip it. Any viscoelastic that I lose I will replace prior to beginning phacoemulsification.

The disadvantages of phaco flip are that it (1) is performed close to the corneal endothelium, (2) delivers more energy to the eye if you use ultrasonic energy instead of mechanical disassembly (chopping) to remove the nucleus, (3) can be difficult to use with dense nuclei, and (4) can be intimidating initially.

### TIPS TO MAKE IT EASY

I prefer to fill the hydrodissection syringe only halfway. I feel that I have much better control if my thumb is closer to my index and middle fingers when I hold the syringe. When you advance the hydrodissection cannula under the capsulorhexis edge, make sure that you do not push the plunger until the cannula is in position, otherwise it may loosen its seal with the capsule and prevent a full hydrodissection. Although I use a straight, regular cannula, using a flattened or bent olive-tip cannula may also facilitate the procedure. You may also flip the nucleus with a phaco probe by pushing on the subincisional

nucleus. To achieve the flip, I tell surgeons to think of the cataract as a coin. To flip a coin, you push on its edge, not its center. Thus, the technique uses a flipping maneuver more than a pushing motion. Also, it may be helpful to place Ocucoat viscoelastic (Bausch & Lomb) behind the lens after flipping it to prevent it from subluxing back into the capsular bag.

The most common question I hear about phaco flip is, "What size should my capsulorhexis be?" The answer varies depending on the density of the nucleus. For a soft nucleus, a capsulorhexis of 4.5 mm is fine; 5.0 mm works well for an average nucleus; and 5.5 mm is sufficient for the densest nuclei. I like to see a small bit of the capsulorhexis covering the optic's edge at the end of the case. You do not need a giant-sized capsulorhexis in order to achieve the phaco flip.

### SOFT VERSUS DENSE NUCLEI

For a soft cataract, mild hydrodissection may prolapse the entire nucleus out of the capsular bag and into the anterior chamber. In such a case, use the phaco probe to eat away at the nucleus, much like eating an apple. I orient the probe so as to fully embed the bevel into the nucleus. Then, I stay in pulse mode and let the phacoemulsification forces do the work. I use minimal settings, no more than 10% of phaco power (usually in this type of case, I use an average of 3% to 4% effective phaco power).

For a dense nucleus, I use the chopper to mechanically disassemble the nucleus after flipping it. In 90% of my cataract surgeries, I flip the nucleus and chop it. My patient population tends to have dense cataracts, and a supracapsular technique alleviates the stress on the capsulorhexis' edges. For a dense nucleus, performing phaco flip and using only ultrasound energy to disassemble the nucleus may deliver too much energy into the eye and prolong the patient's postoperative recovery. In these cases, I recommend combining flipping and chopping to reduce the phaco energy and help ensure a clear cornea the next morning.

### CLOSING WORDS

The flip technique is also excellent for soft "Beverly Hills cataracts," as we call them in Los Angeles, or for patients undergoing refractive lens exchange. Once these soft nuclei are free of



Figure 4. Dr. Packer demonstrates the vertical chop technique.

the capsular bag, it is easy to remove them with minimal energy while maintaining a safe distance from the posterior capsule, a paramount consideration in these cases.

I encourage you to try phaco flip in your practice, particularly for soft nuclei (cases with which divide-and-conquer surgeons often have difficulty). If you are unable to achieve the flip on your first few cases, simply place some viscoelastic behind the prolapsed portion of the lens to prevent it from falling back into the capsular bag, and then gently phacoaspirate it.

## PANEL DISCUSSION: MICROINCISIONAL CATARACT SURGERY: PEARLS FOR MAKING THE TRANSITION—PART 1

Mark Packer, MD

I have performed microincisional cataract surgery for the past 1.5 years in 100% of my cataract surgery patients. It is worth learning why this technique has been the subject of many journal articles as well as papers and courses at the 2004 ASCRS meeting.

### THE INCISION

The incisions that my colleagues and I use in microincisional cataract surgery have a maximum width of 1.2 mm. We employ trapezoidal diamond blades designed by Doug Mastel (Mastel Precision, Inc., Rapid City, SD) that measure 0.7 mm at the shoulder and up to 1.2 mm externally. These blades create a funnel-shaped incision that facilitates instrument manipulation.

### THE CAPSULORHEXIS AND HYDRODISSECTION

The capsulorhexis requires a novel approach. You do not use your wrist, as you do with a standard, 2.5-mm fulcrum; you instead perform a finger motion. Fortunately, the forceps designed by various instrument companies are superb, and I encourage you to try them, even for a 2.5-mm incision, because the degree of control that they provide is exquisite. Control is even more important as surgeons transition to accommodative IOLs such as the Crystalens (Eyeonics, Inc., Aliso Viejo, CA), the final effective lens position of which is largely determined by the size, shape, and centration of the capsulorhexis, owing to the IOL's small optic and flexible haptics.

I perform hydrodissection with microincisional cataract surgery similarly to other modern techniques. The incisions allow plenty of room for the viscoelastic to egress, thereby averting overinflation of the anterior chamber and the potential compromise of the posterior capsule.

### PARAMETERS

I use 15% ultrasonic power and 200 milliseconds of burst mode. The Millennium Phaco System enhances chamber stability by reducing the burst width. For example, 200 milliseconds is a fairly aggressive setting; you may want to begin with approximately 80 milliseconds. I use the latter setting if I have any concerns regarding chamber stability, because it effectively reduces surge (the effect is somewhat counterintuitive). I

completely agree with Barry Seibel, MD, who noted that the maximum vacuum to which you build is the primary parameter in terms of the surge that is developed, although it is possible to effectively reduce the surge by taking smaller bites with a smaller pulse width.

I often use a fairly high flow rate, 46 mL/min, and an upper vacuum limit of 400 mm Hg. I arrange my foot pedal with extra vacuum in the yaw position. Also, I often keep the bottle 140 cm high. Fortunately, the Millennium features a pressurization module that allows me to pressurize the infusion. I can change the pressurization from 35 to 45 mm Hg and achieve extra bottle height or irrigation flow, which protects against surge.

### PHACO TECHNIQUE

I perform vertical chop with the Tsuneoka chopper (Micro-surgical Technologies, Redmond, WA), a canoe paddle-shaped device. I prefer a front-flow irrigating chopper, because I can use the flow of irrigation fluid to manipulate material in the bag.

After some experimentation, I found that the same basic maneuvers of horizontal and vertical chop that I used coaxially worked best (Figure 4). You can place the horizontal chopper under the capsulorhexis rim and still get plenty of irrigation flow. During phacoemulsification, you work from two sides, so you need slightly more room. My colleagues and I are able to use very low amounts of ultrasound.

### CORTICAL CLEANUP

I manage the epinucleus with a technique similar to that popularized by I. Howard Fine, MD. Trimming the epinucleus allows cortical material to wash over the epinucleus into the phaco tip. I perform all or most of my cortical cleanup during epinucleus management. You can use either the phaco tip or the irrigating chopper to manipulate the epinucleus. I rotate the material with a horizontal chopper. I find that the flow of irrigation fluid is like a third hand in the eye. For instance, it can wash the epinucleus into an area from where it is more easily aspirated. This flow of fluid is now a tool on which I rely.

I strongly recommend keeping a bimanual I/A set in your OR. This instrumentation can be extremely useful in instances of posterior capsular compromise. A bimanual approach allows you to gingerly remove cortex without getting any irrigation fluid into the area where the capsule is broken, and you can access hard-to-reach cortex.

### CONCLUSION

Microincisional cataract surgery is safe, but it does involve a learning curve. Early in my experience, I induced a couple of capsular tears, but they both occurred while I was experimenting instead of using my tried-and-true chopping technique. My surgical time is identical to when I performed coaxial surgery. To me, however, a surgery's efficacy is measured by how well the patient sees 1 day postoperatively, and the UCVA's of 20/25 or 20/20 that I have achieved result in happy patients.

## PANEL DISCUSSION: MICROINCISIONAL CATARACT SURGERY: PEARLS FOR MAKING THE TRANSITION—PART 2

Richard L. Lindstrom, MD

I am going to discuss an alternative approach for bimanual microincisional cataract surgery. I think that the reason that only approximately 2% of US ophthalmologists today use this technique is that we cannot yet take advantage of small incisions with a small-incision lens implant. These IOLs are coming, however, so it may be appropriate for cataract surgeons to begin learning this technique.

### CONSIDERATIONS

When performing bimanual microincisional phacoemulsification, most important is to find a comfortable position and maintain the anterior chamber. Manufacturers have put much effort into developing instruments with adequate flow rates, and we surgeons now have a choice between a two- and a three-port phaco system. I currently use a three-port chamber maintainer system that I think will perform well with the next generation of phaco machines (Figure 5). These new systems will probably feature a chamber maintainer system with which we can actively pump fluid into the eye, as well as a pressure transducer that will maintain anterior chamber pressure and likely require a three-port system. The three-port chamber maintainer system is compatible with any phaco technique.

To prepare for implanting microincisional IOLs, begin making incisions consistently smaller. Incisions that have an outer diameter slightly larger than their inner diameter seem to perform best. As for instrumentation, most surgeons today use a sleeveless phaco tip and a 19-gauge phaco system. I find, however, that a 20-gauge phaco system works much better for bimanual microincisional phacoemulsification, and it requires a smaller needle.

### TECHNIQUE AND POWER SETTINGS

I primarily use a flipping technique that I call *tilt-and-tumble*, which requires a learning curve. The easiest way to transition to this technique is to begin performing bimanual I/A, which requires the same hand positions as bimanual microincisional phacoemulsification. Because this technique does not use a

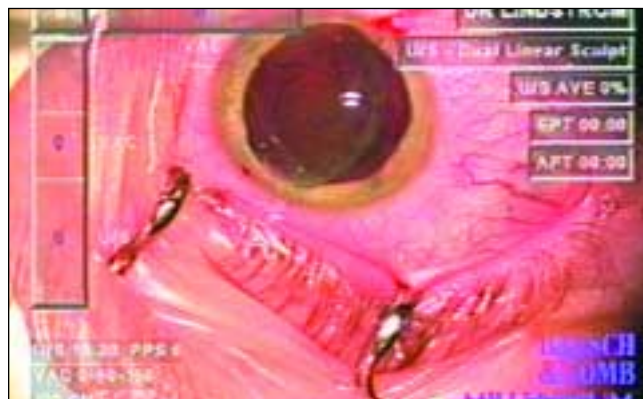


Figure 5. Three-port bimanual phacoemulsification.



phaco sleeve, you must be careful about applying heat to the wound. Most bimanual microincisional phaco surgeons maintain the phaco powers below 30% and use pulse or burst mode. I usually use a high-frequency pulse mode at six to eight pulses per second.

In order to achieve adequate infusion with bimanual microincisional surgery, you must raise the bottle (most of us hang it from the ceiling); I keep my bottle height at 130 or 140 cm. Alternatively, you may use a positive pressure system, which Bausch & Lomb provides for the Millennium system.

### AN ALTERNATIVE SURGICAL APPROACH

In any cataract case, I may opt to perform the anterior capsulectomy with a cystatome before I tilt the nucleus. Then, I use three-port bimanual phacoemulsification, insert a chamber maintainer (available from Bausch & Lomb and Storz Medical [St. Louis, MO]), and then use a 20-gauge phaco needle in my right hand to perform phacoemulsification through a non-sleeved incision. With this technique, you are slightly more oar-locked than you may be used to with standard systems, and you will need to learn to rotate on that fulcrum. Once the phaco needle is in position and bevel-down, I use my left-hand instrument, a trident that I developed, to manipulate the nucleus. I think that holding the nucleus back with a supracapsular procedure and turning the bevel posteriorly produces clearer corneas postoperatively.

From this point on, I perform the case no differently than if I were using a standard phacoemulsification approach. The disadvantage of a three-port approach is the inability to direct the fluid precisely, as is possible with the second instrument. The advantage is the absence of a bulky instrument in your left hand. As bimanual cataract surgery progresses, I think the third port will enable an active inflow system with a pressure transducer. I encourage those who dislike the two-port system to try the three-port, and I also suggest that you begin learning this technique (first starting with bimanual I/A and soft nuclei) in preparation for the next step: performing bimanual cataract surgery in combination with small-incision IOLs.

### IN CLOSING

I especially like to use bimanual microincisional cataract surgery with soft nuclei of densities of up to 3+, and I only perform this procedure in approximately 20% to 30% of my cases. Although I like the technique, I have not seen a great benefit as far as clinical outcomes because I still have to enlarge the incision to insert the IOLs that are currently available.

## PANEL DISCUSSION: MICROINCISIONAL CATARACT SURGERY: PEARLS FOR MAKING THE TRANSITION—PART 3

Rosa Braga-Mele, MD, FRCSC

During bimanual microincisional cataract surgery with the Millennium Phaco System, I use burst mode (100-millisecond intervals), because lower burst intervals maintain more superior anterior chamber stability. I use 15% ultrasonic power for very



Figure 6. Dr. Braga-Mele demonstrates the microflow needle.

soft nuclei and a maximum of 20% power on the burst modality, even for 4+ nuclei. My vacuum level does not vary from what I use for coaxial phacoemulsification, and fluctuates between 165 and 325 mm Hg using dual-linear technology. The Millennium's dual-linear control eliminates my need to raise the bottle's height beyond 125 cm. I use a 19-gauge, microflow needle (Figure 6) and the 19-gauge, side irrigating chopping instrument made by Bausch & Lomb.

I operate through a 1.4-mm incision and prefer to use a trapezoidal blade for wound construction. I have found that a dual-port irrigating chopper facilitates my control of fluid flow. The only drawback to using this instrument is that pulling it back too far can occlude the port, so we strove to develop this instrument to keep the dual port close to the chopping tip. Burst mode provides followability of the lens fragments, and flow from the irrigating chopper helps in directing these pieces to the chopping tip.

In particular, I favor microincisional cataract surgery in cases of pseudoexfoliation, because this technique allows me to control the direction of fluid within the eye. I sometimes find that coaxial phacoemulsification, by contrast, pushes fluid over areas of zonular instability and can thereby worsen it.

## PANEL DISCUSSION: MICROINCISIONAL CATARACT SURGERY: PEARLS FOR MAKING THE TRANSITION—PART 4

I. Howard Fine, MD

I would like to offer a few pearls for transitioning from standard to bimanual microincisional phacoemulsification. The bimanual procedure is a better operation for cataract surgery. Having performed it in 100% of my cataract cases during the past 1.5 years, I am convinced of the technique's efficacy. Bimanual microincisional phacoemulsification is a step closer to the ideal surgery: a totally closed system.

My colleagues and I use a 1.2-mm internal incision and a 1.4-mm external incision. This construction allows all of the fluid to enter the eye on one side and exit it through the other, and it eliminates the creation of competing currents around the phaco tip. The bimanual technique also enables you to use the incoming stream of fluid as an additional instrument.

