The Influence of New Technology

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WILLIAM J. FISHKIND, MD

The past few years have brought the introduction of noteworthy new phaco technologies that have altered the way we surgeons analyze and execute the procedure. To better understand these advances, we must partition phacoemulsification into its components of power and fluid. The former is characterized as the combined effect of cavitational and jackhammer energy (the debate over the role of cavitational energy is beyond the scope of this discussion).

The fluidic element of the procedure includes the management of vacuum and flow. When the fragment is adjacent to the phaco tip during emulsification, it obstructs the inflow of fluid and allows vacuum to increase to the preset maximum (defined as occlusion). The instant of occlusion is a critical dividing point in the procedure. The act of removing the fragment can therefore be divided into preocclusion phacoemulsification, occlusion, and postocclusion phacoemulsification (Figure 1A).

In the past, we performed the majority of the procedure with occlusion inevitably followed by postocclusion phacoemulsification. Every occlusion resulted in a surge, which we came to accept, albeit unhappily.

Micropulse phacoemulsification is a revolutionary power modification composed of extremely short bursts of phaco power, for use even with hard nuclei. This technology and torsional phacoemulsification have shown us that we can emulsify the fragment near the tip without total occlusion. As a result, there is rarely an occlusion or surge. If we perform phaco chop, we create multiple fragments early in the procedure. We remove these fragments with low amounts of power in stable anterior chambers (Figure 1B).

If we take an expansive look at the new phaco technologies, their major effects are to permit the phacoemulsification of fragments in the preocclusion phase and therefore avert postocclusion surge.

STEVEN DEWEY, MD

Six years ago, the introduction of the original Whitestar micropulse technology (Advanced Medical

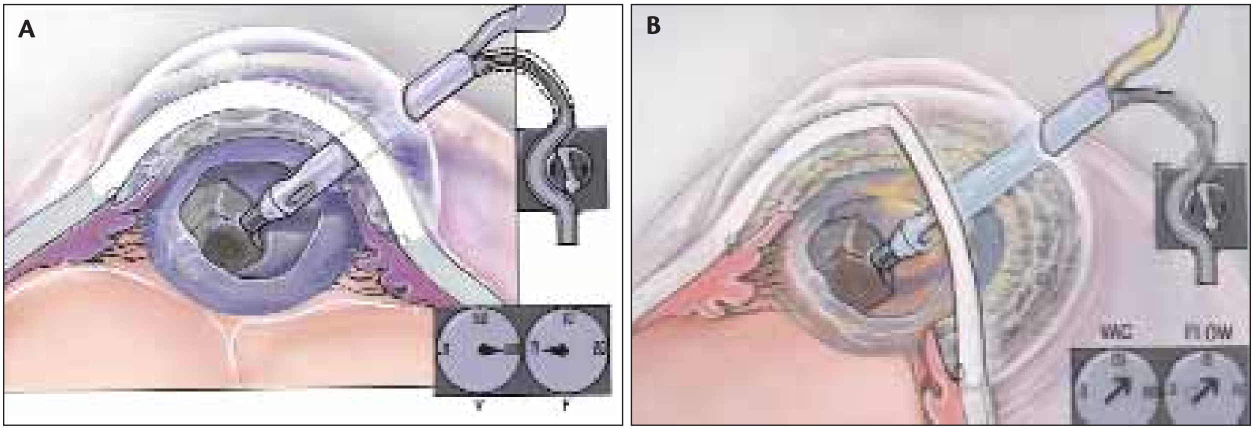

Figure 1. The fragment occludes the phaco tip. There is full vacuum and no flow. When phaco power is energized, the fragment is emulsified, resulting in greater outflow through the phaco tip than inflow, a situation that inevitably leads to surge (A). The fragment is near the phaco tip but does not occlude it. There is always partial vacuum and flow. Without occlusion, there is no surge, and the anterior chamber remains deep (B). (Reprinted with permission from Fishkind WJ, ed. *Complications in Phacoemulsification: Avoidance, Recognition, and Management*. 1st ed. New York, NY: Thieme Medical Publishers; 2002.)

