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PHACO RELOADED:

Level Up Your Cataract Game

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Content Source

This continuing medical education (CME) activity captures content from a roundtable discussion.

Activity Description

This supplement summarizes a discussion among cataract surgeons on fluidics-driven phacoemulsification and innovations in cataract surgery. Faculty experts share clinical experiences and insights into phaco techniques, fluidics systems, and intraocular lens implantation.

Target Audience

This certified CME activity is designed for cataract and refractive surgeons, as well as ophthalmologists involved in the surgical management of cataracts.

Learning Objectives

Upon completion of this activity, the participant should be able to:

- **Manage** machine fluidics to enhance chamber stability and minimize complications during cataract surgery
- **Assess** ergonomic innovations in phacoemulsification systems that reduce surgeon fatigue and improve procedural precision
- **Propose** surgical techniques for managing complex cataracts

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PRETEST QUESTIONS

Please complete prior to accessing the material and submit with Posttest/Activity Evaluation/Satisfaction Measures for credit.

1. Which statement best describes a key difference between venturi and peristaltic vacuum systems in modern phacoemulsification?

a. Peristaltic pumps generate vacuum instantly without occlusion, improving followability
b. Venturi pumps rely on occlusion to build vacuum, enhancing holdability
c. Peristaltic pumps provide gradual vacuum rise with occlusion, aiding fragment holdability
d. Venturi pumps are less efficient than peristaltic pumps in fragment removal

2. How confident are you in your ability to optimize fluidics settings (eg, pump mode, infusion pressure, tubing choice) to enhance chamber stability and minimize complications during cataract surgery?

a. Not confident at all
b. Slightly confident
c. Moderately confident
d. Very confident

3. A cataract surgeon performing high-volume phacoemulsification reports leg, wrist, and arm pain following long surgery days. Which innovations most directly address these concerns?

a. A dual-linear foot pedal with smaller excursion, and dual-durometer tubing
b. Pliable tubing, and a universal-fit foot plate to accommodate multiple surgeons
c. A single-linear control foot pedal with larger increments, and rigid tubing
d. A fixed-angle handpiece tip, and foot-pedal-controlled irrigation switch

4. During cataract surgery on a dense nucleus with weak zonules, the surgeon begins with a chop technique. Which intraoperative fluidics strategy provides the best balance of holdability and efficiency throughout the case?

a. Remain in venturi mode throughout the case for speed and followability
b. Switch from peristaltic mode during chopping to venturi mode for fragment removal
c. Use peristaltic mode exclusively to maximize occlusion and chamber stability
d. Alternate between venturi and peristaltic randomly to avoid fluidics surges

5. How confident are you in your ability to adjust phaco machine settings (eg, power modulation, pump mode) to manage complex cataracts?

a. Not confident at all
b. Slightly confident
c. Moderately confident
d. Very confident

PHACO RELOADED:
Level Up Your Cataract Game

Phacoemulsification (phaco) in cataract surgery has transformed over the past decade, evolving from a primarily ultrasonic to a fluidics-based procedure that prioritizes efficiency, safety, and optimal patient outcomes. A recent closed roundtable discussion captured insights from leading cataract surgeons on the technological innovations that have revolutionized modern phaco, including advanced vacuum systems, improved fluidics, and enhanced ergonomics. These surgeons share how to achieve excellent surgical results by using a fluidics technique that minimizes energy and reduces corneal trauma. They also share their surgical pearls and real-world experiences with modern phaco platforms for both routine and challenging cases. In addition, this roundtable discussion also considers the future of cataract surgery and emerging technologies.

Eric Donnenfeld, MD: Welcome everyone. We've brought together some of the top cataract surgeons to discuss innovations that have recently taken place in cataract surgery—innovations that have truly changed cataract surgery from a phaco ultrasound technique to a fluidics technique. When thinking about cataract surgery, what are your main objectives as a surgeon?

Eva Liang, MD: I want to do the best job I can, as efficiently as possible, and deliver reliable results for patients. For most of my patients, this procedure is not only medical but also refractive. My goal is to remove the cataract with as few complications as possible and minimize damage to the cornea. Our phaco device is one of the most critical tools that we use in modern ophthalmology practices.

Dr. Donnenfeld: Agreed. Dr. Yuen, do you have additional insights into what you're looking for in cataract surgery?

Carlton Yuen, MD: I agree with Dr. Liang, and I also consider the importance of reducing energy from phaco and minimizing damage to the corneal endothelium. Ultimately, I think it's about performing a clean, precise cataract surgery and having the tools to do so with the goal of reducing secondary complications, like posterior capsular opacification.[1] This approach provides great value to our patients. Considering that cataract surgery is the most common surgery in the world,[2] even seemingly small innovations can help millions of people per year.

Dr. Donnenfeld: I grew up in an era when cataract surgery evolved from being considered as a visually rehabilitating procedure to a truly refractive procedure. The changes have been extraordinary in my career, and I believe we're living in the golden age of cataract surgery. It has become one of the few opportunities that gives older patients the chance to improve their lives by restoring vision to levels comparable to that of their youth.

When I think about cataract surgery, I focus on exceeding patient expectations, providing the safest possible procedure, and offering spectacle independence whenever possible. One key concept with cataract surgery is that you get only one chance to make a good first impression. My goal isn't just for patients to see well, but to see well quickly. I like patients to return the day after surgery saying that their experience has been extraordinary because these are the patients who tell their colleagues and friends about the procedure, which leads to more referrals.

Fortunately, significant innovations in cataract surgery over recent years have allowed us to achieve much better outcomes. Dr. Liang, which innovations in phaco have you seen in your career that you think have truly changed the procedure?

Dr. Liang: Both the IOLs and surgical devices have evolved in cataract surgery. When I first started performing cataract surgery, we were transitioning to foldable IOLs. Over time, the phaco devices advanced to enable smaller incisions and lower energy use.[3-5] For most of my career, phaco machines have outpaced IOL technology by producing smaller wounds than were required for IOL delivery. However, we're at an excellent junction now where IOLs pair well with the machines and ultrasound devices, so that we can deliver excellent results with very efficient surgery.