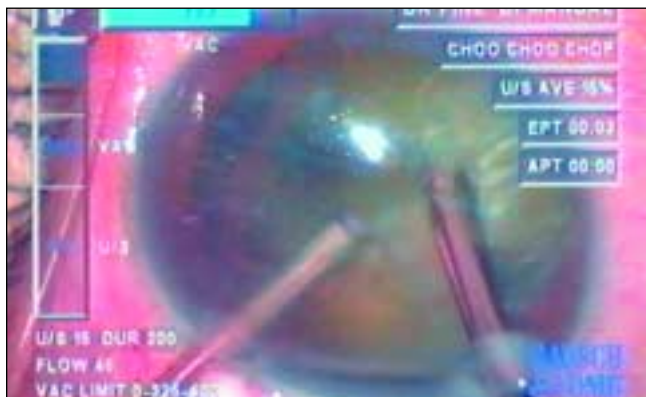


Figure 7. Dr. Fine demonstrates his bimanual technique.

My colleagues and I have abandoned all high-tech phaco tips in favor of the bevel-down tips, which offer three advantages. First, they direct all of the cavitational and phaco energy toward the cataract rather than the endothelium, cornea, and trabecular meshwork. Second, the angle of approach through a clear corneal incision is 30°, and a 30° bevel-down tip can become occluded immediately upon touching the endonucleus. Third, you can mobilize pie-shaped segments out of the bag at the level of the capsulorhexis without having to enter too deeply into the endolenticular space, as with a bevel-up phaco tip.

In our practice, we generally use a vertical or a horizontal chop technique. Our basic cataract procedure involves occluding the tip and then chopping and mobilizing the pie-shaped nuclear segments toward the bevel-down phaco tip (Figure 7). We prefer that the material enter the tip in short spurts; we think this approach (made possible through power modulations) is much safer than quick aspiration. The other feature that I like about a front-opening tip is that I can touch the incision as I enter it; the technique completely inflates the anterior segment and eliminates the danger of injuring the capsule, iris, endothelium, or other intraocular structures.

Unlike traditional coaxial phacoemulsification, with bimanual microincisional phacoemulsification, we have learned not to allow the irrigating tip to get close to the phaco tip and thereby dislodge occluded material from the tip. You must work slightly behind and below the chopping instrument with the phaco tip to bring material to it.

When managing the endonucleus, I turn the chopping element horizontally and work in continuous irrigation. We rotate the epinuclear shell by using the phaco needle in foot position 0 in order to eliminate the danger of damaging the capsule with the sharp instrument, the height of which has been increased by the diameter of the cannula. The epinucleus moves easily when rotated with the phaco tip. We also use the incoming stream of fluid rather than the instrument to flip the epinucleus after we purchase the distal rim in the last quadrant.

Bimanual I/A is the best way to utilize two small instruments through sideport incisions. I never enlarge either sideport incision; I always make the implantation incision between them. If I have a lens that may be inserted through a 1.5-mm incision, I

will not enlarge my sideport incisions because they are already stretched from my manipulation of the handpieces. Instead, I create a 1.5-mm incision between the two sideport incisions. There is never a disadvantage to using a sideport incision, and you can always use an additional one if necessary. ■

## MEET THE PRESENTERS



*Rosa Braga-Mele, MD, FRCSC, is Assistant Professor at the University of Toronto and Director of Cataract Unit and Surgical Teaching at Mount Sinai Hospital in Toronto. She is a consultant for Bausch & Lomb but holds no financial interest in the products mentioned herein. Dr. Braga-Mele may be reached at (416) 462-0393; rbragamele@rogers.com.*



*Uday Devgan, MD, FACS, is in private practice in Sun Valley, California, and also serves as Assistant Clinical Professor at the Jules Stein Eye Institute at the University of California, Los Angeles. He is a paid consultant for Bausch & Lomb but he holds no financial interest in any product or technology discussed herein. Dr. Devgan may be reached at (310) 612-3993; devgan@ucla.edu.*



*I Howard Fine, MD, is Clinical Professor of Ophthalmology at the Casey Eye Institute at Oregon Health & Science University in Portland, Oregon, and is in clinical practice with Drs. Fine, Hoffman & Packer, LLC, in Eugene, Oregon. He is a consultant for Bausch & Lomb but holds no financial interest in the company or its products. Dr. Fine may be reached at (541) 484-3883; hfine@finemd.com.*



*Richard L. Lindstrom, MD, serves as the managing partner of Minnesota Eye Consultants, P.A., in Minneapolis and as a clinical professor of ophthalmology at the University of Minnesota. He holds a financial interest in the technology mentioned herein and is a consultant for Bausch & Lomb.*

*Dr. Lindstrom may be reached at (612) 813-3600; rlindstrom@mneye.com.*



*Mark Packer, MD, is Assistant Clinical Professor at the Casey Eye Institute, Oregon Health and Science University, and he is in private practice at Drs. Fine, Hoffman & Packer, LLC, in Eugene, Oregon. He has received travel and research grants as well as honoraria from Bausch & Lomb and Eyeonics, Inc. Dr. Packer may be reached at (541) 687-2110; mpacker@finemd.com.*



*Barry S. Seibel, MD, is in private practice in Beverly Hills, California. Dr. Seibel also serves as Clinical Assistant Professor of Ophthalmology at the Jules Stein Institute of UCLA Medical School. He is a paid consultant for Bausch & Lomb, but has no direct financial interest in the technology discussed herein. Dr. Seibel may be reached at (310) 208-3937; eyedoc2020@earthlink.net.*

# Advances in IOL Technology

---

MODERATOR: I. HOWARD FINE, MD

IOL MATERIALS AND EDGE DESIGNS

THOMAS W. SAMUELSON, MD

IOL INSERTION: SOFPORT PLANAR DELIVERY SYSTEM

LOUIS "SKIP" D. NICHAMIN, MD

UPCOMING IOL TECHNOLOGY: MULTIFOCAL, ACCOMMODATIVE, AND SMALL-INCISION

RICHARD L. LINDSTROM, MD

---

## IOL MATERIALS AND EDGE DESIGNS

Thomas W. Samuelson, MD

It is important to define a few terms when discussing biocompatibility related to IOLs. As described by Amon,<sup>1</sup> *capsular biocompatibility* refers to the interaction between the IOL and the anterior and posterior capsule. *Uveal biocompatibility* speaks to the predilection for inflammatory deposits to accumulate on the surface of the IOL (Figure 1). This presentation will focus on the biocompatibility of IOLs and on how I select those that work best for my patients and my practice.

## SCIENCE, MARKETING, AND TIME

In my opinion, many myths exist concerning the biocompatibility of the various IOL materials. These myths have been perpetuated by three main sources. First, as IOLs have evolved, lens manufacturers' marketing campaigns have

often surpassed what the science and literature support in terms of biocompatibility. Second, many surgeons continue to be influenced by literature published in the early 1990s that has since been made obsolete by newer lens designs and more recent studies that often refute the earlier papers. For example, many studies and published articles from the mid-to-late 1990s examined the subject of giant-cell deposits on the anterior surface of the IOL. Some of these papers had very strong conclusions; in particular, one study conducted in the UK explicitly advised against the use of silicone in high-risk eyes.<sup>2</sup> Researchers and IOL manufacturers quite appropriately used this and other published research to build a platform based on the need for a new and more biocompatible foldable IOL material. The use of acrylic as a biomaterial for IOLs arose from this perceived need to improve upon biocompatibility. Third, while the science of the mid-1990s did indeed support the

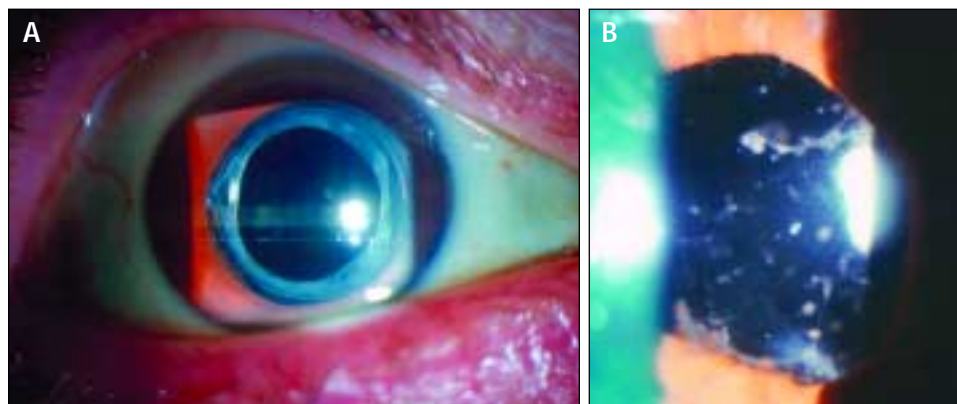


Figure 1. These images show the effects of capsular biocompatibility (A) and uveal biocompatibility (B) within the eye.

notion that first-generation silicone IOL materials were susceptible to giant-cell deposits, many more recent studies have suggested that recent-generation silicone may actually be a more biocompatible material. The arrival of acrylic as a biomaterial for IOLs could not have had a more fortuitous timing. Specifically, the AcrySof IOL (Alcon Laboratories, Inc., Fort Worth, TX) became available in 1994, within the same timeframe that many of the articles describing the relatively poor biocompatibility of first-generation silicone lenses were published. Many surgeons appropriately switched from first-generation silicone to acrylic. Many of these physicians have remained wary of using silicone, despite new data that suggest that silicone may indeed be a more biocompatible material, at least from the perspective of uveal interaction.

### MY EARLY EXPERIENCE

I joined Richard Lindstrom, MD, in practice in 1991, directly out of my fellowship. He introduced me to the small-incision technology of foldable IOLs, and I learned to use such early lenses as the SI18 and SI26 IOLs (Advanced Medical Optics, Inc., Santa Ana, CA), as well as some of the foldable IOLs by STAAR Surgical Company (Monrovia, CA) and Chiron. With these implants, I was able to incorporate the benefits of small incision cataract surgery into my glaucoma practice, which was a tremendous advantage in a patient population where conjunctival and limbal tissue is at a premium. Unfortunately, however, I also witnessed giant-cell deposition that was often visually significant. By the mid-1990s, the giant cells virtually disappeared from my practice. At the time, I did not understand why, although the reason is obvious retrospectively. The giant cells stopped occurring with the arrival of the second-generation silicone material. My experience with second-generation silicone showed that it behaved beautifully inside the eye, quite contrary to what was published in the literature of the day. This disparity between my clinical experience and the published literature prompted me to explore these

materials and their respective biocompatibilities further with a prospective, randomized study.

### THREE-LENS STUDY

In the mid-1990s, I conducted a prospective, randomized study<sup>3</sup> to help determine whether silicone or acrylic IOLs were best to use in high-risk eyes. This high-risk model consisted of patients with coincidental cataract and glaucoma who were scheduled for combined

phacoemulsification and trabeculectomy. The study involved 151 consecutive patients prospectively randomized to receive one of three IOLs: the Chiron C10 plate lens, the SI40 (Advanced Medical Optics, Inc.), and the AcrySof IOL (Figure 2).

Approximately 50% of the patients in this referral-based study were using pilocarpine and had small pupils that required intraoperative stretching. Additionally, nearly one-third of the patients had exfoliation. My colleagues and I studied a multitude of risk factors to determine which were the most important in the genesis of giant-cell deposits.

### RESULTS

I first presented the results of our study at the American Glaucoma Society meeting in 1999. It was the first study to demonstrate a significant difference between the generations of silicone materials. The C10, a first-generation silicone IOL, had a statistically significantly greater incidence of giant-cell deposits. Conversely, the SI40, a more recent-generation silicone lens, performed extremely well in terms

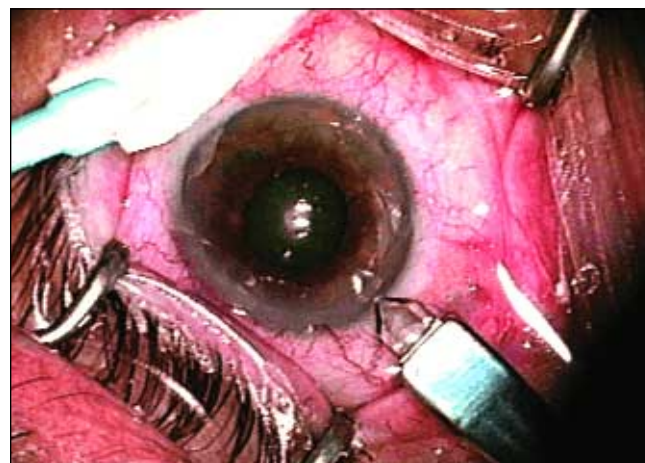


Figure 2. The high-risk study's eye model included small pupils, IOP extremes, shallow chambers, and exfoliation.

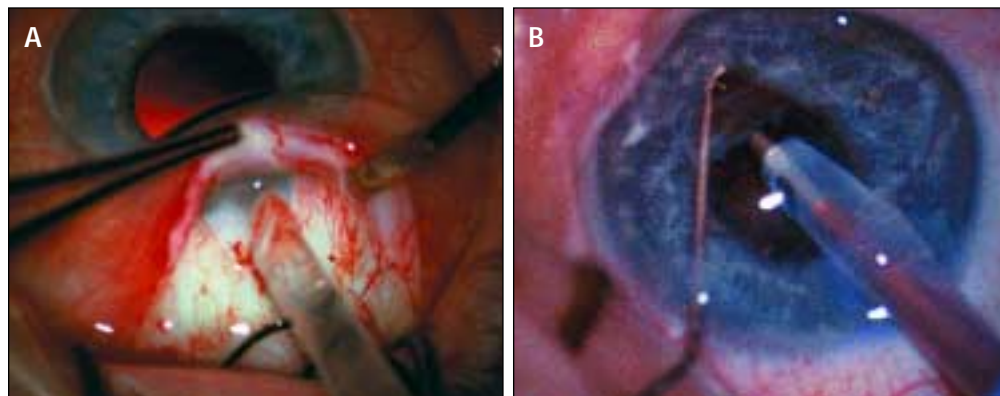


Figure 3. Glaucoma-combined procedures (A) and cataract extraction with small pupils (B) require IOLs with favorable biocompatibility profiles, such as recent-generation silicone or acrylic.

of uveal biocompatibility; indeed, it had the best biocompatibility score of the three lenses. The acrylic IOL performed well, but not as well as the second-generation silicone.

**EXPLAINING THE DISCREPANCIES**

My study, at first glance, appeared to be an outlier compared with the existing literature of the day. As mentioned, most of the previously published reports suggested that silicone was the most likely to develop giant cells on an IOL's surface. However, the second-generation material in my study was the most biocompatible. How could this apparent discrepancy be explained? Quite easily, actually. Our study included both ends of the spectrum of silicone IOLs. The first-generation material, which showed poor biocompatibility in my study, was the same silicone material so disparaged in the 1990s. However, the second-generation material represented a dramatic improvement over its predecessor, demonstrating better uveal biocompatibility than acrylic.

**VALIDATING RESEARCH**

My results have been corroborated by several other studies. For example, Ravalico et al<sup>4</sup> found second-generation silicone to be considerably more biocompatible than PMMA and surface-modified PMMA. More recently, the Vienna group, led by Abela-Formanek and Amon,<sup>5</sup> studied different lens types in high-risk uveitic eyes and found that hydrophobic acrylic IOLs had the highest incidence of giant-cell deposition among the different lens types. The third-generation silicone lens, the

CeeOn 911 (Advanced Medical Optics, Inc.), had the lowest score of giant-cell deposition. This study found a statistically significant difference of giant-cell deposition among IOL types in uveitis-type groups, but not in the control groups. Again, these IOLs, when implanted in a hostile environment (Figure 3), may produce differences in biocompatibility, but these differences may not be

evident in the generally healthy eyes found in most clinical practices.