Optics, Inc., Santa Ana, CA) ushered out the remnants of traditional longitudinal phacoemulsification by significantly reducing chatter, turbulence, and instability of the chamber seen with older phaco systems. With the latest Whitestar ICE technology (Advanced Medical Optics, Inc.) upgrade, three features now transform the micropulse power delivery: micropulse shaping; variable duty cycle power delivery; and chamber automated stabilization environment (CASE; Advanced Medical Optics, Inc.).

The benefits of the original Whitestar Technology in reducing effective phaco time are well known.[1] My own measurements comparing Whitestar generations show further gains with the ICE technology. Using a nonstop horizontal chop, my effective phaco time has decreased by 40% for a 2+ nuclear sclerotic cataract and by 20% for a 3+ cataract. By reviewing digital video, I can measure the time from the phaco needle's insertion to its removal. I find my phaco needle is a few seconds more efficient with the Whitestar ICE technology than the original technology.

To understand how my surgical efficiency improved, I wanted to evaluate how the equipment interacted with my technique. While reviewing hundreds of surgical videos using the Whitestar ICE technology, I observed virtually no surge, turbulence, or chatter; far less bouncing of the chamber; and impressive followability of particles.

I believe the Whitestar ICE technology allows me to attack the point of occlusion instead of hesitantly engaging the material. I use vacuum much more effectively to shear the nucleus apart and achieve occlusion prior to applying power. As occlusion breaks, I no longer depend on my response with the foot pedal to release vacuum and prevent surge or on my placement of a second instrument against the capsule to prevent its engagement with the tip. Instead, I work as comfortably with the last quadrant as I did the first. This technology allows me to remove the nucleus efficiently without having to anticipate the limitations of the equipment.

ROBERT J. CIONNI, MD

Just when I think that cataract removal technology cannot improve further, something revolutionary knocks my socks off. The introduction of Ozil torsional phacoemulsification (Alcon Laboratories, Inc., Fort Worth, TX) is one of the most impressive advances that I have witnessed during the last decade.

Traditional phacoemulsification is characterized by a longitudinal motion of the phaco tip along its long axis. The forward striking movement of the sharp metal tip emulsifies the nucleus of the cataract. This force, however, also encourages the movement of nuclear material away from the tip, thereby requiring higher vacuum levels and aspiration rates as well as power modulations to keep nuclear material from chattering away. Additionally, because the tip only cuts with a forward movement, the 50% of the time that it is moving backward is wasted energy that generates potentially harmful heat.[2]

> "Torsional phacoemulsification emulsifies in both the to and fro directions and thereby does not waste energy."
> —Robert J. Cionni, MD

Torsional phacoemulsification is characterized by an oscillatory motion around the long axis of the phaco tip. This motion generates sufficient energy to emulsify the nucleus but has several advantages over traditional longitudinal ultrasound. First, the oscillatory motion does not encourage the chattering of lenticular material.[3] Followability is therefore markedly improved. Second, torsional phacoemulsification emulsifies in both the to and fro directions and thereby does not waste energy. The rotational movement induces less frictional heat at the incision as well. The net result is lower energy delivered and less risk of thermal damage to the incision (data on file with Alcon Laboratories, Inc.).

I have found that the best-performing tip for Ozil torsional ultrasound is the tapered Kelman tip (Alcon Laboratories, Inc.) through a 2.7- to 3.0-mm incision. With traditional longitudinal ultrasound, a strong holding force is needed to prevent lens chatter, and a high aspiration rate is needed to improve followability. With Ozil torsional phacoemulsification, I decrease the vacuum from 500 to 350 mm Hg and the aspiration rate from 40 to 25 mL/min. Because the vacuum level and aspiration rates are lower, I can also decrease the bottle's height to 90 cm without inducing volatility in the chamber. Finally, I no longer need to rely on power modulations and simply set the torsional amplitude on linear continuous control. These settings work well with chopping or dividing techniques.

Torsional ultrasound has increased my safety profile for cataract removal while simplifying my technique so much that it feels like cheating.