In the past when encountering a dense black cataract, or cataracta nigra, it sometimes took about 45 minutes to break through, making me wonder whether there was an advantage to phaco. I could probably have removed the dense cataract faster with traditional extracapsular extraction, although obviously with a larger incision.[6] However, with current phaco devices, there's very rarely a lens I can't successfully phacoemulsify.[6]

Dr. Donnenfeld: I completely agree that the phaco machines have become remarkably more efficient. Dr. Yuen, what's your perspective on the innovations you've observed?

Dr. Yuen: When we started using phaco devices, surgeons were particularly concerned about postocclusion surge.[7-10] We had grown accustomed to holding our second instrument against the posterior capsule, concerned that everything would surge forward into the tip and create a complication at the exact moment you were about to complete a successful surgery. I also remember

early in practice about 20 years ago, we used to grade cataracts as being either "phacoable" or needing traditional extracapsular cataract extraction. Back then, I still performed extracapsular extractions on really dense nuclei because I didn't feel that the tools were adequate enough at that time.

Today, significant improvement has been made in surgical devices, specifically in their fluidics and tubing. In my opinion, this newer technology can basically never fail on you. The newer technologies leverage everything we understand about physics to ensure safer and more efficient surgery. One of the latest innovations are dual pumps, which offer fluidics control.[11] It can provide efficiency when cutting through dense nuclei by using both linear ultrasound and elliptical motion.[11]

Marjan Farid, MD: Yes, in phacoemulsification specifically, I think that improvements in fluidic pumps have been significant. I started my training using peristaltic modes, and the eventual shift to venturi mode made me a much more efficient surgeon. Innovations in modes, particularly hyper modules that decrease phaco or ultrasound energy going into the eye, have really improved my efficiency and safety during cataract surgery.[12,13] In addition, rigid tubing has decreased surge during phaco, allowing us to operate at a lower intraocular pressure to maintain chamber stability and decrease fluid movement in the eye.[8,14,15] Less surge provides my patients with better comfort and corneal endothelial health. All these advances have made us more efficient and safer phaco surgeons today.

Dr. Donnenfeld: I completely agree with all your insights. The biggest innovation we've witnessed is that phaco has evolved from an ultrasonic procedure, which induces large amounts of energy into the eye, to a fluidics operation.[5] So, recent advances in fluidics now enable us to perform cataract surgery with minimal ultrasound, resulting in less corneal edema, reduced endothelial cell loss, and faster visual recovery. [5,16-18] I strongly believe in the advantages of both venturi and peristaltic pumps and the ability to switch between these pumps at a moment's notice during surgery.

OPTIMIZING FLUIDICS: THE IMPACT ON PHACO TECHNIQUE

Peristaltic vs Venturi Pumps

Dr. Donnenfeld: Regarding vacuum systems, what are the differences between peristaltic and venturi-based pumps?

Dr. Liang: I have a simple analogy to describe venturi pumps. Venturi is similar to drinking boba tea, ie, when you drink boba tea, a small piece of boba comes up your straw immediately. Therefore, an instantaneous vacuum occurs when you use your phaco pedal in venturi mode.

Dr. Yuen: Alternatively, peristaltic pumps build vacuum power gradually until you achieve an occlusion in the tube, then you reach the vacuum level.[19,20] The advantage of using a peristaltic system is that I can hold onto lens fragments better than with venturi, while venturi systems offer instant vacuum.[19,20] Venturi allows me to stay away from the posterior capsule and cornea by making fragments come to me.

Dr. Farid: Correct, peristaltic vacuum depends on occlusion to build power. Specifically, a piece must completely occlude your tip to build the vacuum and power to effectively grasp it. Holdability is critical in cataract surgery. With venturi, you get adequate followability because the pieces come to you quickly without relying on occlusion to generate a powerful vacuum.

Dr. Liang: Another analogy that I often use for venturi versus peristaltic is electric cars. If you've driven an electric car, you get instant acceleration without buildup, like a venturi pump. In a gas automobile, you have a gradual power buildup, which is similar to a peristaltic system.

Dr. Donnenfeld: The electric car comparison is an excellent analogy. Also, venturi and peristaltic pumps work well synergistically. Peristaltic only achieves vacuum with occlusion, while venturi can have vacuum without occlusion.[19,20] So, venturi compared to peristaltic has slightly lower vacuum, creating less holdability.[21] Both systems play significant roles in cataract surgery. Dr. Farid, when do you use peristaltic versus venturi in cataract surgery?

Dr. Farid: I mostly use venturi because it offers better speed and efficiency, and I'm comfortable maintaining that pace.[21,22] Again, the key advantage of peristaltic mode is holdability.[20,21] If you are able to switch modes during your case, I think it is quite efficient to use peristaltic mode mid-case to occlude and hold the piece while chopping. Then, when removing nuclear pieces, switch to venturi for speed in consuming the fragments.

Dr. Liang: Dr. Farid is a chopper, and I use more of a divide-and-conquer, old-school approach. When you're initially chopping, Dr. Farid, are you using peristaltic or venturi?

Dr. Farid: I've essentially switched fully to venturi. I've become very quick with my chops and can perform the entire case in venturi. However, when teaching residents, I sometimes switch between modes to demonstrate the differences in the pumps and help them understand how these pumps feel and function.

Jason Jones, MD: I have found the best advantage is a machine that incorporates both pumps, allowing me the ability to use peristaltic for one mode and venturi for another. The Veritas is the only machine I am aware of that provides this capability.[11] In particular, I prefer peristaltic for chop because, as Dr. Farid said, it gives great holdability. From my experience, I have trained myself to listen to the tones of the machine, so that I can notice when I have reached occlusion and then chop. I find that venturi is remarkable in evacuating pieces after they've been created.