Another study examined groups of patients with pseudoexfoliation and found that uveal and capsular biocompatibility depended on the intensity of the ocular inflammation.<sup>6</sup> The more inflammation that was present, they discovered, the lower the acrylic material's biocompatibility was. The investigators concluded that the sharp-edge optic of the AcrySof IOL and the advantages of the Hydroview lens (Bausch & Lomb, Rochester, NY) in normal eyes are less apparent in compromised eyes. This and the previous articles validate what we showed in the mid-to-late 1990s. One other study concluded that acrylic IOLs tend to generate more giant cells on their surface than silicone designs, although the difference was not statistically different.<sup>7</sup>

**CLOSING THOUGHTS**

In addition to my own clinical experience, my comfort with silicone stems from medicine's long-term use of this material. Silicone is used in many specialties other than ophthalmology and has been well studied in the literature. Acrylic as a biomaterial is considerably less studied.

To conclude, my IOL material of choice for high-risk eyes

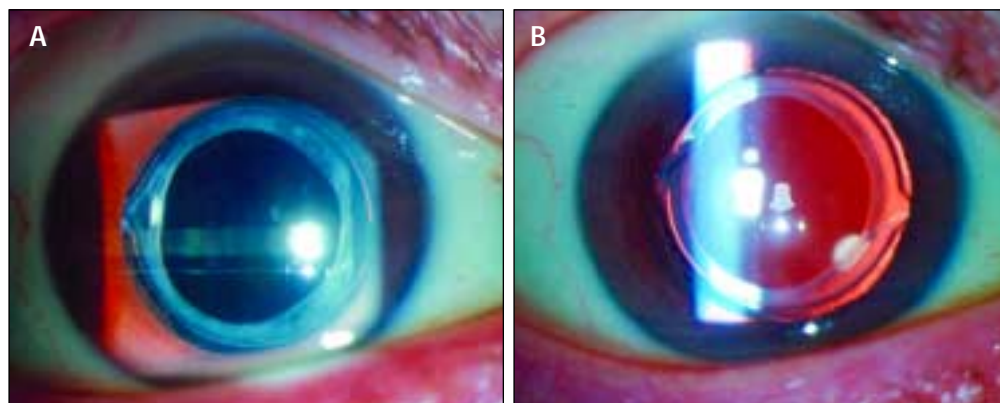


Figure 4. Ideally, the anterior capsular edge should overlap the anterior surface of the optic for 360°.

is third-generation silicone, based on my own experience. Further, I believe that the bulk of the literature suggests that silicone has the best uveal biocompatibility. Capsular issues are rather edge-dependent (Figure 4). Both recent-generation silicone and acrylic biomaterials have brought excellent capsular biocompatibility. Now that several lens options are available, we will likely see many more head-to-head IOL comparisons, and we will expand our knowledge of issues affecting the posterior capsule.

1. Amon M. Biocompatibility of intraocular lenses. *J Cataract Refract Surg.* 2001;27:178-179.
2. Hollick EJ, Spalton DJ, Ursell PG, Pande MV. Lens epithelial cell regression on the posterior capsule with different intraocular lens materials. *Br J Ophthalmol.* 1998;82:1182-1188.
3. Samuelson TW, Chu YR, Kreiger RA. Evaluation of giant-cell deposits on foldable intraocular lenses after combined cataract and glaucoma surgery. *J Cataract Refract Surg.* 2000;26:817-823.
4. Ravalico G, Baccara F, Lovisato A, Tognetto D. Postoperative cellular reaction on various intraocular lens materials. *Ophthalmology.* 1997;104:1084-1091.
5. Abela-Formanek C, Amon M, Schild G, et al. Uveal and capsular biocompatibility of hydrophilic acrylic, hydrophobic acrylic, and silicone intraocular lenses. *J Cataract Refract Surg.* 2002;28:50-61.
6. Abela-Formanek C, Amon M, Schauersberger J, et al. Results of hydrophilic acrylic, hydrophobic acrylic, and silicone intraocular lenses in uveitic eyes with cataract: comparison to a control group. *J Cataract Refract Surg.* 2002;28:1141-1152.
7. Rausz S, Stavrou P, Murray PI. Evaluation of foldable intraocular lenses in patients with uveitis. *Ophthalmology.* 2000;107:909-919.

## IOL INSERTION: SofPort PLANAR DELIVERY SYSTEM

Louis "Skip" D. Nichamin, MD

I will reiterate some of the points that Dr. Samuelson made because they are important, and then I will address the SofPort technology (Bausch & Lomb).

Selecting a lens is just as important as the insertion techniques we use in cataract surgery so that our procedures are reproducible and safe. We have at our disposal different biomaterials (silicone, hydrophobic acrylic, hydrophilic acrylic, and collamer), various lens designs (one-piece or three-piece), different dimensions in regard to the haptics, as well as various optic sizes. Increasingly, we will be faced with choices regarding optics, such as multifocal, accom-

modating, and aspheric designs, and I think this is going to be one of the hottest areas in ophthalmology over the next several years.

Dr. Samuelson has done a remarkable job during the last few years of single-handedly dispelling myths about IOL materials. These myths developed, in part, due to some manufacturers' marketing messages. As patients' advocates, it is our job to examine the literature carefully. Unfortunately, as Dr. Samuelson eloquently stated, many of the articles about IOL biocompatibility that have been quoted in the past have reported on older-generation lenses or surgical techniques that have since been replaced. In this way, ophthalmologists still occasionally confuse issues regarding material versus design.

## THE SofPort INJECTION SYSTEM Upgrades

The SofPort system is growing in popularity for good reasons. It includes the Soflex LI61SE IOL and the newly refined Mport SI injector (Bausch & Lomb). The previous lens was the LI61U; the SE now stands for square edge, which, of course, is important in preventing posterior capsular opacification (PCO) as shown by Nishi's work (Figure 5).<sup>1</sup> The LI61SE has a 6-mm optic made of what I consider to be a third-generation silicone. Its haptic length is 13 mm, which also permits safe implantation into the sulcus.

## IOL Selection

Acrylic, both hydrophobic and hydrophilic, is a wonderful biomaterial. However, some years ago, Samuel Masket, MD, suggested that we not place hydrophobic acrylic in the sulcus, and as Dr. Samuelson noted, this is particularly important with those lenses that have a tacky surface. To date, I have explanted four acrylic IOLs because of advanced cases of pigment dispersion.

In regard to technique, I would stress Dr. Samuelson's point about covering the edge of the optic with the anteri-

(Courtesy of David Apple, MD)

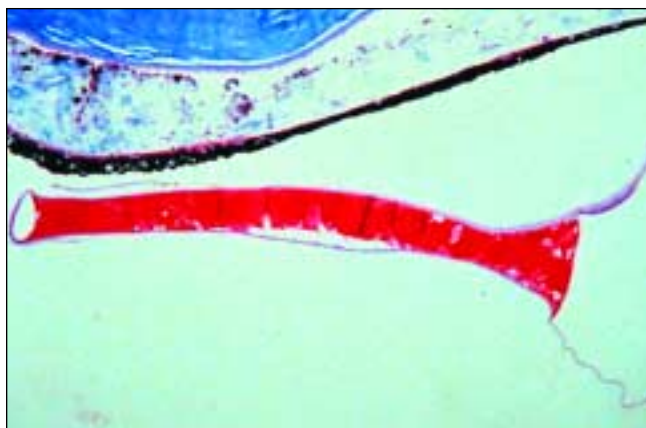


Figure 5. Histopathology of the peripheral capsular bag shows the abrupt edge of epithelial cell proliferation and migration secondary to the square edge of the optic.



Figure 6. SEM photography (38X magnification) shows the truncated edge of the Soflex LI61SE IOL.



Figure 7. The Mport SI inserter (Bausch & Lomb) compresses the IOL into an "M" shape in preparation for insertion into the eye.

or capsulorhexis and allowing the shrinkwrap effect to take hold to further decrease PCO. Furthermore, I completely agree with him about the anterior capsular leaflet's tendency to fuse posteriorly and cause a dense, rigid band of fibrosis when the capsulorhexis does not cover the optic. Almost certainly, these patients will require a YAG capsulotomy. However, with an exfoliative eye or weakened zonules, I think it is reasonable to make a larger capsulorhexis to facilitate surgery and then address PCO later.

It is imperative that we understand and examine optical performance in the FDA studies of new IOLs in order to take quality of vision and ocular symptoms into account. Thus far, I am pleased to report that my practice has not had a single significant complaint of glare or halos with the LI61SE's truncated edge (Figure 6). Admittedly, I use lenses other than the LI61SE; I have a busy vitreoretinal practice and use multifocal and accommodative as well as other types of lenses to address individual patients' needs. I do, however, choose the LI61SE for the majority of my patients because it performs consistently well and it is an easy lens to work with, particularly in conjunction with the Mport inserter. Also, it is a wonderful lens to use in situations of zonular compromise, although one contraindication may exist with exfoliation; one downside of silicone is a slightly higher incidence of anterior capsular fibrosis and metaplasia than with other materials, so we therefore avoid using silicone in cases of advanced exfoliation.

### Using the Device

I consider the Mport SI injector to be the most surgeon-friendly injector available. The SI stands for *small-incision*; the device may be inserted through a 2.85-mm incision. The Mport is a single-handed, plunger-style, closed-delivery system that, best of all, delivers the implant in a planar fashion. Two small slits on the side of the device's distal end allow the leading haptic to sweep out, thus eliminating the need to perform gymnastic maneuvers with torsion of your

hand as it delivers the lens. The Mport is also unique in the way it compresses the lens into an "M" shape (Figure 7). The plunger eases the lens into the eye before automatically snapping back into place. The trailing haptic may then be easily engaged with the plunger for completing insertion in a closed-chamber manner.

1. Nishi O. Capsule bend formation at the optic edge: Theory on the development of PCO. Paper presented at: The ASCRS/ASOA Symposium on Cataract, IOL, and Refractive Surgery; May 23, 2000; Boston, Massachusetts.

### UPCOMING IOL TECHNOLOGY: MULTIFOCAL, ACCOMMODATIVE, AND SMALL-INCISION

Richard L. Lindstrom, MD

I want to review ophthalmology's direction and some of the decisions we will have to make in the best interest of cataract patients over the next 5 to 10 years. The wish list of developments we would like to see in the future includes minimally invasive implantations, progressively smaller incisions, and long-term IOL biocompatibility and biostability. Furthermore, we are learning how to measure and treat the aberrations of the eye instead of merely restoring vision. Also, I believe that we will soon have the opportunity to enhance vision in cataract patients. Appreciably, 80 to 100 million baby boomers and aphakes would love a solution to presbyopia. Another goal of ophthalmology is to minimize refractive aberrations of the eye, which is why it will be important for all cataract surgeons to begin measuring wavefront aberrations, and I believe the technology for doing so will greatly improve.

Following is a brief review of some of the advancements we can expect for cataract surgery.

### IOL OPTIC SHAPE, SIZE, AND MATERIALS

Most surgeons today implant lenses that have between 4.5- and 7.0-mm optics (the 6-mm optic is most common). In the future, I expect optic size to increase. If we had the capability, I think most surgeons would prefer to implant a lens with a 9-mm optic, which is the size of our natural lens. A larger optic would reduce edge glare, although most capsulorhexes will opacify and eliminate edge glare if placed over the edge of the IOL.

The natural lens is biconvex, and I think that most of the lenses of the future will be as well. In addition, it is not impossible to imagine injectable lenses with the capability to create membranes and improve upon IOL materials, although I think it is unrealistic to expect a silicone or acrylic material injected into the capsular bag to achieve the correct shape and power.

Dr. Samuelson's data well support the use of silicone IOL materials, even in high-risk cases. I advocate silicone myself. The future will likely produce hybrid IOLs in the form of elastic acrylics, which will be developed at sophisticated laboratories such as Bausch & Lomb's. One reason I like partnering with Bausch & Lomb is that the company has great technology to develop new polymers.

## HAPTICS

Surgeons in general departed from using plate-haptic lenses because these lens designs depended heavily on a perfect capsulorhexis and decentered more frequently than other designs. As we progress toward smaller incisions that utilize more demanding injectors, however, we may return to using these types of lenses, because they and other one-piece designs pass easily through a microincision if made from an elastic material that can deform and elongate.

## SHRINKING INCISIONS AND IMPLANTS

I believe that, although small incisions are less invasive to the eye, at some point, small size delivers a diminished return on investment. This point is clearly at a 1-mm paracentesis incision. This type of incision is self-sealing, will never increase the risk of endophthalmitis, does not require hydration, and will seal very well.

Two lenses currently available in Europe will fit through a 1.6- to 1.8-mm paracentesis; the ThinOptX silicone IOL (ThinOptX, Abingdon, VA) and the AcriSmart one-piece acrylic lens by Acri.Tec (Munich, Germany). One must question how resistant these implants are to long-term PCO and spherical aberration. Jorgé Alió, MD, of Alicante, Spain, who implants a large number of both IOLs, claims that they produce excellent results with less spherical aberration than the typical lens.

I have worked with a couple of companies in developing materials that fit through microincisions and expand to almost five times their size in water. These hydrogel lenses may potentially be formed into a small pellet shape for insertion into the eye. Another innovation, the idea of injecting a polymer into a balloon, is being researched in the US and elsewhere.

Medennium, Inc. (Irvine, CA), is currently developing a SmartLens. After being formed into the correct size and

shape for the recipient eye, the SmartLens is formed into a tiny rod that will insert through a microincision and then blossom into shape once inside the eye. I believe that the SmartLens technology will be realized within the next 5 to 10 years. The challenges to its development include (1) how to make reproducible lenses with high-quality optical elements and (2) whether such a lens would resist a YAG capsulotomy.

## MULTIFOCAL OPTICS

The Array multifocal IOL (Advanced Medical Optics, Inc.) has the longest track record in the US, and it certainly has performed very well, but it has had some problems. It does not provide quite as effective near acuity as many of my patients would like; some of my patients see halos at night, and there clearly is some loss of quality of vision.

One exciting technology that I think may be very well received comes from 3M Vision Care, which Alcon Laboratories, Inc., acquired. The lens is a center-surround, refractive/diffractive, multifocal IOL that is available in Europe now and will be in the US before long. It allows patients to perform near-dominant work through its center and manage scotopic situations without nighttime symptoms via its diffractive optics around the periphery of the optic.