ALAN S. CRANDALL, MD

Phacoemulsification has progressed since its introduction more than 40 years ago by Charles Kelman, MD. Technical advances such as the continuous curvilinear capsulorhexis have improved outcomes. Understanding the lens' anatomy led to different techniques of disassembly (including divide and conquer and various forms of chopping) that have improved the safety of the procedure and reduced the risk of capsular rupture.

New phaco software to increase surgical safety has included measures to reduce surge and pulse and burst modes to decrease the energy delivered. A better understanding of the combination of aspiration flow, vacuum, and ultrasound power with all the available phaco units has increased procedural safety and improved outcomes. Research into alternate methods for removing the lens (eg, lasers and water jets) has yet to replace traditional phacoemulsification, however.

> "The next frontier ... is the delicate balance of fluidics within the confines of the anterior segment."
> —Uday Devgan, MD

Traditional phacoemulsification uses longitudinal motion of the phaco tip to emulsify the lenticular material. The frequency of the tip varies with different units from the middle 20,000s to 46,000 cycles per second. Heat is produced with this motion, and fluid is used to lower the risk of burns to the cornea and iris. With the longitudinal motion of the tip, there is a repulsive force that can decrease the efficiency of the procedure. Part of the art as well as the science of the phaco procedure is using various modes, flows, and phaco powers to effectively remove cataracts of different hardness safely and with the least amount of energy and fluid. Alterations to phaco tips have allowed further variations in technique.

In the 1990s, the Neosonix tip (Alcon Laboratories, Inc.) had a 2º oscillation along with longitudinal phacoemulsification, but the oscillation was very slow at a few oscillations per second. The theory was that the movement would help prevent occlusion, so it was helpful in divide and conquer techniques or anytime that nuclear material was being removed due to improved flow.

Torsional phacoemulsification involves an ultrasonic torsional motion (33,000 cycles/sec) that significantly improves the followability of nuclear material. The technology can use variations such as pulse and burst modes to further reduce potential heat-related complications and surge. The Ozil handpiece permits surgeons to use longitudinal (traditional) phacoemulsification for hard nuclei or for their comfort during the transition to full-time torsional phacoemulsification.

The torsional motion reduces friction at the incision,[4] which should lower the risk of wound burn. The small phaco tip (0.9 mm) and the torsional motion work well for 2.2-mm microincisional phacoemulsification.

I currently use Ozil torsional phacoemulsification almost exclusively. The followability of nuclear fragments allows me to reduce vacuum to 300 mm Hg and aspiration flow to 38 mL/min. I am still learning about the intricacies of the new technology and how to use the system most efficiently.

UDAY DEVGAN, MD

The current phaco platforms have successfully made the use of phaco power modulations the standard of care. This decrease in phaco energy has resulted in less endothelial cell damage, a near-zero rate of phaco wound burns, and patients happy with their clear corneas and minimal inflammation immediately after surgery. The new machines have not significantly decreased the rate of posterior capsular complications, however, because the inadvertent rupturing of the capsule is most often due to issues of fluidics and not ultrasonic power.

The next frontier for safety and efficiency in cataract and IOL surgery is the delicate balance of fluidics within the confines of the anterior segment. As surgeons transition to refractive cataract surgery, they require an increased level of stability, followability, efficiency, and, most importantly, safety to deliver the expected outcomes for patients. Fluidic balance is the key.

The Stellaris Vision Enhancement System (FDA approved; Bausch & Lomb) delivers a superb balance of fluidics. The system includes new-generation fluid pumps, customized control software, options for advanced surgical control, and high-vacuum restrictive phaco tubing. The results are rock-solid stability of the anterior chamber during surgery, an efficient phaco procedure with magnetic followability, and a large margin of safety. I have found that the fluidic control and balance are outstanding and fully integrated into a true next-generation system. Whether the surgeon favors a bimanual or coaxial approach, flow-based or vacuum-based surgery, a divide-and-conquer or phaco chop technique, the Stellaris Vision Enhancement System delivers the performance and fluidic control that empowers ophthalmologists and benefits the patient. ■

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