Forced Infusion for Anterior Chamber Stability

Dr. Donnenfeld: Initially, I was concerned about the introduction of venturi in phaco machines because having vacuum without occlusion leads to less control over the fluidics, easily causing surge and anterior chamber trampolining. One great advancement I've observed is forced infusion, which allows us to dramatically increase vacuum while maintaining anterior chamber stability.[11,20,23-25] Dr. Yuen, could you explain forced infusion and how it changes your approach to cataract surgery?

Dr. Yuen: I agree that with older phaco machines we were concerned about postocclusion surge, leading to a ruptured posterior capsule or prolapsed iris. Forced infusion is an advantageous technological advancement because it can help maintain intraocular pressure, which is critical in maintaining a stable anterior chamber and preventing posterior chamber rents and iris prolapse.[11,23-25] It also allows you to operate on shallow anterior chambers.

Dr. Donnenfeld: Could you describe how your vacuum level has changed? What was the vacuum measurement with the gravity-fed system compared to the forced infusion system? Additionally, by how much has your vacuum increased?

Dr. Liang: Many of us using the newer technology do not remember the settings because the machines are so well calibrated and automatically optimized.

Dr. Yuen: Yes, 20 years ago, I would have known my exact settings. Now, there's minimal effective phaco and longitudinal ultrasound time with phaco.[3-5,12,13] My reaction today is simply, "The phaco worked great."

Dr. Donnenfeld: When operating with gravity-fed infusion, my peristaltic vacuum was 350 mm Hg. With venturi-based infusion, I'm working at 525 mm Hg, making me a more efficient cataract surgeon. By increasing vacuum, the fluidics do most of the work, and I can use ultrasound at much lower levels—oftentimes not at all for some cataracts because of the improved holdability and followability with venturi.

Dr. Jones: I agree. With pressurized infusion we can work at higher vacuum levels and with greater efficiency while maintaining excellent safety.[11,20,24,25] Pressurized infusion has widened the performance envelope.

Reducing Postocclusion Surge With Rigid Tubing

Dr. Donnenfeld: Let's talk about antisurge algorithms and active pressure control to minimize postocclusion surge. What impact does tubing have?

Dr. Yuen: In conjunction with forced infusion, the second critical advancement is tubing. As an example, the Veritas tubing consists of a rigid inner lumen with a softer outer layer providing an inelastic tubing that maintains its shape, which also helps maintain chamber stability.[11]

Dr. Farid: Tubing pliability influences fluidics, similar to my pliable boba straw analogy. Highly pliable tubing causes a shift in fluidics when suddenly released, leading to a rapid decrease in irrigation and an increase in egress.[7] These events lead to sudden surge or chamber instability, increasing the risk of the posterior capsule moving rapidly toward your tip. In contrast, more rigid tubing prevents a sudden volume change after releasing a nuclear piece, which decreases the rapid pressure changes between the anterior chamber and the pump.[8,14,15] So postocclusion surge can be lessened by incorporating more rigid tubing. Postocclusion surge can also be minimized with automatic IOP-based pressure adjustments (eg, active fluidics systems that modulate irrigation pressure in real time) and hybrid pump technologies (venturi + peristaltic) designed to stabilize chamber dynamics.[8,14]

Dr. Donnenfeld: When postocclusion surge occurs, what does the surgeon notice? What does the patient experience?

Dr. Yuen: As surgeons, it's terrifying because the posterior capsule, vitreous, and essentially "everything," surges forward toward your sharp phaco tip, which can easily penetrate the capsular bag. Patients let you know when you have postocclusion surge because it is very uncomfortable and painful. So, eliminating or minimizing postocclusion surge is critical. In theory, a rigid steel tube would be ideal.

Dr. Donnenfeld: I also consider surge a safety issue because it causes a trampolining or bouncing effect, where you see the lens and iris diaphragm flowing backward and forward. Patients complain of pain and discomfort. I have observed that surge is more prominent in myopic patients who have deeper anterior chambers.

Advances in Phaco Tips

Dr. Donnenfeld: How have we modified our power delivery systems? What advances are we using today that make phaco more efficient?

Dr. Liang: Sometimes I see surgeons wiggle the tip of the phaco tip, and I would encourage them to keep the phaco tip both steady and at the center of the pupil. Working with a phaco tip is similar to using an electric toothbrush. You don't manually move the toothbrush in circles but do move the toothbrush straight along the teeth, while the electric head does the work of moving in a circular pattern. This concept is similar to using the modern phaco tip.

However, a pulsing phaco tip moves so rapidly that all its movement is not readily visible, and this movement is responsible for driving fragments toward the tip. This advancement in phaco tips is significant because early in my career, I remember having to pulse

manually with my foot pedal and wiggle the tip more. Now, the machine does most of the manual work of breaking up the lens.

Dr. Donnenfeld: One previous concern in cataract surgery was using phaco as a jackhammer, which constantly repelled the lens and pushed it away.[26] The newer pulse mode, as Dr. Liang described, allows the lens to stay on the tip almost as if it's magnetized. This innovation gave surgeons the ability to reduce energy while increasing holdability.[27]

In addition to pulse mode, we now have phaco tips with various power modes and tip movements, including longitudinal, torsional, and elliptical.[26,28] How does this change phaco efficiency beyond longitudinal mode alone?

Dr. Yuen: I think the change in efficiency is significant. Longitudinal phaco creates substantial heat like a jackhammer.[26] For example, when I began my residency, phaco wound burns were a significant concern; we had to ensure careful timing of fluid flow. Given its powerful method, longitudinal phaco is necessary for some nucleus removals; however, elliptical mode is more efficient and safer for most nucleus removals by producing less heat.[29]

The phaco tip in elliptical mode moves in an elliptical pattern with added longitudinal motion, unlike the simple forward and back movement of longitudinal mode. By holding rather than repelling the material, elliptical mode allows the surgeon to effectively sculpt, chop, and remove fragments. It essentially creates a more efficient tip for cataract removal.

Dr. Donnenfeld: I think that elliptical phaco represents our most advanced phaco technique. To reiterate, an elliptical tip moves simultaneously both laterally or side-to-side and longitudinally or forward-and-back, creating a constant ellipse. This mode can deliver energy more effectively and improve efficiency, reproducibility, and followability.[6,30,31] Previously, phaco was more challenging because it consistently pushed the lens away. Now, we hold the lens much more efficiently, which has been an excellent addition to our armamentarium.