With multifocal IOLs, we have learned that it is necessary to have 1.00 D or less of residual ametropia and 1.00 D or less of astigmatism. Therefore, accurate biometry and sharp refractive cataract skills are essential for the surgeon who wants to perform multifocal or accommodative refractive cataract surgery. This technology does carry some negatives, such as loss of contrast, halos at night, and mild distortion of color, and this risk is only worth it to the patient if he achieves the outcome described previously. So again, the real pressure of performing refractive cataract surgery

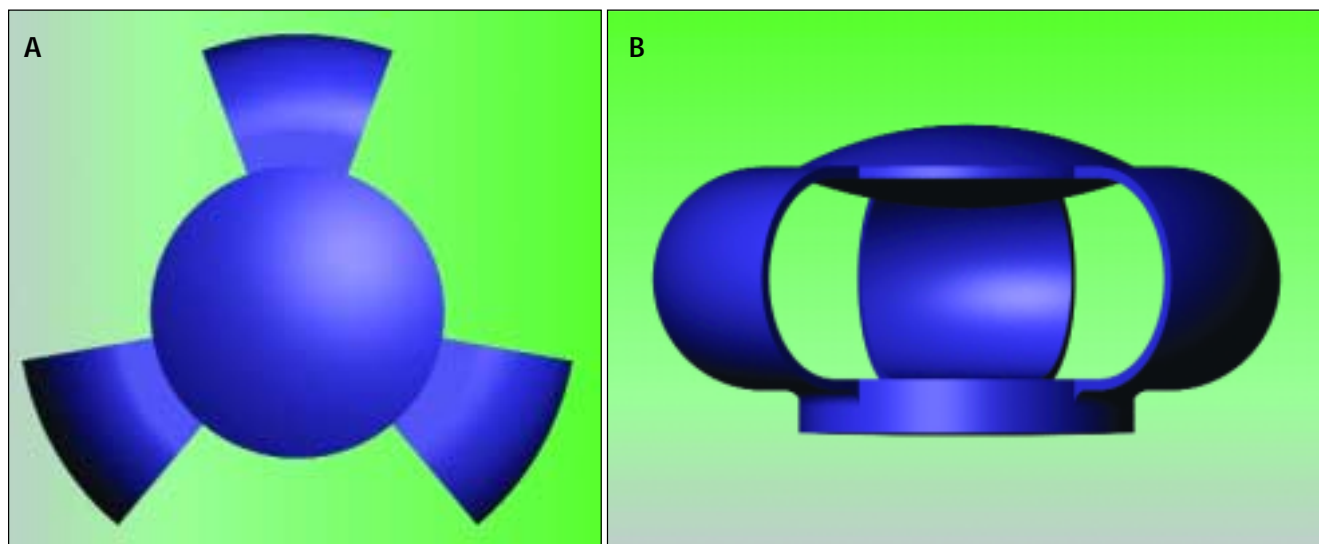


Figure 8. These illustrations show the Sarfarazi dual-optic accommodating IOL by Bausch & Lomb from above (A) and the side (B).



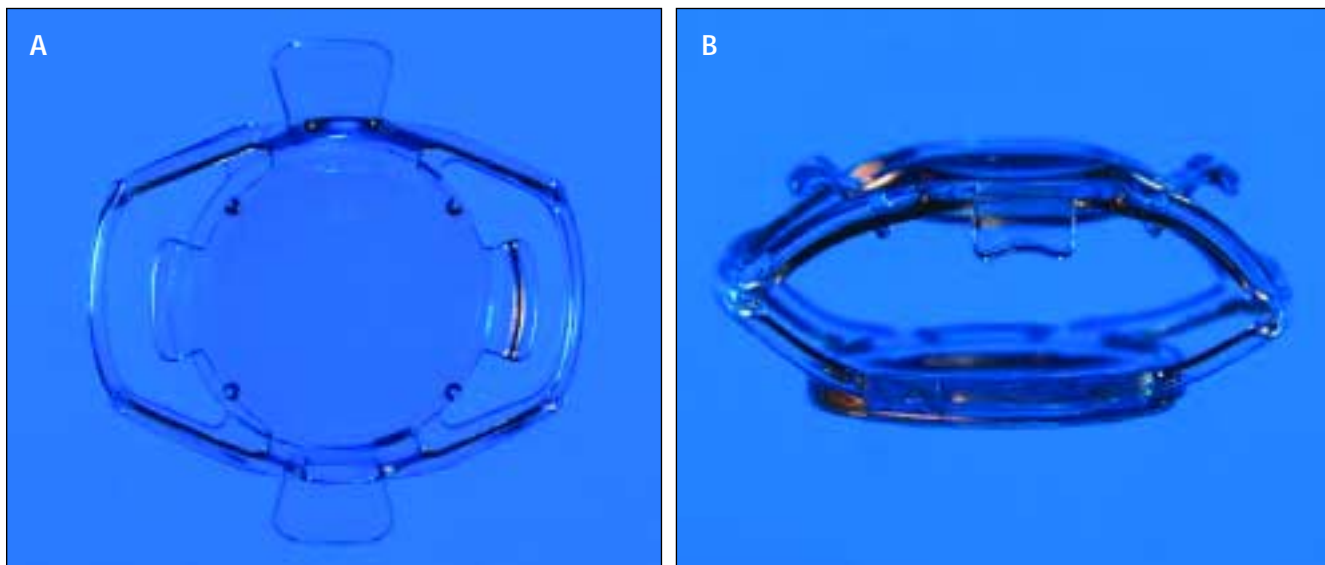


Figure 9. These images show the top (A) and side (B) view of the Synchrony IOL by Visiogen, Inc. (Irvine, CA).

is on us surgeons, and the key to performing it successfully is for the patient to choose the right surgeon, not the other way around.

**ACCOMMODATING IOLs**

I believe that accommodating IOLs are the future. I want to see as well as I did when I was 35, and I think most of our patients feel similarly. To this end, two single-optic IOLs have been developed: the Crystalens (Eyeonics, Inc., Aliso Viejo, CA), and the 1CU by HumanOptics. I have only minimal experience with the Crystalens; my practice has implanted approximately 10 of these lenses. Many surgeons are starting to develop experience with it, which is exciting. The deficit with this IOL is that it lacks an adequate accommodative amplitude to give all patients the acuity they want (J1, for example).

Two companies are currently developing dual-optic accommodating IOL technology: Bausch & Lomb with its Sarfarazi lens (Figure 8A and B), and Visiogen, Inc. (Irvine, CA), with its Synchrony IOL (Figure 9A and B). Both lenses potentially work the same way, with a negative lens positioned against the capsule and a high-plus lens that rests in front. For example, a plus-powered lens of +30.00 D paired with a negative-powered lens of -10.00 D would work together to achieve 20.00 D. In addition, forward movement of the lens combined with separation of the optics provides accommodative amplitude. There are many considerations with the development of this type of lens, such as how to insert it in the capsular bag, whether the optics can really separate, and what amount of accommodative amplitude they provide.

Through this and other technologies, we have learned quite a bit more than we originally thought we knew about accommodation. I have no doubt that Helmholtz's is the

correct theory of accommodation. We now know that when the ciliary muscle contracts, it takes on additional space, just as any other muscle does. As the ciliary muscle contracts, the longitudinal muscle in the ciliary body produces some forward movement of the lens-capsular diaphragm (Figure 10). The Crystalens and 1CU take advantage of this forward movement. Careful review of these studies show, however, that the Crystalens and the 1CU will provide only approximately 0.50 to 1.00 D of accommodative amplitude out of that forward movement. In order to achieve greater amplitude of accommodation, we need either a dual-optic system that can double the power, or we must develop a lens that changes the curvature of the implant.

I expect to see the development of dual-optic systems that will enhance our accommodative amplitudes, either through separation of the optics or simply forward move-

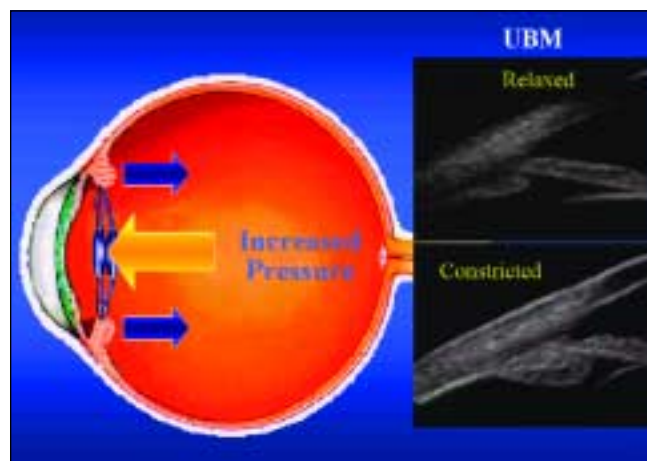


Figure 10. This image shows the movement of the ciliary muscle during accommodation within the eye.

ment. Furthermore, we will likely develop lenses that change shape and generate 4.00, 5.00, or 6.00 D of accommodative amplitude. Naturally, many unanswered questions remain, as well as controversy, and I think we must evaluate this technology carefully and not jump to conclusions. I have no doubt, however, that accommodating IOLs will some day achieve regular use.

### WAVEFRONT OPTICS

As cataract surgeons, we must understand spherical aberration, even those of us who do not have a laser. It turns out that both the cornea and conventional IOLs have positive spherical aberration, and we often thereby induce significant spherical aberration in cataract patients that can be measured with wavefront analysis. To address this problem, aspheric lenses are emerging. In the future, I think we will have the ability to perform customized treatments. The Tecnis aspheric IOL (Advanced Medical Optics, Inc.), for example, was designed to have appropriate negative spherical aberration to counteract the positive spherical aberration of the average cornea. Its efficacy, or at least its ability to enhance quality of vision, has been shown in studies (personal communication, Mark Packer, MD). This lens has issues, however; developers still are unsure of its ability to provide good optical function in cases of IOL tilt/decentration or surgically altered corneas, for example. Bausch & Lomb is also working on an advanced optic lens based on the concept of not inducing typical spherical aberration created by a standard IOL. The lens is designed to be independent of IOL decentration/tilt, or change in pupil size, and I think it will be an exciting advance.

### ADJUSTABLE OPTICS

Today's IOLs have fixed optic powers, but research continues on adjustable optics. Calhoun Vision, Inc. (Pasadena, CA) is the first company to work in this area with its Light Adjustable Lens, but other companies are following suit. I believe that we will reach the point where biometry issues will be resolved by adjustable IOLs. Issues exist with this technology as well; for example, the first time that Calhoun's researchers tried to adjust its IOLs, they induced uneven radiation by failing to place a contact lens on the eye, and they created distorted optics. Thus, much work must be done on this technology before it is ready for day-to-day use.

### SURFACE MODIFICATION AND DRUG IMPREGNATION

IOLs of the future will employ surface modification to reduce capsular opacity and cell adhesion. Although this technology already exists, issues regarding the healing response after cataract surgery remain. Researchers must determine out how to keep capsular cells from undergoing fibrous metaplasia.

I also anticipate drug impregnation in the future of IOLs.

If we impregnated a drug such as mitomycin into the lens, could it reduce capsular opacity? We always want to reduce inflammation and infection, and I can imagine having lenses impregnated with anti-inflammatories and antibiotics to enhance our outcomes.

### LOOKING AHEAD

If I am still standing in approximately 10 years, I would like to give a lecture about the lenses I'll be using then. Ideally, I would want these lenses to be biconvex with an optic as close to 9 mm as possible, made of injectable copolymer, and that is accommodative. As a matter of fact, I might like to give a lecture with one of them in my own eye, so I can put my readers away. I think IOLs of the future will be one-piece, wavefront-adjustable, and able to be power-customized to the correct power for the exact spherical aberration of each patient's eye. I also anticipate IOLs to be photochromic, surface-modified, and implantable through a 1-mm incision.

As technology continues to evolve, I think we have the responsibility to critically evaluate all of the information that we receive for the benefit of our patients. Also, I want to say, get ready: learn about diagnostics, wavefront, and topography if these are not already a part of your practice. Refine your surgical techniques in order to achieve accurate biometry and astigmatism management. Our patients are only going to continue to demand higher refractive outcomes.

### MEET THE PRESENTERS



*Thomas W. Samuelson, MD, is an attending surgeon at Minnesota Eye Consultants in Minneapolis and serves as Clinical Associate Professor of Ophthalmology at the University of Minnesota. He is on the Bausch and Lomb speakers' bureau and is a consultant for Advanced Medical Optics, Inc. He holds no financial interest in any company or technology mentioned herein. Dr. Samuelson may be reached at (612) 813-3600; twsamuelson@mneye.com.*



*Louis "Skip" D. Nichamin, MD, is Medical Director of Laurel Eye Clinic in Brookville, Pennsylvania. He is a medical monitor for Bausch & Lomb but holds no financial interest in any company or technology mentioned herein. Dr. Nichamin may be reached at (814) 849-8344; nichamin@laureleye.com.*



*Richard L. Lindstrom, MD, serves as the managing partner of Minnesota Eye Consultants, P.A., in Minneapolis, Minnesota, and is an adjunct professor emeritus of ophthalmology at the University of Minnesota. He holds a financial interest in the technology mentioned herein and is a consultant for Bausch & Lomb Surgical. Dr. Lindstrom may be reached at (612) 813-3600; rllindstrom@mneye.com.*

# Phacoeficiency

---

MODERATOR: UDAY DEVGAN, MD, FACS

## THE HABITS OF A HIGHLY EFFICIENT ASC: OR LOGISTICS

PAUL S. KOCH, MD

### QUESTION & ANSWER:

UDAY DEVGAN, MD, FACS

PAUL S. KOCH, MD

RICHARD L. LINDSTROM, MD

LARRY E. PATTERSON, MD

---

## THE HABITS OF A HIGHLY EFFICIENT ASC: OR LOGISTICS

Paul S. Koch, MD

I will share several time-saving pearls that my staff and I use in our OR to move our surgery days along reasonably quickly.

### Liquid Dial Soap

I leave Liquid Dial soap (The Dial Corporation, Scottsdale, AZ) on the check-in desk. When a cataract patient's family member asks one of my staff members to explain what a cataract is, the staff person hands the individual the bottle of Liquid Dial soap and tells him to look through it. When he sees the difference between viewing the room through the

bottle of soap and viewing it in normal light, he understands what a cataract is (Figure 1).

### Computerized Surgery Center Records

My staff and I used to get tied up in paperwork, so one night we spent 2 hours reorganizing all of our surgery center records with MicroSoft Word (Microsoft Corporation, Redmond, WA). We used the Merge function on Microsoft Word and duplicated all of our data for our files back into the program. We used fields for the patients' names, addresses, and other information. Now, every patient has a



Figure 1. Liquid Dial Soap helps interested persons understand what the world looks like through cataracts.

page with the information we need for surgery, and that information is automatically converted into a 10-page OR record.

**Minimizing Paperwork Within the OR**

To cut down on the paperwork in the OR itself, we have a table on which my staff place four pieces of paper. The first is my operating notes, which has a standard heading and two spaces underneath it with a line that reads, "complications, variations, and interesting situations." Below that, it says "alternate technique." When I leave the patient, I go to that table and pick up my OR notes and either sign it or write in comments about anything unusual that happened during the operation. Next to that paper is the patient's history and physical, which is ready for my signature. The third piece of paper is the office record for the next patient, so that I may see who the next patient is and what treatment he requires. The fourth piece of paper is the IOL calculation sheet for the next patient so that I may plan for that procedure if need be. So, after every procedure, I walk over to that table and sign two papers and review two papers, and then I have completed the paperwork for both the last patient and the next patient (Figure 2).

**An IOL Shelf**

Right next to the paperwork table in my OR is an IOL shelf, from which my staff and I select the proper IOL for the next operation.

**Aqua Shoes**

I used to have a problem deciding which kind of footwear was best for the OR. If I wore shoes, I could not feel

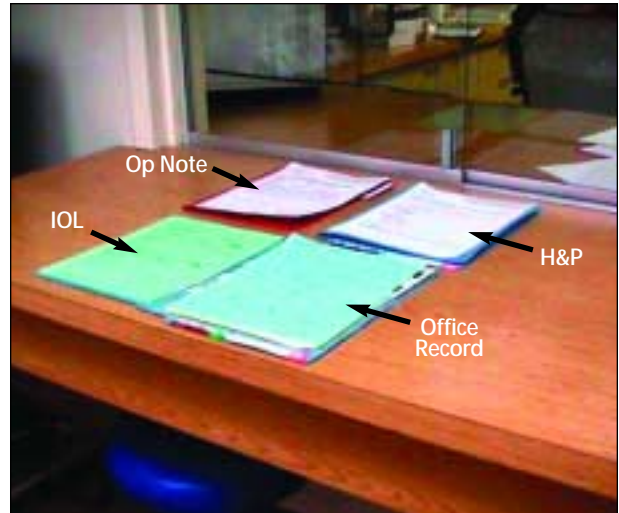


Figure 2. A table in Dr. Koch's OR holds patients' paperwork for his review between cases.

the foot pedal on the phaco machine, and if I went bare-foot, I stubbed my toes. I found a solution 7 years ago when I bought water shoes. They are very thin and flexible as well as inexpensive. With them, I do not stub my toes, but I can still feel the foot pedal.

**Tubing for Wires**

My staff and I grew tired of tripping over wires in the OR, and one day we noticed the large, 1-inch tubing on the anesthesia machine, which we don't use. We cut a slit in this tubing and used it to encase the cables that lay on the floor from the other machines (Figure 3). These tubes of cable we can kick out of the way quickly if they get underfoot.

**Foam Scrub**

We started using foam scrub years ago and continue to use it today. In fact, my staff and I debated whether to install



Figure 3. One-inch plastic tubing encases the wires of machines in the OR to keep the floor clear.



Figure 4. The manual and electrical Steris surgical stretchers in Dr. Koch's OR.

a scrub sink in our ASC because nobody uses anything but the foam scrub. It saves a lot of time in between cases.

### Surgical Stretchers

We use two types of Steris surgical stretchers (Steris Corporation, Mentor, OH) for our patients (Figure 4): one works manually to recline the patient, and the other is electrical and reclines the patient slowly with the press of a button. I prefer the electrical ones because they spare the nurses' backs. We wheel these chairs between the OR and the recovery room, and we have four: one for recovery; two for the preoperative work-up; and one in the OR.



Figure 5. The rod taped to the surgery tray forms a catch pocket when a drape is placed over it.

### Basket for Miscellany

Next to my paperwork table is a Rubbermaid (Newell Rubbermaid, Atlanta, GA) wall-mounted basket in which we keep extra surgical items such as a suture set, forceps, etc. This way, I can simply grab these things as I need them.

### Surgical Cart Catch Pocket

We modified our surgery cart to be simple to use. We use four strips of duct tape to secure a rectangular rod onto the end of the surgical cart. We drape a sheet over this rod to create a catch pocket (Figure 5). When I operate, I may quickly throw items that I no longer need into the pocket (Figure 6).

### Third-Party Centering

We always have someone assigned to control the microscope's x-y movement because it is easier for me. One of my nurses watches the monitor while I am operating and uses the handswitch to keep the eye centered on the screen. She performs the focus for me, too. The only thing I have on the OR floor is my phaco foot pedal.

### Sterile Microscope Handles

Sometimes I drop the microscope handles on the floor or otherwise contaminate them, so we use handles that we can sterilize and use again. They fit on the microscope and act as our backup set of handles for the microscope.

### Multiple Autoclaves and Instrument Sets

We run three autoclaves on a regular basis and use a fourth for items that I accidentally contaminate. We use a sterile set of autoclaves, and there are several good brands available. We also use four sets of instruments in order to



Figure 6. Dr. Koch's catch pocket in use during surgery.



Figure 7. An individual blood pressure monitor remains on each patient until his surgery is complete.

keep the flow moving. We have a one-OR facility, but we move at a rapid pace. We keep almost nothing on the surgical trays, maybe eight to 10 instruments that we use routinely.

#### A Microinstrument Tray

On the surgical tray we keep a Fox Shield that holds all of the little things, such as cannula and artery tips, and we call it our *microinstrument tray*, if you will.

#### Sterilization

We take great pains to learn which surgical items we can sterilize fully assembled and which we have to disassemble to sterilize. Depending on the instruments, sterilizing assembled instruments can save the staff time.

#### Dilation Pledgets

My staff learned quite a lesson with dilation pledgets. We cut a wick drain into little squares and placed them in the cup. Into the cup, we used to add a solution of three parts 1% tropicamide (diluted to 0.6%), one part 4.0% lidocaine (diluted to 0.8%), and one part 10% phenylephrine (diluted to 2.0%). Although we thought this solution was safe, it induced a dramatic blood pressure rise in our patients. Immediately following instillation, some patients experienced blood pressure increases to 200/135. The problem was the 10% phenylephrine, which we subsequently reduced to 2.5%. Now, our solution contains 0.5% phenylephrine, and it dilates patients' pupils effectively without raising their blood pressure. We no longer use this method much anymore, however; we now let patients take home a bottle of Cyclogyl (Alcon Laboratories, Inc., Fort Worth, TX) and instruct them to start using it 2 hours before their surgery at



Figure 8. Dr. Koch's triple dosage of anesthesia, used pre- and intraoperatively.

half-hour doses and then throw the bottle away. This approach means that patients arrive at our ASC on their date of surgery fully dilated, and they can simply sign the paperwork and immediately begin being prepped for surgery. The Cyclogyl costs approximately \$3 per bottle, but the price is worth it in terms of the flow through our facility.

#### Blood Pressure Monitors

We don't bother with buying a big, expensive blood pressure machine such as DataScope (DataScope Corp., Montvale, NJ) that cost hundreds if not thousands of dollars. We go to Sam's Club and buy individual blood pressure monitors that cost approximately \$30 (Figure 7). We buy four or five at a time and just throw them away when they die. The nurse puts one on every patient and does not remove it until the patient leaves the facility. This way, we don't have to repeatedly place and remove the cuffs. These blood pressure monitors work very well for our needs.

#### Anesthesia

We try to eliminate if possible any pain patients might feel during cataract surgery, so we make sure their eye area is numb. We use a triple dosage of anesthesia: lidocaine drops, then a Betadine (Purdue Pharma L.P., Stamford, CT) preparation, and finally lidocaine gel. In the OR, I place lidocaine inside the anterior chamber, one part 4% lidocaine buffered with three parts BSS (Figure 8). This dosage is probably overkill for many patients, but it eases my worry.

#### Postoperative Instructions

We give our patients their postoperative instructions preoperatively, as soon as they arrive at our facility and before

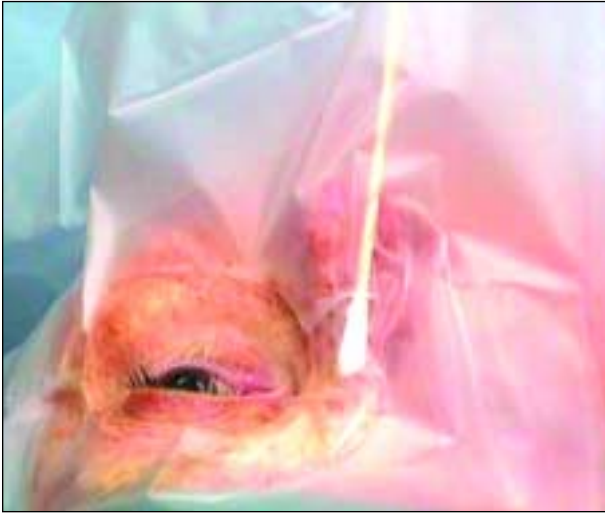


Figure 9. A cotton swab taped lengthwise down a patient's nose keeps the drape away from his mouth.

they have time to get nervous. Doing so allows them to leave immediately after surgery.

#### Preoperative Preparation

We prep patients' eyes in the preoperative area. We place large tags on the patients' foreheads with their names written on them so that I may address patients by name.

#### Occupying Patients' Hands

We give every patient a little stuffed animal to hold during surgery to keep their hands occupied. This way, they don't try to assist.

#### Cardiac Monitor

We use a two-lead cardiac monitor with EKG wrist clips that are commonly used at the hospital. We connect the EKG clips to the monitors using battery testers from Radio Shack.

#### Mouth Guard

We tape a long cotton swab to the patient's nose that holds the drape up above his mouth (Figure 9). This technique keeps the mouth clear while we operate.

#### Sedation

We sedate patients using either intravenous methods, or orally by adding Versed (Hoffmann-La Roche Inc., Nutley, NJ), to orange juice. If we're in a really good mood, we have the nurse make a batch of Jello shots with some Versed and give these shooters to patients. This fun approach relaxes them a bit. Intravenously, we use Versed 5.0 mg per 1 mL. We used to pay \$14 per dose of Versed to a local supplier, but we



Figure 10. Dr. Koch's complete draping system is shown, including the head drape and drainage bag.

found a supplier called Florida Infusion/NationsDrug (Palm Harbor, FL) that charges \$4.75 per dose. I also use an inexpensive pulse oximeter with the sedative.

#### Head Drape

A head drape helps to secure patients' heads so they don't wiggle during surgery. For drainage bags, we buy 2,000 to 3,000 plastic baggies from Sam's Club, sterilize them, and attach them to the tape that holds the head drape. Then, we insert the corner of the head drape into the bag, thus creating an effective drainage system using inexpensive materials (Figure 10).

#### No Bows

We never tie bows on our gowns in the OR; we instead tie an overhand knot so that when the operation is over we can quickly pull the gowns off.

#### Stand Up

I prefer to stand during surgery if the patient has a breathing condition and has to sit upright partway.

#### Filter

We use a 0.22- $\mu$ m filter to prevent infections. We've had a few infections caused by damaged bottles.

#### Working Hours

Our working hours are essentially 9 a.m. to 5 p.m. We never begin before 9 a.m., because I think having patients get up very early for surgery is silly. I think good working hours are critical to keeping an independent ASC running well. ■

# Question & Answer Session

*The following questions are from audience members and directed to the panelists.*

## What do you feel contributes most to OR efficiency?

**Dr. Koch:** The key is for the surgeon never to leave the OR. As soon as he leaves to do some paperwork, take a telephone call, or get a drink of water, everything stops. If he stays in the OR, everything moves more quickly.

## If you use just the phaco foot pedal, do you not change the focus during the case?

**Dr. Koch:** Yes, if I need to focus up or down, I ask the nurse holding the microscope control handswitch.

## Do you use IVs in each patient during surgery?

**Dr. Patterson:** We stopped using IVs routinely 2 years ago. We may use an IV once or twice per month, but we routinely use sublingual Versed instead. We give about 5 mg to patients mixed into a flavored syrup, and it works very well. I cannot imagine anything's improving efficiency in the OR better than not having to start 20 or 30 IVs.

**Dr. Lindstrom:** My staff and I still use IVs, but I do not find the practice logical. The Phillips Eye Institute has 150 ophthalmologists on staff, and, when studies came out a number of years ago suggesting that blood tests, EKGs, and IVs probably were unnecessary, these physicians formed a committee to make a decision. Despite the research, they decided that we would still require these preoperative tests and use IVs. It may be tradition, but I think the surgeons need to follow their community's standards somewhat regarding such issues, particularly those who run an ASC.

## What level of disrobing do your patients perform?

**Dr. Koch:** Our patients wear a cap to cover their heads, but do not remove any clothing.

**Dr. Lindstrom:** My nurses have patients remove their tops and wear a gown and also take off their shoes, but they wear all of their other clothing.

## I work in a hospital where "fast" turnover is 45 minutes to 1 hour per case. Typical surgery time is 10 minutes. How do I make the hospital work?

**Dr. Lindstrom:** You not only need to get into an ASC environment, but you also have to own equity in it. If you perform a \$1,600 all-inclusive cataract procedure, and your fee is \$600 and \$1,000 is for the lens and the facility, the profitability is going to be greater on the facility's side. Also, efficiency is clearly greater in an ASC. I think it's very important for someone who wants to be a successful ophthalmic surgeon to buy into an ASC.

**Dr. Koch:** Hospitals turn cataract surgery into a hobby. If a hospital surgeon performs one cataract surgery per hour and nets a profit of \$150, then he would make more profit seeing patients in the office and not operating at all.

**Dr. Lindstrom:** We have three medical ophthalmologists in our group who are senior surgeons. They decided to join our group and then transition out of surgery. They were performing approximately four cataract surgeries per week in a hospital before they decided to

stop practicing, and, as soon as they stopped doing surgery, each one increased his income.

**Dr. Patterson:** As a benchmark, in our one-OR ASC, we perform five and up to six cases per hour. In a hospital, if you can't achieve at least three surgeries per hour,

---

**"I cannot imagine anything's improving efficiency in the OR better than not having to start 20 or 30 IVs."**

**—Larry E. Patterson, MD**

---



then practicing surgery really does become a hobby.

**Dr. Koch:** In one of my books, called *Simplifying Phacoemulsification*,<sup>1</sup> Chapter 19 is about the Landmark Medical Center in Woonsocket, Rhode Island, a small, 190-bed community hospital. Its staff used to perform four cataract surgeries per day, at 7:30 a.m., 9:30 a.m., 11:30 a.m., and 1:30 p.m., and the 1:30 case would finish on the second shift. They asked me to install some efficiency systems, and now they daily perform 25 cases before lunchtime. Efficiency is possible in a hospital, and many ophthalmologists send staff members to Rhode Island to see the systems we installed. Unfortunately, many of these representatives adopt the attitude that their hospital is different and cannot accommodate the changes we made in Rhode Island, and they walk out learning nothing. Change requires the commitment of the entire team, from the administration down to the nurses.

**Dr. Devgan:** I agree with Dr. Lindstrom. I worked in a hospital that now lies 300 yards away from my ASC. Once while in the hospital, I booked 12 cataract cases for 1 day, and the administrators gave me a lot of grief over how we were going to accomplish them with that workload. Needless to say, I opened an ASC 300 yards away from this hospital, and my staff and I have done very well.

#### How much Versed is in the Jello shot?

**Dr. Koch:** We give 5 mg to almost all patients, perhaps a little less to small people and a little more to large.

#### What is the total number of staff needed to run an efficient ASC, and what role do they play?

**Dr. Patterson:** That's a good question. The answer depends on exactly what procedures you are doing. Generally, in a one-OR ASC like ours, which allows you to perform approximately 1,000 cases per year operating 1 day per week, you need a scrub nurse, a surgery coordinator to help you turn over the room, and a main OR RN. So that's three people, not counting the surgeon and the anesthetist, in the OR. Out in the holding area, you need two people to run pre- and postopera-

tive patient care. Finally, you need one person to run the front desk. Six people to run an entire ASC is as lean as I could make it, and everyone works continuously; nobody has downtime. I like having an ASC and an office under the same roof because many of our staff are cross-trained to handle a coworker's responsibilities if someone is out sick.