Dr. Farid: This advancement in phaco has also decreased "chatter," where lens pieces move away and are thrown across the eye or into the cornea, potentially causing the risk of increased corneal trauma or nuclear pieces being lost or hidden.[12,32] Excessive chatter essentially increases the risk of retained lens fragments. Elliptical motion can lessen chatter, because it allows you to emulsify pieces while holding them close to the tip.

Clinical Benefits and Patient Outcomes

Dr. Donnenfeld: As you described, Dr. Farid, combining elliptical with venturi settings results in efficient lens removal. Viscoelastic removal also benefits from venturi settings. Do all my colleagues here use venturi for viscoelastic removal?

Dr. Liang: Yes.

Dr. Farid: Yes.

Dr. Yuen: Yes.

Dr. Jones: Yes.

Dr. Donnenfeld: A main advantage to venturi for viscoelastic removal is that the viscoelastic is visible while moving toward the tip. I'm a strong believer in what I call the "zone of safety," ie, I keep my phaco tip equidistant from the capsule, cornea, and iris. In other words, I keep my phaco tip in the center of the anterior chamber when possible and allow the cataract to come to the tip rather than chasing it with the tip. A venturi setting enables me to accomplish this technique. I avoid reaching into the eye because sudden movement by the patient could damage their capsular bag. So, in my opinion, venturi is not only helpful but also safer by allowing me to control my phaco tip and mostly work with my nondominant hand by using my chopper to bring material to my tip.

Dr. Yuen: I particularly like that you mentioned your zone of safety, Dr. Donnenfeld, and staying in the middle of the chamber. The eye becomes exponentially shallower toward the edges, and you should not work with a potentially dangerous tool in the periphery of the cataract. With venturi, pieces are brought to the middle, safe zone. I think that, anecdotally, surgeons who use venturi mode probably have lower rates of posterior capsule tears because we keep our tip in the middle to allow pieces to move to you rather than chasing pieces around the eye.

Dr. Donnenfeld: We've discussed new tubing and how it enhances fluidics, minimizes postocclusion surge, and improves chamber stability, all which improve efficiency. Have you observed that your patients have clearer corneas at their 1-day postoperative?

Dr. Farid: Yes.

Dr. Yuen: Absolutely.

Dr. Jones: Corneas are clear. I definitely notice a "wow" effect.

Dr. Donnenfeld: As surgeons, we notice the safety and efficiency improvements. What do patients notice about these new technologies, and how has this made us better surgeons?

Dr. Yuen: In our center, we›re fortunate to have access to 3 different phaco platforms, including the UNITY CS, Stellaris Vision Enhancement System, and Veritas, which we previously mentioned. We strongly consider 1-day postoperative visual acuity because most patients care about their vision from day 1. In my experience, the newer platforms offer rapid visual recovery for patients and enhance their surgical experience.

Dr. Donnenfeld: I have also observed that using the newer

phaco platforms results in an efficient cataract surgery and a clear cornea the day after surgery. These systems create a great feedback loop, ie, we perform surgery more efficiently, and patients are happier. It makes you want to perform more cataract surgery.

ERGONOMICS AND EFFICIENCY

Technological Innovations in Modern Phaco Systems

Dr. Donnenfeld: Let's discuss other technological innovations we've seen in cataract surgery, specifically with modern phaco machines. Dr. Liang, can you explain some of the newest features?

Dr. Liang: Improvements in foot pedal ergonomics have been universally adopted in some form across platforms.[33] Each system has a different approach to delivering more ergonomic foot pedals. The Centurion Vision System has smaller increments or rises in its dual-linear foot pedal design to limit foot fatigue.[33] The Veritas offers a new wireless, dual-linear foot pedal designed with a fulcrum to improve comfort and reduce fatigue while performing phaco for hours.[11,33] These ergonomic features are critical to me as a high-volume cataract surgeon who spends 2 to 3 days, often for 7 to 8 hours, in surgery.

When I used older systems that had more excursion between the top and bottom of the foot pedal, my leg would become very fatigued and develop cramps by the end of my surgical day. It was similar to driving for hours on a road trip without using cruise control, ie, my leg would cramp. Instead, this newer fulcrum design of the phaco foot pedal has much less excursion.[11] In addition, a foot plate can be added according to foot size, which increases comfort. These small improvements greatly improve ergonomics for surgeons.

Dr. Yuen: The Stellaris machine also offers dual-linear control with sideward motion capabilities.[33,34]

Dr. Farid: I'm at a university teaching center, and I love that we consistently have different surgeons working on different systems. It's important for the system to have a user-friendly platform that's easy to understand and navigate between screens, ultimately making it easy to change between surgeons. I appreciate how much effort industry puts into improving ergonomics for surgeons.

I also like the handpiece of the Veritas that includes lightweight materials, which allows for tip rotation that reduces heat and improves efficiency in the surgeon's hands.[11]

Dr. Yuen: Yes, a well-balanced and light handpiece reduces my fatigue when I perform many cases throughout the day. Each feature of these newer phaco machines is critical for surgeons to gain better control and ergonomics.

Dr. Jones: A lighter handpiece greatly reduces my fatigue, especially during a longer surgical day or longer individual case. Dual-durometer tubing, which was mentioned earlier, improves fluidic efficiency and safety.[11] It is noticeably easier to handle, in my opinion. I feel less tugging on my handpiece and find it effortless to maintain proper hand position. So, this tubing improves not only my ergonomics and comfort but also safety. Using the latest innovations, I have less fatigue and exert less effort to achieve great surgical and patient outcomes.

Dr. Donnenfeld: I also appreciate integrated video capabilities. I enjoy recording my cases and especially having video capability available within the phaco machine. I then review my own videos and present them for educational purposes.

Dr. Liang: Another newer feature included with the Veritas is an intuitive or automatic continuous irrigation function.[11] This feature activates when the phaco is positioned within the eye and automatically deactivates upon exiting, which provides additional control compared to manually turning irrigation on or off with the foot pedal. In my opinion, the automatic nature of this irrigation function can improve safety and prevent the unintentional escape of fluid while removing the phaco from the eye.

Vitrectomy Capabilities

Dr. Donnenfeld: Another nice aspect of newer phaco machines is their vitrectomy capabilities. As an anterior segment surgeon, I'm becoming increasingly comfortable performing pars plana vitrectomies. Many of the new phaco machines offer this advantage. Cataract surgeons can achieve excellent results by performing well-controlled pars plana vitrectomy with cataract systems.[35,36] Are my colleagues here routinely performing pars plana vitrectomies with these machines, or do you defer to retinal colleagues?

Dr. Farid: I'm glad you addressed this topic. Being at a teaching institution, it's common to unintentionally encounter vitreous during surgery. So, a reliable platform is essential to safely perform anterior vitrectomy, whether via an anterior or pars plana approach. I choose the approach depending on the needs of the case. It's also important to efficiently and quickly switch modes because often the transition must happen rapidly from phaco or irrigation/aspiration to anterior vitrectomy.

In addition, being able to manipulate cut rates is important because sometimes we still have cortex in the eye, so we don't necessarily need high cut rates—we need aspiration before cutting. Some machines allow you to switch between aspiration-cut and cut-aspiration modes depending on what you're trying to remove and address. These are really important features on modern phaco machines.

Dr. Donnenfeld: During routine cataract surgery, we rarely perform vitrectomy. However, the cataract surgeons in this

roundtable are premier cataract surgeons from around the United States who manage complex cases that often require vitrectomy at the time of surgery. Overall, having the ability and control to perform successful vitrectomies when needed makes us better cataract surgeons, in my opinion.

MASTERING CHALLENGING CASES WITH NEW TECHNIQUES

Case Example of Modern Phaco and Surgical Approaches

Dr. Donnenfeld: Let's discuss modern phaco technique and some of the advantages we have today. I want to share what I consider my routine phacoemulsification procedure. I'm a strong believer in femtosecond laser-assisted cataract surgery (FLACS), which I think represents robotic surgery and the next level of cataract surgery. I'm not claiming it's dramatically superior to routine cataract surgery, but I prefer this approach. FLACS creates a precise capsulorhexis, softens the lens, and reduces endothelial cell loss.[37,38] However, controlled hydrodissection is key because excessive force risks damaging the posterior capsule.[39,40] So, I use light manipulation and rotate the lens carefully with my probe. What I want you to notice in this case is that when I start, I usually begin with peristaltic mode for my first quadrant (Figure 1). What phaco energy settings do you use for sculpting, Dr. Farid?

Dr. Farid: I don't sculpt, Dr. Donnenfeld. I go directly to quick chop, either horizontal or vertical, and start quadrant removal with high vacuum phaco energy. I typically continue with the high vacuum setting throughout the procedure. I advise residents to find the splitting technique (eg, divide and conquer, quick chop, or stop and chop) that works best for them, then to master their chosen technique.[41-44]

Dr. Liang: My chosen splitting technique is to divide and conquer with heminucleus or "hemi" by breaking the lens in halves because our modern phaco devices are highly effective.

Dr. Donnenfeld: That's a good point, and I frequently use this same approach.

Dr. Liang: I can manage most (about 98-99%) of my cataract surgeries with the hemi technique. Obviously, with large lenses or dense cataracts, you must break the lens into smaller pieces, whether chopping the remainder of the lens half or performing the traditional divide-and-conquer technique.

Because of its peristaltic and venturi capability, the Veritas device is often my machine of choice.[11] I'm in venturi mode mostly, but I like the ability to switch to peristaltic mode on the fly. For example, I like the option of switching to peristaltic mode when I am removing a large cataract and having difficulty pulling up half of the nucleus. Peristaltic gives me sufficient holdability to maneuver the larger half into the pupillary space, where I can then start emulsification and directly feed that piece into the phaco tip.

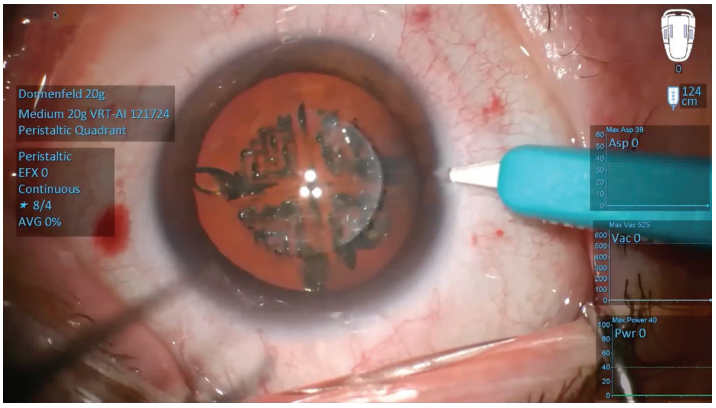

Figure 1. A routine phacoemulsification procedure after FLACS demonstrating use of peristaltic mode to remove the first quadrant of the lens.

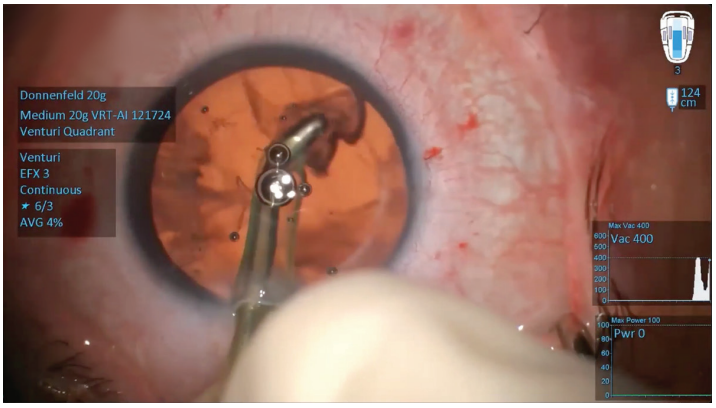

Figure 2. A chopper instrument extends to the base of the trough during lens dissection in a routine phacoemulsification procedure.