**Dr. Lindstrom:** I have a one-room ASC and use five staff members, but I am happy to perform three cataract cases per hour. I think the number of personnel an ASC requires depends on how many surgical cases the surgeon wants to complete per hour.

#### Do you talk with the patients' families postoperatively for PR value, or do you find doing so requires too much time between OR cases?

**Dr. Devgan:** I typically do not visit with the patients' families immediately postoperatively, between cases. I like to stay in the OR to keep things moving.

**Dr. Koch:** I try not to talk to anybody other than the patient if I can avoid it.

**Dr. Lindstrom:** I think the answer to that question comes down to a stylistic issue for each individual surgeon. I speak with each patient and say hello to his family before surgery so that I'm not just standing in the OR waiting for the next patient. When the patient leaves, one of my nurses interacts with him, and if time permits me, I will visit with the family again. That's just my old-fashioned style, and performing three cases per hour permits this interac-

tion. Surgeons executing five or six cases per hour, however, should remain in the OR so that they can simply move on to the next case.

**Dr. Patterson:** My ASC has a viewing room with an observation window that looks into the OR, and one of my staff members sits and talks with patients' families and friends as they watch us work in the OR. Allowing individuals to watch live surgery is the best PR of all, because the experience is something they talk about with their families and friends afterward. Having a viewing window requires a certain amount

---

“[The Landmark Medical Center’s staff] used to perform four cataract surgeries per day. They asked me to install some efficiency systems, and now they daily perform 25 cases before lunchtime.”

—Paul S. Koch, MD

---

“Most state and federal certification is becoming tougher. For example, states that did not previously require a Certificate of Need are now doing so. If you’re planning on joining an ASC on the equity side, do it as soon as you can.”

—Richard L. Lindstrom, MD

of nerves on the part of the surgeon; sometimes, things don’t go well, but odds are that they have never seen vitreous loss before and are impressed with the vitrectomy.

#### What does the anesthesiologist do, especially when you aren’t using intravenous sedation?

**Dr. Lindstrom:** If you aren’t going to use intravenous sedation, I don’t think you need an anesthesiologist.

**Dr. Patterson:** An anesthesiologist will assist in performing the patients’ preoperative assessments and monitor their vital signs. Also, we occasionally have a patient who requires more sedation, in which case I ask the anesthesiologist to prepare an IV.

#### Are ASCs Medicare-certified facilities?

**Dr. Devgan:** Yes, most ASCs must be certified.

**Dr. Lindstrom:** Most state and federal certification is becoming tougher. For example, states that did not previously require a Certificate of Need are now doing so. If you’re planning on joining an ASC on the equity side, do it as soon as you can. This may mean that you have to team up with another ophthalmologist and perform 1,200 cases per year instead of 600, and, if the ASC only has one OR, you may have to alternate the days you use it. My advice is to work hard at making friends with somebody in the community and build yourself an ASC; it will make a huge difference to your future financially.

#### Do you each take a preoperative patient history and physical?

**Dr. Lindstrom:** We still do in my practice; we’re rather old fashioned that way. The patient’s internist does it, and, if he’s unavailable, one of my fellows or I will do it.

**Dr. Patterson:** I think taking the patient history and physical is a state-by-state issue. Some states require it;

ours carries minimal requirements.

**Dr. Devgan:** Gentlemen, thank you for your insight and pearls for increasing efficiency in the OR. With increased efficiency, we will achieve higher patient safety and satisfaction, better surgical outcomes, and increased cost savings. I personally picked up quite a few pearls that I plan on integrating and implementing into my own practice right away. ■

*Uday Devgan, MD, FACS, is in private practice in Sun Valley, California, and also serves as Assistant Clinical Professor at the Jules Stein Eye Institute at the University of California, Los Angeles. He is a paid consultant to Bausch & Lomb but holds no financial interest in any product or company mentioned herein. Dr. Devgan may be reached at (310) 612-3993; devgan@ucla.edu.*

*Paul S. Koch, MD, is Medical Director of Koch Eye Associates in Warrick, Rhode Island. He is a consultant for Bausch & Lomb. Dr. Koch may be reached at (401) 748-4800; paulkoch@kocheye.com.*

*Richard L. Lindstrom, MD, serves as the managing partner of Minnesota Eye Consultants, P.A., in Minneapolis, and is an adjunct professor emeritus of ophthalmology at the University of Minnesota. He is a consultant to Bausch & Lomb. Dr. Lindstrom may be reached at (612) 813-3600; rllindstrom@mneye.com.*

*Larry E. Patterson, MD, is Medical Director of Eye Centers of Tennessee in Crossville. He is a consultant to Bausch & Lomb. Dr. Patterson may be reached at (931) 456-2728; larryp@ecotn.com.*

1. Koch PS. *Simplifying Phacoemulsification: Safe and Efficient Methods for Cataract Surgery*, 5th ed. Thorofare, NJ: Slack Incorporated; 1997.



# Refractive Cataract Surgery

MODERATOR: LOUIS "SKIP" D. NICHAMIN, MD

## LIMBAL RELAXING INCISIONS

LOUIS "SKIP" D. NICHAMIN, MD

## BIOPTICS IN CONJUNCTION WITH CATARACT SURGERY

STEPHEN G. SLADE, MD, FACS

## REFRACTIVE PRESBYOPIC LENS EXCHANGE

I. HOWARD FINE, MD

### LIMBAL RELAXING INCISIONS

Louis "Skip" D. Nichamin, MD

In order to function at the cutting edge, ophthalmologists must begin to genuinely embrace the concept of *refractive cataract surgery*. One may be surprised to know that the single most common cause for litigation in relation to cataract surgery is IOL-related complications, and the complication that most frequently draws verdicts in favor of the patient is a refractive surprise. Therefore, optimizing refractive outcomes is more important than ever, and I will focus on the issue of astigmatism.

### APPROACHES TO ASTIGMATIC CORRECTION

The literature contains varying reports of the incidence of significant astigmatism. Roughly 10% of patients have 2.00 D or more of cylinder. Ophthalmologists have found, through keratorefractive experience, that patients experience visual symp-

toms with errors as slight as 0.75 D. I think surgeons should now approach cataract and IOL patients in the same manner that they do LASIK patients and aspire to similar refractive goals. In my practice, I perform some type of astigmatic treatment in one of every three cataract patients and in six of every 10 refractive lensectomy cases.

Our options for astigmatic correction are multiple. One approach is to tailor the position and design of the phaco incision; this continues to be a popular technique in Europe, where surgeons place the incision upon the steep meridian and further modify it based on the amount of pre-existing cylinder. A more common alternative in the US is to use additional astigmatic relaxing incisions. When introduced more than 20 years ago, these types of incisions were made in the cornea. However, Richard Lindstrom, MD, and others have been instrumental in moving these incisions out toward the periphery; they are now

positioned just within the surgical limbus. Although a toric IOL may adequately address astigmatic error, the only toric implant currently approved for use in the US is the STAAR model #AA4203TF/TL IOL (STAAR Surgical Company, Monrovia, CA). I personally enjoy using this implant, particularly in combination with limbal relaxing incisions (LRIs), to treat higher levels of astigmatism. Some surgeons, however, shy away from plate-haptic and first-generation silicone implants.

### PERIPHERAL ARCUATE INTRALIMBAL RELAXING INCISIONS

I tend to prefer the term *peripheral arcuate intralimbal relaxing incision* because the term *LRI* is a bit of a misnomer: the ideal location of these incisions is not actually at the true surgical limbus, but just inside the limbus at the peripheral-most extent of clear corneal tissue. The advantages of moving out to the periphery include (1) a lesser likelihood of causing a postoperative shift in the cylinder axis and (2) a reduced potential for inducing irregular flattening and hence irregular astigmatism. Although LRIs are admittedly less powerful than earlier, purely corneal, astigmatic relaxing incisions in the setting of cataract surgery, our aim is not to overcorrect the astigmatic refractive error or throw off the resultant axis. LRIs enable the surgeon to correct up to 3.00 D in most cataract patients. I have examined my data carefully and firmly believe that the coupling ratio is very close to 1:1 with peripheral relaxing incisions. The term *coupling ratio* refers to the amount of flattening induced in the incised meridian compared with the amount of steepening that occurs opposite, in other words, the effect that the relaxing incisions have upon the resulting spheroequivalent. I therefore make no power adjustments to the IOL calculation when utilizing these incisions, and have also found that these incisions are quite stable over time.

### BECOMING FAMILIAR WITH LRIs

Ophthalmologists have almost 10 years of follow-up with this type of relaxing incision. Those interested in learning this procedure must first select a nomogram, of which there are many available. The nomogram I use utilizes degrees of arc, because corneal diameter may significantly influence the arc length of the incision and its resultant effect (Figure 1). Additionally, multiple types of instrumentation exist. Although the technique may seem exotic to a surgeon who is inexperienced with keratotomy incisions, it falls well within the purview of all modern phaco surgeons. The real challenges with LRIs are understanding and measuring astigmatism and devising an appropriate surgical strategy for treatment.

The surgeon must know what effect the cataract incision will have upon the degree of resulting astigmatism and factor that into the surgical plan. Many surgeons now

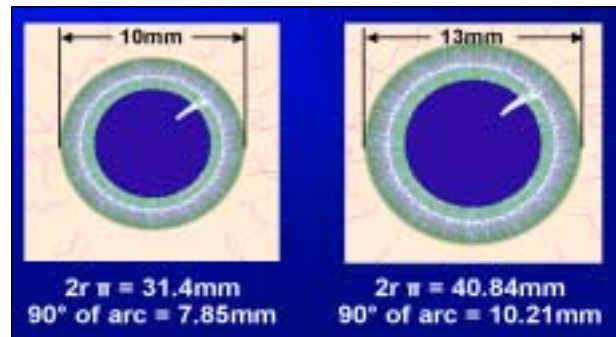


Figure 1. In this nomogram design, note the relative disparity in the incision length between a large and small corneal diameter if measured in millimeters. Degrees of arc lend consistency irrespective of corneal size.

use the temporal single-plane incision developed by I. Howard Fine, MD, which dovetails beautifully with the use of LRIs. LRIs may be superimposed upon any type of phaco incision, however.

### INSTRUMENTATION

Surgeons who want to approach astigmatic correction seriously and refine their outcomes should use the best instrumentation available. I recommend investing in high-quality diamond blades. One instrument I favor is an adjustable micrometer blade from Bausch & Lomb (Rochester, NY). Similar designs are available from Mastel Precision (Rapid City, SD) and Rhein Medical (Tampa, FL). I prefer a single foot plate to improve visibility. I also like to use an aggressive cutting diamond. Various corneal markers are available to delineate the extent of the incisions and their positioning; I am fond of the Dell-Nichamin marker and the Kershner-Nichamin arcuate markers, both manufactured by Rhein Medical. Honestly, I find that, with experience, the surgeon can in most cases omit this marking step and instead use a modified Fine-Thornton fixation ring (Storz [St. Louis, MO], Rhein Medical, and Mastel Precision). The fixation ring has 10° incremental radial marks to delineate the extent of arc incised as well as one pair of broad, diametrically opposed hash marks that are used to align the ring with the steep meridian and center the incisions. As the surgeon creates the incision, he visually extrapolates to the 10° radial marks on the surface of the ring as it is juxtaposed to the incision. Thus, he can accurately titrate the appropriate arc length called for by the nomogram. Alternatively, he may still mark the cornea and the extent of the incisions utilizing a two-cut RK marker.

### OPTIMIZING RESULTS

I strongly recommend that surgeons use some type of intraoperative keratotomy to help center the incisions upon

the appropriate steep meridian. One can develop a keen eye for detecting levels of cylinder as low as 0.75 D. It is very important to place the incisions at the correct meridian. Failure to do so is the single most common error involved with this type of surgery, and mistakes often involve 90° errors that will, of course, double the amount of resulting astigmatism.

Perhaps the greatest challenge of astigmatic surgery is devising a treatment strategy. Methods of measuring astigmatism have greatly improved over time. In years past, surgeons would often ask if performing corneal topography on surgical candidates were a prerequisite, and my reply was typically "no." Today, however, I believe that this measurement and topographic screening are necessary in order to deliver the best possible care. Doing so occasionally uncovers pre-existing pathology, be it irregular astigmatism due to epithelial basement membrane dystrophy or a subtle cone that the surgeon otherwise would have missed.

#### APPROACH

Variations in surgical technique certainly exist. I prefer to rely upon standard K readings to determine the placement of the incisions. Refracting a cataract patient can be challenging, and one often encounters difficulty determining the exact cylinder axis at the spectacle plane. Increasingly, I have come to rely upon topography to determine both cylinder axis and quantity. With less dense cataracts, my staff and I refer to the refraction, but we will compromise between measurements should they differ significantly. For example, with disparate measurements of 1.00 D on keratometry and 2.00 D of astigmatism upon refraction, we would aim to correct 1.50 D.

#### TECHNIQUE

I recommend preparing a written plan for the procedure prior to surgery. My staff and I mark the 6-o'clock limbal position for proper orientation and place the incisions at the most peripheral extent of the clear corneal tissue. The positioning of the incisions is important, because placement farther out at the true surgical limbus can result in a significant decrease in effect. We ignore pannus, and any bleeding encountered will stop spontaneously. It is very important to position the diamond blade perpendicular to the corneal surface and not upright or perpendicular to the OR floor.

The potential for problems obviously exists with every ocular procedure, and I have probably experienced as many complications as anyone. I have had three perforations, each because the blade's epoxy had given way after many autoclave runs and resulted in blade extension beyond that which was intended. My staff and I routinely use a 600- $\mu$ m setting for all cataract patients. For refractive lens exchange

candidates, however, who are typically younger, we perform pachymetry and use an adjustable micrometer blade set at 90% of the thinnest reading. The one mistake that surgeons must avoid is operating upon the wrong axis. LRIs are always placed on the steep corneal meridian at the plus refractive cylinder axis.

#### TIPS FOR SUCCESS

The key to success with LRIs is to properly center and place the incisions. Fortunately, peripheral relaxing incisions are far more forgiving than more central corneal astigmatic incisions. One caveat exists for against-the-rule astigmatism when the nomogram is calling for incisions of greater than 40° of arc: in this situation, the temporal arcuate relaxing incision will be superimposed upon the temporal clear corneal phaco incision. To avoid intraoperative gaping, foreign body sensation, and overcorrection, the surgeon should not extend the temporal relaxing incision beyond 35° of arc until he has completed phacoemulsification and I/A. After increasing the eye's firmness with viscoelastic and prior to inserting the IOL, the surgeon may reinsert the blade into the partial arcuate incision and extend the incision to its full length according to the nomogram.

Using a fixation ring or similar device is handy because, depending upon the exposure through the speculum, it is possible to bump up against the nasal bridge or the speculum. The fixation ring also allows the surgeon to change the position of the eye for better exposure (Figure 2).

To create the incision, I use the limbus as a stencil and inscribe a gentle arc. I hold the blade between my thumb and index finger and rotate it as I move along.