Also, FLACS often creates a waffle pattern on the lens, which breaks it into smaller fragments. I prefer using venturi mode to draw these small pieces to my phaco tip, like my boba tea analogy, whereas in peristaltic these smaller pieces tend to scatter more.

Dr. Donnenfeld: For teaching purposes, I think a major challenge with splitting techniques is ensuring your chopper reaches the bottom of the trough when you dissect the lens (Figure 2).

Once I remove the first quadrant, I switch to venturi mode and stay in the middle of the eye. In this case of an approximately 20/40- cataract or what I'd call a "level 2 phaco," I've turned off my ultrasound completely and relied entirely on continuous vacuum (Figure 3). With venturi, I'm using a vacuum setting of approximately 400 mm Hg; it works very simply.

At the end of the case, I like to hydrodissect the lens, and venturi lends itself well for cortical cleanup (Figure 4). I appreciate the control and followability of this mode. Nuclear pieces come to the tip more quickly, which allows me to achieve my goal of removing the cortex and any residual viscoelastic.

To reiterate, for my routine cataract surgeries (about 75%), I rely mostly on fluidics without using ultrasound, which is a newer

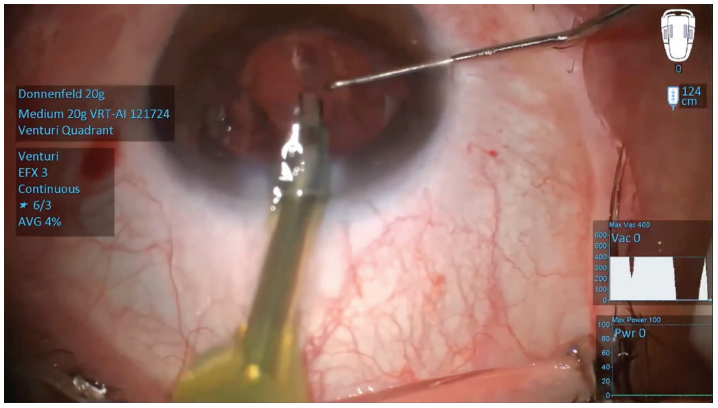

Figure 3. A routine phacoemulsification procedure demonstrating switching to venturi mode without ultrasound to remove the last 3 quadrants of the lens and keeping the instrument in the center of the anterior chamber.

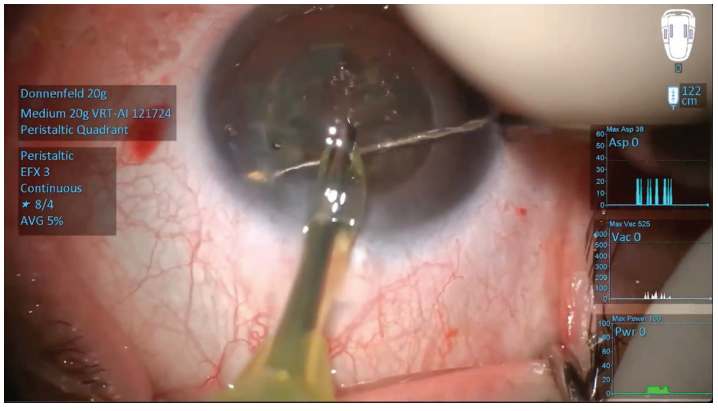

Figure 4. Cortical removal using venturi mode during routine cataract surgery.

approach for me over the last couple of years. Have any of you tried performing cataract surgery without ultrasound?

Dr. Farid: I use minimal phaco energy for my surgeries now. As an aside, we could rename some procedures "phaco aspiration" instead of "phacoemulsification" because we mostly aspirate softer cataracts. I keep my phaco available in case I need it to break up some of the centrally dense pieces. However, most soft cataracts are easily manageable with only aspiration and vacuum.

Dr. Liang: I call those "slurpees."

Dr. Donnenfeld: I've observed that venturi mode consistently removes nuclear fragments, so that they are not easily missed. Small nuclear pieces can sometimes hide in the inferior angle in peristaltic mode, but not in venturi. I find that venturi helps prevent patients from returning with retained fragments. Dr. Yuen, could you share your phaco technique and pearls in using your phaco machine to achieve optimal results?

Dr. Yuen: When performing FLACS, particularly in cases with a soft nucleus, I typically use my probe to divide the nucleus because the femtosecond laser effectively precracks it. I agree that a key consideration following FLACS is performing a gentle hydrodissection. This approach should be considered as back-cleaving rather than aggressive hydrodissection, where we push substantial fluid.

Instead, minimal fluid should be used to gently dissect the capsule to avoid trapping the nucleus and damaging the capsular bag. Then, I mostly choose the divide-and-conquer technique. I also use peristaltic for my first quadrant, and venturi for the remaining quadrants. When using venturi, I use minimal phaco energy to remove the nucleus; I do not turn it off completely.

For nonfemtosecond cataract surgery, I perform my own unique technique that combines the methods of Drs. Donnenfeld and Liang by considering the lens structure and suture lines. I hydrodissect and rotate the lens, creating a single, half groove along a suture. When I crack the lens, it will often crack at a 120° angle. Then, I rotate another 120° and create another small groove. I've essentially created only one groove with minimal phaco energy but divided the lens into 3 pieces by leveraging the weakness of the sutures, which I remove.

Managing Patients With Pseudoexfoliation Syndrome

Dr. Donnenfeld: Let's discuss a surgical scenario of a patient with pseudoexfoliation syndrome (PXF), which raises our concerns for weak zonules.[45-47] What is your 1 pearl to achieve optimal outcomes when managing patients with PXF?

Dr. Farid: I think that it is critical to reduce turbulence and intraocular pressure in an eye with potentially weak zonules. Minimizing lens manipulation is key because the more we manipulate and rotate the lens, the greater the potential for zonular trauma.[48] We should perform a proper hydrodissection and use sufficient holdability to draw pieces centrally to minimize excessive manipulation and rotation. I also prefer using FLACS to soften the cataract, which can minimize time spent manipulating the lens.