I strongly advocate the use of LRIs to all cataract surgeons. The technique is an indispensable adjunct to modern refractive cataract surgery.

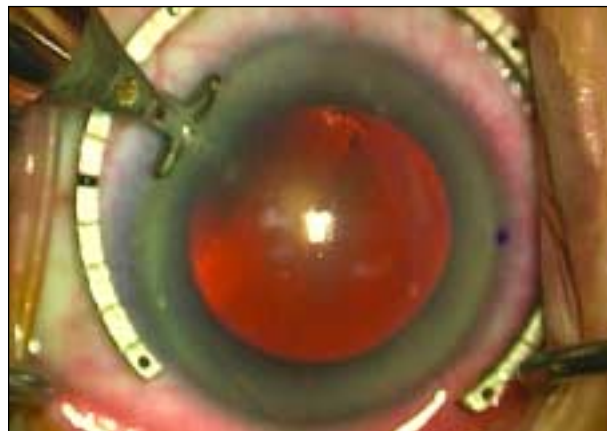


Figure 2. The author fixates the globe with the modified Fine-Thornton fixation ring, places the diamond blade just inside the limbus, and achieves the appropriate length of the incision by visually following the degree marks on the ring.

## BIOPTICS IN CONJUNCTION WITH CATARACT SURGERY

Stephen G. Slade, MD, FACS

Bioptics, in my mind, is any combination of two operations, whether it be the original procedure devised by Roberto Zaldivar, MD, of Argentina that involved implanting a STAAR Implantable Contact Lens (STAAR Surgical Company) and subsequently performing LASIK, cataract surgery and LASIK, or LRLs with cataract surgery. The two new terms that have occurred to me, as cataract surgery becomes refractive surgery and vice versa, are *extraocular refractive surgery* and *intraocular refractive surgery*.

### MERGING TWO SPECIALTIES

I feel we must combine cataract with refractive surgery so as to follow the fields' natural course of progression. When I first started in refractive surgery approximately 19 years ago, surgeons performed myopic keratomileusis with a manual microkeratome, a procedure that involved removing 350  $\mu\text{m}$  of corneal tissue, freezing it, grinding it, replacing it, and sewing the eyelid shut. Back in mid-1980s, RK surgeons were thrilled to correct 80% of their patients to 20/40 visual acuity or better. Now, we have nearly reached a correction rate of 100% 20/40. That figure is well over 90% of patients with amazing accuracy. Refractive surgery has certainly improved.

### ARGUING IN FAVOR OF BIOPTICS

I divide refractive surgery into three mechanisms of action: (1) corneal modeling, which includes RK, Intacs corneal ring segments (Addition Technology, Inc., Des Plaines, IL), conductive keratoplasty (CK; Refractec, Inc., Irvine, CA), LASIK, and PRK; (2) subtractive or tissue-removal techniques such as LASIK and PRK; and (3) additive refractive surgery, such as intraocular refractive surgery, which is typically lens-based and includes phakic IOLs, aphakic IOLs, and keratophakia. The reason cataract surgeons need to be able to perform bioptics and wavefront calculations has to do with the visual complaints we regularly hear from patients. A patient's ability to read the 20/20 line on the eye chart does not necessarily translate into good quality of vision and, by extension, quality of life. We must be aware of and continually emphasize quality of vision.

Through conversations with various respected colleagues, it has become clear to me that cataract surgery needs to combine with refractive surgery and thereby save refractive surgery from itself. Why does refractive surgery have continually improving technology but continually decreasing reimbursements? Why does a surgeon from Georgia fly into Houston to perform \$299 LASIK surgery? When I was a resident, ophthalmologists received \$3,600 in reimbursements to perform cataract surgery, but they now earn \$600.

Cataract surgery's transformation into intraocular refractive surgery can correct these inadequacies, because the price of IOLs is not within the control of ophthalmologists. We typically hurt ourselves with discounting. Patients already get it: most individuals have more money invested in their mouths than we ask them to pay for refractive lens exchange. Moreover, the average income of face-lift patients is \$35,000. Certainly, surgery to provide excellent visual acuity is well worth the price.

### LASIK ON CATARACT PATIENTS

We have now defined one role of bioptics in refractive cataract surgery by performing LASIK on top of cataract procedures. The inclusion/exclusion criteria for this treatment covers most candidates, as long as we pay particular attention to the epithelium, signs of glaucoma, and compromised ocular nerves. I will typically perform LASIK on a cataract patient 3 months after his cataract surgery. I do not make the flap beforehand in case I decide against using one.

I use my standard LASIK technique on cataract patients, except that I pay close attention to their epithelium. Older patients have looser epithelium, which may present intraoperative problems. The postoperative LASIK outcomes on cataract patients are excellent, and in this regard, LASIK becomes a touch-up procedure performed after you have implanted a phakic or aphakic IOL. Bioptics can produce exquisite results without pushing any one procedure past its limit, as was the case with RK. By maintaining a maximal optical zone above 7 mm, it is possible to induce far fewer aberrations. Furthermore, this approach leaves options available for retreatment. How many times have patients been told that they may undergo LASIK but may never have a retreatment because of the amount of tissue that will be ablated? When the procedure is applied correctly, patients recover much more rapidly, and we as surgeons improve its reproducibility. Also, I avoid suspect keratoconus eyes, which have too little tissue for me to feel comfortable performing extraocular refractive surgery.

### ADVANTAGES OF BIOPTICS

Bioptics offers many advantages. It produces a better quality of vision than conventional treatments, and research shows that current wavefront-guided LASIK technology not only addresses the dread Snellen acuity but also quality-of-vision issues. I am certain that some day wavefront technology will be available in IOLs, but until then we can use the two technologies in tandem to produce a similar effect. Furthermore, bioptics removes less corneal tissue, can possibly produce BCVAs better than 20/20, and, of course, reduces the amount of corneal aberrations via a phakic or an aphakic IOL.

Two intraocular approaches to bioptics exist: (1) under-

going cataract surgery and receiving an aphakic IOL, or (2) simply receiving a phakic IOL. Dr. Fine will discuss these choices in his selection criteria, and each has advantages and disadvantages. A phakic IOL could maintain accommodation and decrease the risk of retinal detachment and macular edema in myopes. On the other hand, this approach may entail performing two procedures versus one, and the risk of a cataract and glaucoma increases with a phakic IOL.

**EXPERIENCE**

Bioptics does not require calculating any special LASIK treatment parameters. I still perform bilateral complicated cases on one eye at a time. Bioptics may enable us to perform wavefront retreatments in the extremely complicated eyes of patients who underwent previous LASIK surgery. Doing so, however, requires some decision making. Are you recutting or lifting the flap? Most surgeons lift the original flap in order to re-treat a patient. With this technology, an aberrometer is essential, and treatment planning is very important. When I perform retreatments with Zywave (Bausch & Lomb), I check the centroids, raw data, consistency, and centration and then develop a sound treatment. From experience, I have learned how to identify and fix a flat spot and manipulate a treatment to flatten the entire surface. If there is an insufficient amount of tissue, then the surgeon can actually see planned treatments where he is coming in on the back side of this flat spot and making it steeper so that he produces the effect he intended. I have now performed more than 400 topographical and wavefront-guided retreatments with good results; my experience has been that approximately two-thirds of patients receive good-quality vision, and one-third of them receive excellent vision. The results take longer to emerge, however, than initial surgeries; I tell all of my retreatment patients that their vision will continue to improve for up to 6 months or longer.

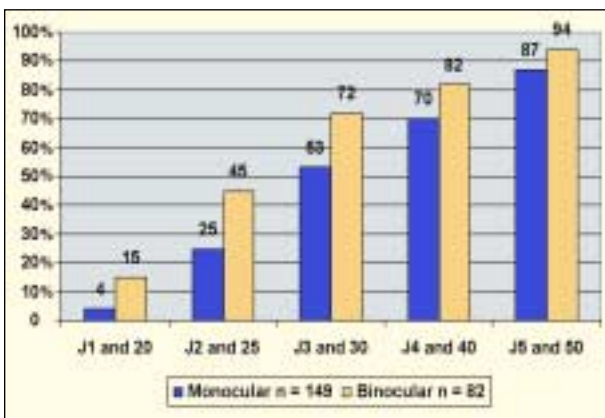


Figure 3. Postoperative UCVA measured monocularly and binocularly at near and distance.

**FINAL THOUGHTS**

Lens technologies may induce less aberration than corneal treatments. John Vukich, MD, of Madison, Wisconsin, conducted a study comparing the amount of spherical aberration induced by the ICL and LASIK treatments between -9.00 and -12.00 D.<sup>1</sup> He found that the average induced spherical aberration with the ICL was 0.13 D, compared with LASIK at 0.39 D. Combining these two treatments would lessen the spherical aberration further. Again, procedures must not be pushed past their limits.

Refractive surgeons who choose to perform more extraocular refractive surgery may be interested in Zyoptix (Bausch & Lomb) for hyperopia treatments. The first preliminary study of this customized treatment conducted outside the US shows 6-month data that are already better than results achieved with the company's customized PlanoScan treatment. The Zyoptix customized hyperopic treatment features next-generation technology such as an eye-recognition rotational eye tracker, a 100-Hz laser, and a sonic feedback loop that indicates the amount of tissue being removed. This modality will be available soon and heads a wonderful pipeline of upgrades for the Zyoptix system.

The future of ophthalmology looks bright. We will perform far more extraocular refractive surgery as well as intraocular refractive surgery on both cataract patients and those without cataracts.

1. Sanders DR, Vukich JA. Comparison of implantable contact lens and laser assisted in situ keratomileusis for moderate to high myopia. *Cornea*. 2003;22(4):324-331.

**REFRACTIVE PRESBYOPIC LENS EXCHANGE**

I. Howard Fine, MD

In 2001, my partners and I described the use of power modulations that reduced the levels of energy directed into the eye during phacoemulsification.<sup>1</sup> We were able to show dramatic reductions in effective phaco times and average phaco powers while removing cataracts of all nuclear densities with markedly enhanced outcomes. We knew that the burst mode of phacoemulsification delivered greater energy into the eye because of its fixed power. With these power modulations, a huge percentage of patients experienced completely clear corneas 2 to 24 hours postoperatively and UCVA's of 20/40 or better. This study produced excellent data that I thought we would be unable to beat for at least 1 decade. Within 1 year, however, we published another paper in which we surveyed all of the new phaco technologies and followed the same study design as we had previously.<sup>2</sup> We experienced dramatic improvements in effective phaco times and average phaco powers as well as in the percentage of completely clear postoperative corneas and the percentage of UCVA's that were 20/40 or better for each of these new technologies.

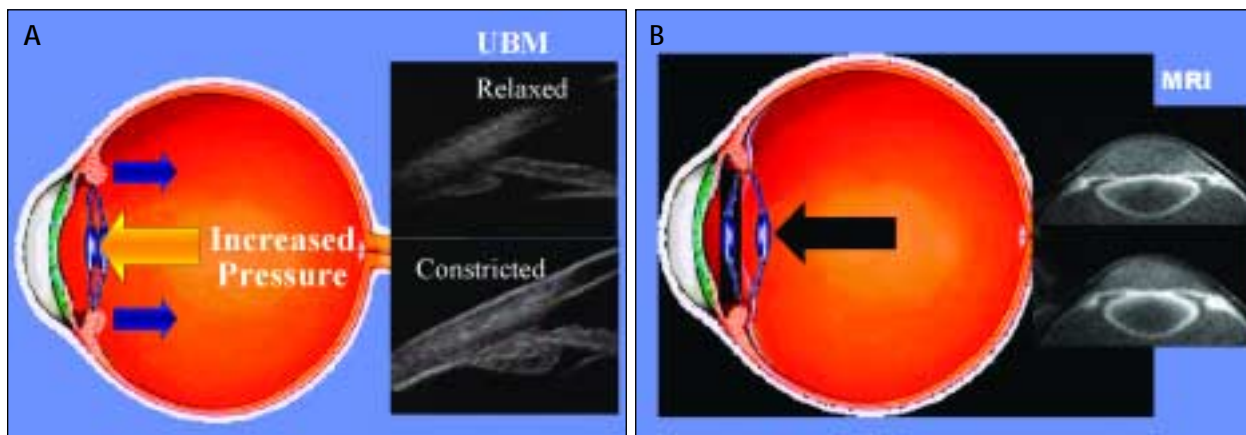


Figure 4. MRI imaging shows a shift in ciliary body mass upon accommodative effort with the Crystalens IOL (A and B).

We followed that study with one on bimanual microincisional phacoemulsification (Table 1).

**LASER PHACOEMULSIFICATION**

My partners and I also participated in two laser phacoemulsification studies for the FDA with the Phacolase (Asclepion-Meditec AG, Jena, Germany) and Photon Laser Phacoemulsification System (Paradigm Medical Industries, Inc., Salt Lake City, UT). We saw excellent results in these studies as well. Both laser systems limited us to treating soft nuclei. The Photon Laser Phacoemulsification System actually delivered more energy and fluid through the eye, and the procedure took two to three times as long to complete compared with bimanual microincisional phacoemulsification. We concluded that laser phacoemulsification presents no competition for conventional ultrasound with power modulations and that cataract or lens extraction today is incredibly safe and efficacious.

**PARTIAL COHERENCE INTERFEROMETRY**

We also took part in the FDA study on partial coherence interferometry and compared the results of the FDA study with the Quantel Axis II Ultrasonography Unit (Quantel Medical, Boscman, MT).<sup>3</sup> We found that the two technologies produced the exact same results. A coefficient correlation of 0.996 led us to conclude that preoperative measurements and calculations allow for excellent results.

**CATARACT SURGERY'S FORAY INTO REFRACTIVE SURGERY**

Through the use of less energy, smaller incisions, and techniques such as the one described by Dr. Nichamin for addressing astigmatism, cataract surgery has delivered increased accuracy, enhanced safety, and improved outcomes. My partners and I ultimately published our early cases on refractive lens exchange using the Array Multifocal IOL

(Advanced Medical Optics, Inc., Santa Ana, CA) and the Crystalens (Eyeonics, Inc., Alisa Viejo, CA).<sup>4,5</sup> Of all the terms that describe the removal of the crystalline lens and replacement with a pseudophakic IOL, the Refractive Surgery Clinical Committee of the ASCRS believes *refractive lens exchange* is best.

There are certain considerations associated with treating refractive lens exchange patients. Personally, I will perform this surgery on any patient 20 years of age or older who has a stable refraction, wears full-time corrective lenses, and desires refractive surgery, as well as all presbyopes who wish to be free of glasses (some of whom are plano) and all patients over the age of 40 who seek LASIK. With hyperopic patients in need of refractive correction greater than 2.00 D, I will opt almost exclusively for refractive lens exchange rather than LASIK. I also consider this treatment for all patients who desire spectacle independence and are not LASIK candidates. I am not willing to perform refractive lens exchange on patients who have adequate (if imperfect) distance vision and are not presbyopic.

The workup and surgical procedures for refractive lens exchange patients are exactly the same as for cataract patients who desire less dependence on corrective lenses.