I use the quick chop technique in these cases because it avoids the stretching, pulling, and separating that the divide-and-conquer technique requires, although whichever technique works most efficiently for the surgeon is key. In these challenging scenarios, surgeons need to understand occlusion and the power of grasping, occluding, and moving pieces around. The key is to fully understand fluidics and holdability power to perform these manipulations in a nonturbulent manner.

Dr. Liang: Another challenge with patients with PXF is poor pupil dilation, which makes FLACS more challenging.[45] A well-dilated pupil is necessary to maximize the benefits of FLACS. So, I often perform surgery without using FLACS for patients with PXF because of this pupil issue.

I think that my hemisection method of lens removal works well in these cases. After making the initial crack, I can pull one half of the lens forward by directing my phaco slightly to the right, then I use my second instrument to move the

first lens piece slightly to the left or out of the way. Using this method, the lens requires little spinning. After removing the first half, I can direct the phaco tip slightly to the left, and the second piece comes forward nicely with minimal manipulation. I call this "cat burglar" cataract surgery, ie, the surgeon gets in and out quickly, leaving as few footprints as possible while completing the case.

Dr. Yuen: I opt for FLACS when the pupil is dilated to at least 4 mm because the laser has setting adjustments that provide smaller openings. FLACS reduces trauma on the lens zonules more than traditional capsulorhexis, which causes increased traction.[49]

I also prefer using capsular tension rings to minimize the risk of IOL dislocation, ultimately to preserve good long-term visual outcomes.[50,51] In patients with compromised zonules, I routinely implant a capsular tension ring to ensure optimal patient safety.

Dr. Donnenfeld: Additionally, I find it beneficial to create a slightly larger capsulorhexis in these scenarios to lessen the risk of capsular phimosis and breaking of the zonules. I also prefer performing most of my phaco in the iris plane by pulling lens pieces out of the capsular bag, which can minimize trauma. Lastly, I prefer to use a fluidic system that avoids trampolining and stretching of the zonules and ensures good control.

THE FUTURE OF PHACOEMULSIFICATION

Robotic and Office-Based Cataract Surgery

Dr. Donnenfeld: What significant advancements or developments do you expect for phaco?

Dr. Yuen: In the future, computers will clearly continue to advance. FLACS already gives us a glimpse of robotic cataract surgery, which may include an excellent "copilot" assisting us to perform cataract surgery effectively and safely. By using femtosecond laser OCT images, this technology may be able to read the type and density of the cataract and subsequently adjust its settings.

So, I envision that the future of cataract surgery will make the procedure customizable for each patient by considering individual variances, such as nucleus density. I foresee robotic cataract surgery acting as an experienced copilot who assists but does not replace surgeons.

Dr. Farid: I am also excited about the future development of robotic cataract surgery.[52-55] Some surgeons are concerned whether robotic cataract surgery removes their surgical control in the eye; however, I think this concern is unfounded. From a positive perspective, robotic stability could prolong the careers of many cataract surgeons, given that many of our cataract surgeon colleagues retire early when their microsurgical skills (eg, stable hands) begin to fail them. This advancement may also effectively help our aging population because we currently lack the number of surgeons needed to meet the increasing demand for cataract surgery.[56]

Additionally, surgeons who engage in robotic cataract surgery could potentially work and operate remotely on patients. I foresee a surgeon potentially located in a different city, country, or even continent operating on eyes remotely through robotics. So, remote cataract surgery could eliminate the need for surgeons to travel to perform cataract surgery. It may sound unlikely now; however, I think that technological progress is beginning to make this idea possible. As I age, I find the potential of robotic surgery exciting because it may prolong my career and others, ultimately helping to address the worldwide shortage of cataract surgeons.

Dr. Donnenfeld: I agree. Dr. Liang, what future advances are you looking forward to in your career?

Dr. Liang: Office-based surgery is currently a hot topic and gaining attention.[57-59] I think that today's advanced equipment makes this concept more feasible. We've discussed how the advanced cataract systems can make patients more comfortable, and transitioning to office-based surgery is a practical consideration. Some of my current patients think they are having surgery the same day that they are coming in for their consult. This is not possible if you are using a separate ambulatory surgery center, but it could be possible with office-based surgery. As cataract surgery demand rises with the baby boomer generation, we need to improve efficiency and adapt our medical practices.

Dr. Donnenfeld: We've heard some wonderful insights here, and I agree that the future in surgery is promising. I think that artificial intelligence may guide our workflow and that future phaco machines may have the ability to recognize the capsule or iris and avoid damaging these structures. I also strongly believe in sustainability, and we should minimize environmental impact by improving efficiency in cataract surgery.

In summary, I believe that we are in the golden age of phacoemulsification, and I think tomorrow looks even better. Phaco is safer and more efficient today than the past, and patients are highly satisfied with their results. The microsurgical demands of cataract surgery compared to many traditional surgeries are unique, and the technological advances of improved fluidics, anti-surge algorithms, and ergonomic enhancements contribute to improving the efficiency, safety, and accessibility of this common surgery. ■

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POSTTEST QUESTIONS

Please complete at the conclusion of the program.

1. Which statement best describes a key difference between venturi and peristaltic vacuum systems in modern phacoemulsification?

a. Peristaltic pumps generate vacuum instantly without occlusion, improving followability
b. Venturi pumps rely on occlusion to build vacuum, enhancing holdability
c. Peristaltic pumps provide gradual vacuum rise with occlusion, aiding fragment holdability
d. Venturi pumps are less efficient than peristaltic pumps in fragment removal

2. How confident are you in your ability to optimize fluidics settings (eg, pump mode, infusion pressure, tubing choice) to enhance chamber stability and minimize complications during cataract surgery?

a. Not confident at all
b. Slightly confident
c. Moderately confident
d. Very confident

3. What do you see as the greatest barrier to implementing modern fluidics technologies (eg, dual-pump systems, active/forced infusion, rigid tubing) in your surgical practice?

a. Limited access to advanced phaco platforms in my OR
b. Lack of training or familiarity with dual-pump fluidics
c. Concern about surgical safety when using newer fluidics modes
d. No significant barriers to implementation in my practice

4. A cataract surgeon performing high-volume phacoemulsification reports leg, wrist, and arm pain following long surgery days. Which innovations most directly address these concerns?

a. A dual-linear foot pedal with smaller excursion, and dual-durometer tubing
b. Pliable tubing, and a universal-fit foot plate to accommodate multiple surgeons
c. A single-linear control foot pedal with larger increments, and rigid tubing
d. A fixed-angle handpiece tip, and foot-pedal-controlled irrigation switch

5. How likely are you to integrate ergonomic enhancements (eg, heads-up displays, swivel handpieces, updated foot pedals) into your surgical practice to reduce fatigue and improve precision?

a. Not likely at all
b. Slightly likely
c. Moderately likely
d. Very likely

6. During cataract surgery on a dense nucleus with weak zonules, the surgeon begins with a chop technique. Which intraoperative fluidics strategy provides the best balance of holdability and efficiency throughout the case?

a. Remain in venturi mode throughout the case for speed and followability
b. Switch from peristaltic mode during chopping to venturi mode for fragment removal
c. Use peristaltic mode exclusively to maximize occlusion and chamber stability
d. Alternate between venturi and peristaltic randomly to avoid fluidics surges

7. How confident are you in your ability to adjust phaco machine settings (eg, power modulation, pump mode) to manage complex cataracts?

a. Not confident at all
b. Slightly confident
c. Moderately confident
d. Very confident

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Expiration Date: November 2026

INSTRUCTIONS FOR CREDIT

To receive credit, you must complete the **Pretest/Posttest/Activity Evaluation/Satisfaction Measures** Form and mail or fax to Evolve Medical Education LLC, 1301 Virginia Drive, Suite 300, Ft. Washington, PA 19034; Fax: (215) 358-0556. To answer these questions online and receive real-time results, go to https://evolvemeded.com/segment/37680/. If you experience problems with the online test, email us at info@evolvemeded.com. *NOTE: Certificates are issued electronically.*

Please type or print clearly, or we will be unable to issue your certificate.

Full Name_____ DOB (MM/DD): _____

Phone (required) _____ Email (required*) _____

Address/P.O. Box_____

City _____ State/Country _____ Zip _____

License Number:_____OE Tracker Number:_____National Provider ID:_____

*Evolve does not share email addresses with third parties.

CME EVALUATION FORM

Your responses to the questions below will help us evaluate this activity. They will provide us with evidence that improvements were made in patient care as a result of this activity.

1. Years in practice:
☐ <1 ☐ 1–5 ☐ 6–10 ☐ 11–15 ☐ >15

2. Primary practice setting:
☐ Academic hospital ☐ Community hospital ☐ Private practice ☐ Outpatient facility ☐ Government ☐ Other:

3. Please select the extent to which you agree/disagree with the following:	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I am satisfied overall with the activity (ie, design/content)	5	4	3	2	1
I would recommend this program to my colleagues	5	4	3	2	1

4. Please indicate the extent to which you agree that the activity/faculty supported the achievement of the learning objectives:	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Manage machine fluidics to enhance chamber stability and minimize complications during cataract surgery	5	4	3	2	1
Assess ergonomic innovations in phacoemulsification systems that reduce surgeon fatigue and improve procedural precision	5	4	3	2	1
Propose surgical techniques for managing complex cataracts	5	4	3	2	1

CME EVALUATION FORM (continued)

Your responses to the questions below will help us evaluate this activity. They will provide us with evidence that improvements were made in patient care as a result of this activity.

5. How confident are you in applying the information from this activity to clinical decision-making/practice? 5 = High, 1 = low
☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1

6. How much of this content is new to you?
☐ <25% ☐ 25%–50% ☐ 51%–75% ☐ 76%–100%

7: How do you rate your knowledge/skills before and after participating in the program?	High				Low
Rate your knowledge/skill level *before* participating in this course.	5	4	3	2	1
Rate your knowledge/skill level *after* participating in this course.	5	4	3	2	1
What is the probability of making a change in your practice as a result of this activity?	5	4	3	2	1

8. As a result of participating in this activity, I anticipate my practice will be improved in the following areas (select all that apply):
☐ Assessment
☐ Differential diagnosis/diagnostic testing
☐ Treatment
☐ Patient education
☐ Shared decision-making
☐ Team-based care
☐ Interpersonal communication
☐ Adoption of new therapy
☐ Adoption of updated or new guidelines
☐ Enrollment of patients in clinical trials

9. What barriers might prevent you from implementing changes? (Select all that apply):
☐ Time constraints
☐ Insurance/financial issues
☐ Formulary restrictions
☐ Lack of support from the care team
☐ Lack of patient-assistance programs
☐ Patient compliance issues
☐ Lack of guidelines or consensus
☐ I don't anticipate any barriers to implementing changes

10. I'm applying some or all of the knowledge and skills gained from this activity in my practice.
☐ Yes
☐ No

11. What changes did you make in your clinical practice due to this activity? (select all that apply):
☐ Modify diagnostic approach
☐ Initiate new treatment options
☐ Improve patient communication/care
☐ Improve team communication/practice improvement
☐ Address treatment adherence
☐ Other_____

12. How many patients' lives do you think you will impact over the next 30 days based on the knowledge you acquired or that was reinforced by this program?
☐ 0
☐ 1-15
☐ 16-30
☐ 31-50
☐ 51-100
☐ >100

13. The activity demonstrated fair balance.
☐ Yes
☐ No

14. Was there any specific patient interaction or clinical moment where this education influenced your approach?_____

15. Can you tell us what other programs/content you would like to see?_____

16. Your feedback is so important and has a direct impact on future education. May we contact you by email with 3 follow-up questions to inquire about the changes you made to your practice as a result of this activity? If yes, please list your email:_____