Our early refractive lens exchange data represent monocular and binocular visual acuity results (Figure 3). The binocular results will obviously be better because, when submitting data for multifocal IOLs, the investigators must report on both parameters, distance and near vision. A binocular patient who is -3.00 D in one eye and plano in the other will do very well. Those patients were at least 20/50 and J5, 20/40 and J4. These data represent monocular distant and near UCVA's, and we consider them to be promising and refractive lens exchange to be quite accurate. These results are as good as we've been able to achieve with LASIK, and I believe that we achieve the desired correction a high percentage of the time.



**IOL TECHNOLOGIES WITH REFRACTIVE LENS EXCHANGE**

**ReSTOR**

The ReSTOR IOL (Alcon Laboratories, Inc., Fort Worth, TX) has the desirable property of offering distance dominance with a wide pupil and near dominance with a small pupil. Its drawback is the intermediate vision necessary for computer screens, because the ReSTOR IOL is really a bifocal lens.

**Tecnis**

The Tecnis IOL (Advanced Medical Optics, Inc.) is interesting. It corrects for spherical aberration in the cornea. The corneal spherical aberration tends to be constant, whereas the eye's spherical aberration changes parallel to changes within the lens. We can demonstrate this effect with point-spread functions or wavefront aberration diagrams. These spherical aberration changes result in a loss of contrast sensitivity. In some cases, optical blur is less disabling than the loss of contrast sensitivity, which is associated with nighttime driving problems and night vision aberrations.<sup>6</sup> The Tecnis IOL has a modified prolate surface to address the positive spherical aberration of the cornea. In our clinic, my partners and I were able to show that senior citizens implanted with the Tecnis IOL achieved mesopic contrast sensitivity as good as the photopic contrast sensitivity achieved

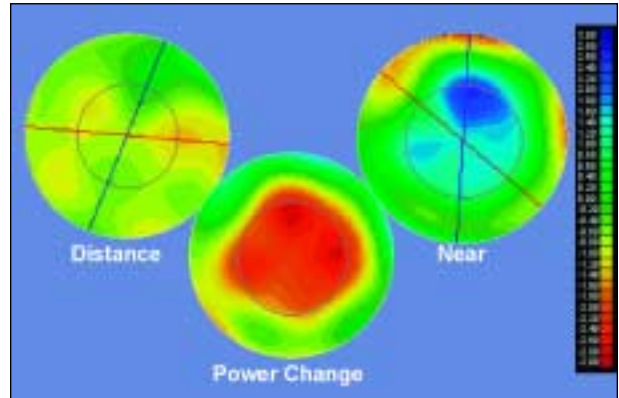


Figure 5. A retinal wavefront map demonstrates a 3.00-D power change upon accommodative effort with the Crystalens IOL.

with spherical IOLs.<sup>6</sup> Furthermore, these senior Tecnis patients had mesopic contrast sensitivity that was comparable or better than that of 20-year-olds who have never developed cataracts. Thus, this lens recaptures the youthful quality of vision. A multifocal version of the Tecnis IOL will begin clinical trials soon.

**A New Aspheric Lens**

Bausch & Lomb will soon introduce an aspheric IOL that will have an optimal function independent of tilt and decentration.

**Crystalens**

Two accommodative IOLs have been in clinical studies, and it is well known that the Crystalens IOL has already been FDA-approved in the US. I will not go into detail about the 1CU Akkommodative IOL (HumanOptics AG, Erlangen, Germany). The model AT45 Crystalens IOL is made of silicone and has a 4.5-mm optic and plate haptics that affix firmly to the capsular bag. The IOL is hinged at the haptic-optic junction so that it can be placed in a capsular bag smaller than the diameter of the lens from loop to loop. This design allows the lens to vault posteriorly in the immediate postoperative period and also, we believe, to be capable of forward movement as a result of accommodation, which creates a redistribution of the ciliary body's mass and an increased pressure that move the optic forward. This forward movement creates a more positively powered lens. In our clinic, we indeed demonstrated with MRI imaging a shift in patients' ciliary body mass upon accommodative effort with the Crystalens implant (Figure 4).

Figure 5 shows a patient of mine who is a high-volume cataract surgeon from Texas on whom I performed bilateral cataract surgery and implantation of the Crystalens. He was +3.00 D in power preoperatively and is now 20/20 and J1 in

TABLE 1. COMPARISON OF OUTCOME RESULTS WITH BIMANUAL VERSUS COAXIAL PHACOEMULSIFICATION

**PERCENTAGE OF EYES WITH A UCVA OF 20/40 OR BETTER 2 TO 24 HOURS POSTOPERATIVELY\***

Machine	Coaxial Results	Bimanual Results
Legacy with NeoSoniX	96%	93%
Millennium with Phaco Burst	100%	95%
STAAR Sonic Wave <sup>†</sup>	74%	100%
Sovereign with WhiteStar	94%	95%

\*P <.01

<sup>†</sup>Chi-Square analysis indicates that the STAAR Sonic Wave showed significant improvement in UCVA with bimanual over coaxial phacoemulsification. All other analyses indicate no other significant differences between coaxial and bimanual phacoemulsification in the percentage of patients with a UCVA of 20/40 or better.

each eye. The wavefront power map shows him achieving 3.00 D of amplitude of accommodation.

My partners and I performed 25% of the FDA-monitored study of the Crystalens. Our data on the 24 patients in whom we were able to binocularly implant the lens show that 100% achieved at least 20/30 distance and J3 near and intermediate vision. Of those patients, 71% achieved at least 20/20 and J1 near and intermediate vision (Figures 6 and 7). If we determine which group of those patients achieved at least 20/25 or better near visual acuity and then ask, through quality-of-life studies, what percentage of the patients are spectacle-independent, we find that spectacle independence requires a high level of near visual acuity. The same percentage of patients who were 20/25 or better are almost completely spectacle-independent.

### Sarfarazi

The Sarfarazi lens is a dual-optic IOL that Bausch & Lomb has licensed. Two other new accommodative IOLs are also currently undergoing preclinical testing. They both will offer between 15.00 and 20.00 D of accommodative amplitude. That range of accommodative amplitude translates to excellent visual acuity for both distance and near. These two lenses represent an entirely different concept than any IOL seen previously, and I look forward to working with them.

### Nulens

The Nulens accommodative IOL (Nulens Ltd., Herzliya Pituach, Israel) has deformable optics and has achieved over 30.00 D accommodative amplitude in primates.

### AcrySof Natural

Alcon Laboratories, Inc., gained FDA approval for its blue-blocking lens. The company says that the natural crystalline lens defends against ultraviolet blue light and that chronic exposure of the pseudophakic eye to these wavelengths can contribute to photo-oxidative stress in the choriocapillaris and retinal pigment epithelium that results in age-related macular degeneration. Alcon Laboratories, Inc., says that the blue-blocking lens mimics the human eye's transmission of light. To support this claim, the company mimicked the eye of one 50-year-old-patient. We know, however, that almost all biological systems perform optimally at age 20, and therefore I question the purpose in using a 50-year-old's eye model instead of that of a 20-year-old. More importantly, 70-year-olds have a 30% loss in scotopic vision, and this lens decreases scotopic vision by an additional 30%. Because patients of this age may become disabled under scotopic conditions, I question the soundness of creating such a compromise in nighttime vision in the absence of firm, universally accepted, scientific evidence that blue light has any role in the etiology of age-related macular degeneration.

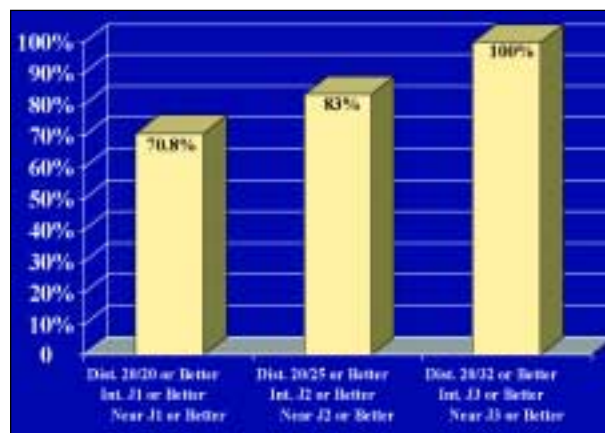


Figure 6. Percentage of patients in the FDA-monitored study with bilateral Crystalens implants who achieved 20/32 or better uncorrected postoperative distance, intermediate, and near visual acuity.

### The Photosensitive IOL

Many are familiar with the Light Adjustable Lens (LAL; Calhoun Vision, Inc., Pasadena, CA) in which free macromers within the lens can be irradiated with ultraviolet light preferentially within a zone. As a result, polymerization takes place with a concentration gradient of free macromers that will then diffuse into the irradiated portion, thus swelling that portion of the lens. This swelling allows surgeons to increase either the LAL's plus power, by irradiating the center of the lens, or the minus power, by irradiating the periphery of the lens. The lens may also be made toric by irradiating a single meridian. Ultraviolet light is sent through the LAL and polymerizes the remaining free macromers. This action locks in the configuration of the macromers, creating a permanent fix within the lens.

### Microincisional Lenses

One other developing area in IOLs is microincisional lenses. The ThinOptX IOL (ThinOptX, Abingdon, VA) is one example; injectable polymers are another. Personally, until there is a lens that can travel through the sideport incisions used for bimanual microincisional phacoemulsification without my having to enlarge them, I will continue to make an incision between the two sideports for the implantation of the IOL, even one that is 1.5 mm small.

### Injectable IOLs

Injectable IOLs are another technology that is now available, although these lenses have formidable barriers to overcome. Having worked with Advanced Medical Optics, Inc.'s injectable polymer, I can tell you that extracting even a clear lens from a 1-mm capsulorhexis is a difficult problem. The SmartIOL (Medennium, Inc., Irvine, CA), however, is a fabu-

lous technology. It is a thermodynamic lens constructed out of hydrophobic acrylic to fill the capsular bag. It is able to be preoperatively imprinted with whatever dioptric power the surgeon desires. At room temperature, the lens converts into a 1-mm rod that can be implanted in the capsule through a normal-sized capsulorhexis, where it reconstitutes to its original size, shape, and imprinted dioptric power. Thus, the SmartIOL fills the capsular bag, cannot decenter, imparts no edge effect, and will likely impair posterior capsular opacification. Also, because it is a stable gel with a high refractive index, the IOL is capable of a large amplitude of accommodation. The lens will also probably withstand a YAG capsulotomy without difficulty. It is easily flexible and adjustable. My partners and I look forward to this technology's availability.

**THE EFFECT OF BIMANUAL MICROINCISIONAL PHACOEMULSIFICATION**

This technique is going to become an important player in refractive lens exchange because it is minimally invasive and much safer than traditional phacoemulsification. If we consider the limitations of lenticular- versus corneal-based refractive surgery, we have to keep in mind that (1) spherical aberration remains constant in the cornea with increasing age and (2) spherical aberration changes that occur in the lens will degrade any surgery performed on the cornea. So, we must ask ourselves, where will the new phaco and IOL technologies take us? I believe refractive lens exchange will become the dominant refractive surgical procedure, because it will address all of the components of the patient's refractive error, including presbyopia. The state of the profession today is that children with refractive errors wear glasses, teenagers wear contact lenses, young adults undergo refractive surgery, middle-aged adults receive bifocals, and senior citizens undergo cataract surgery. Tomorrow, it will be possible to combine all of these steps into one, refractive lens exchange. Patients will be able to enjoy a pre-

dictable refractive procedure that addresses all of their refractive errors, including presbyopia, with rapid recovery. The ability to treat all refractive errors is the key, and equally important will be the opportunity to never develop cataracts, which are associated with significant optical morbidity in the presence of good Snellen visual acuity.

Refractive lens exchange will also benefit surgeons, because they will be able to offer these procedures without the intrusion of private or governmental insurance and therefore have less disruptive relationships with their patients. The government will support this procedure because it will enjoy a decreased financial burden from the expense of cataract surgery, particularly as the increasing ranks of baby boomers move toward the age of needing Medicare coverage as pseudophakes. In short, refractive lens exchange represents a spectacular future for all ophthalmologists, better than any enjoyed by any previous generation of ophthalmologists before. ■

1. Fine IH, Packer M, Hoffman RS. Use of power modulations in phacoemulsification: choo-choo chop and flip phacoemulsification. *J Cataract Refract Surg*. 2001;27:2:188-197.
2. Fine IH, Packer M, Hoffman RS. Power modulations in new technology: improved outcomes. *J Cataract Refract Surg*. 2004;30:1014-1019.
3. Packer M, Fine IH, Hoffman RS, et al. Immersion A-scan compared to partial coherence interferometry: outcome analysis. *J Cataract Refract Surg*. 2002;28:2:239-242.
4. Fine IH, Hoffman RS, Packer M. Clear lens extraction with multifocal lens implantation. In: Friedlander M, ed. *Presbyopia (International Ophthalmology Clinics)*. Vol. 41. No. 2. Philadelphia, PA.; Lippincott Williams & Wilkins; 2001.
5. Fine IH, Hoffman RS, Packer M. Optimizing refractive lens exchange with bimanual microincision phacoemulsification. *J Cataract Refract Surg*. 2004;30:550-554.
6. Packer M, Fine IH, Hoffman RS, Piers PA. Improved functional vision with a modified prolate intraocular lens. *J Cataract Refract Surg*. 2004;30:986-992.

**MEET THE PRESENTERS**

*Louis "Skip" D. Nichamin, MD, is Medical Director of Laurel Eye Clinic in Brookville, Pennsylvania. He is a medical monitor for Bausch & Lomb but holds no financial interest in any company or technology mentioned herein. Dr. Nichamin may be reached at (814) 849-8344; nichamin@laureleye.com.*



*Stephen G. Slade, MD, FACS, is in private practice at the Slade & Baker Vision Center in Houston. He is a consultant for Bausch & Lomb but holds no financial interest in the company or its products. Dr. Slade may be reached at (713) 626-5544; sgs@visiontexas.com.*



*I Howard Fine, MD, is Clinical Professor of Ophthalmology at the Casey Eye Institute at Oregon Health and Science University in Portland, Oregon, and is in clinical practice with Drs. Fine, Hoffman & Packer, LLC, in Eugene. He is a consultant for Bausch & Lomb but holds no financial interest in the its products or other companies mentioned herein. Dr. Fine may be reached at (541) 687-2110; hfine@finemd.com.*

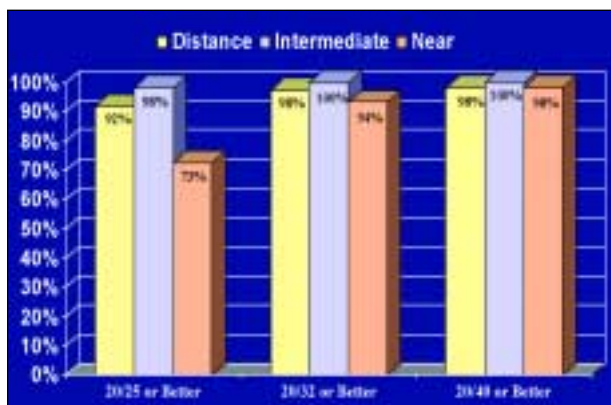


Figure 7. Binocular UCVA in refractive lens exchange patients implanted with the Crystallens.

