The Differences in My Phaco Technique With Laser Cataract Surgery

These surgeons acknowledge that adoption of a femtosecond laser system requires a learning process, but the benefits make it worthwhile.

BY FRANK A. BUCCI JR, MD; MING CHEN, MD, MSc, FACS; H. BURKHARD DICK, MD, PhD; AND PAVEL STODULKA, MD

FRANK A. BUCCI JR, MD

My experience using femtosecond technology for cataract surgery is somewhat atypical. Many private practices in the United States acquire this technology as part of an overall marketing strategy to attract more patients to their practice, and perhaps also to enhance their outcomes with an increasing percentage of premium IOL patients. However, I have been using the LensAR Laser System (LensAR) in the developing world, at my eye institute in Lima, Peru. How this technology has changed my phacoemulsification technique has been significantly influenced by the types of cataracts encountered in this setting.

In the United States, surgeons in private practice with the latest femtosecond technology are likely to attract demanding patients with high expectations. In Peru, however, we are more likely to face a very demanding cataract. Generally, aggressive lens fragmentation has proved to be an invaluable asset when tackling the very dense nuclear cataracts encountered at our institute. More specifically, this technology influences my phacoemulsification technique even prior to commencing with surgery. During the preoperative evaluation, if femtosecond technology is available, I can select phacoemulsification as the procedure of choice, rather than a manual technique (usually a nonphaco, no stitch, 6.5-mm, manual procedure), when confronting very dense nuclear sclerotic cataracts.

A high free-floating capsulotomy rate (98%-99%) has also influenced my pre- and intraoperative decision-making. For example, if a patient presents with an extremely dense, all-white cataract with fair pupil dilation, it is comforting to know that I can achieve a perfect 5.25-mm capsulorrhexis prior to beginning phacoemulsification. Similarly, we have been able to complete flawless capsulotomies under short-term sedation in otherwise uncooperative patients who may have been unlikely to remain relatively still for a traditional phaco procedure on a rock-like cataract. The completed capsulotomy without tags instills confidence in the surgeon before proceeding with phaco in these patients who may become spontaneously uncooperative.

MAXIMUM LENS FRAGMENTATION

In recent years, in both the United States and Peru, I have increasingly used a surpracapsular technique for disassembling the nucleus during phacoemulsification, as opposed to chopping or divide-and-conquer techniques. Maximum femtosecond lens fragmentation greatly facilitates a surpracapsular technique when the dense nuclei are disassembled from outside to inside using a high-vacuum venturi system. Laser lens fragmentation treats the area of greatest pathology and significantly reduces the points of greatest resistance to efficient, rapid, and safe phacoemulsification.

I have observed that the most effective nuclear fragmentation pattern is a combination of pie cuts and concentric circles (Figure 1). Previously rock-like cataracts for which phacoemulsification was insufficient can now be safely emulsified with a femtosecond fragmentation pattern that combines 16 pie cuts with four concentric circles. In addition to increasing the percentage of
cases amenable to phacoemulsification, this technology reduces the risk profile for complications at each level of cataract severity. For example, postoperative corneal edema and the risk for clinically significant endothelial cell damage are clearly reduced. Less phaco energy is used in patients with Fuchs endothelial dystrophy, and I can remain aggressive with high-vacuum venturi phaco when attacking the core of the nucleus, knowing that the fragmentation pattern is in place.

CUSTOMIZED PATTERNS

Some surgeons who prefer chopping find that the concentric circles of lens fragmentation with the femtosecond laser do not support an inside-out chopping technique. When attempting to create their cleavage planes, the nuclear segments frequently crumble before chopping of the nuclear segment is complete. Creation of customized fragmentation patterns is possible with the LensAR system. Eliminating the concentric circles and applying full energy to a pies-only pattern (Figure 2) can relieve the frustration of these chopping aficionados. Four, six, eight, or 16 pie segments can be created to facilitate the surgeon’s personal preference.

When I am performing a chopping technique on a very dense Peruvian cataract, I still choose to include the concentric rings in my fragmentation pattern because it facilitates the efficient removal of the chopped segments, which do not crumble because of the extreme density of the nucleus.

The use of femtosecond technology decreases phacoemulsification time; however, it increases the time for cortical removal early in the learning curve. Frequently, a thinner, more adherent cortical layer—without easily engaged irregular peripheral cortex leaflets—is present after the nucleus and epinucleus have been removed. This layer can be so thin and smooth that some surgeons may not recognize that cortex is still present. The learning curve for this has been relatively steep. I have found that manual irrigation and aspiration with a Simcoe I/A cannula has been invaluable in removing this unusual presentation of cortex. The Simcoe adapts well to a blind pass under the pupil or capsular edge to fish out cortex without disrupting zonules. It is especially effective through the paracentesis site for removing subincisional cortex.

CONCLUSION

Femtosecond laser lens fragmentation has greatly reduced the risk profile of the very dense nuclear sclerotic cataracts encountered in Peru. Our preferred technique was not greatly altered because the core laser fragmentation of the nucleus significantly enhances the outside-to-inside approach of the supracapsular technique. The flexibility to customize the fragmentation pattern also allows the surgeon to make chopping and divide-and-conquer techniques safer and more efficient.

It is somewhat ironic that the least technologically advanced population of Peru’s poor has served to unveil, reveal, and accentuate the true value of this remarkable paradigm shift in technology for the extraction of cataracts.

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MING CHEN, MD, MSc, FACS

The birth of laser cataract surgery can be dated to 2009, when Zoltan Z. Nagy, MD, of Semmelweis University in Budapest, evaluated and described the ability of the LenSx femtosecond laser system (now Alcon Laboratories, Inc.) to perform anterior capsulotomy and lens fragmentation and to create self-sealing corneal...
incisions.\textsuperscript{1,2} For surgeons converting from conventional phacoemulsification to laser phaco, however, there is still a learning curve due to significant differences in technique with the new femtosecond technology.\textsuperscript{3}

This paper describes the differences in my technique, including the learning process of using the LenSx for incision creation and nucleus fragmentation before phacoemulsification. This learning process is the first important step to ensure successful phaco after the preliminary laser procedures.

**TRAINING AND SELECTING PARAMETER SETTINGS**

I received training with the LenSx upon installation of the laser at my center in January 2012. I attended two Alcon seminars and twice visited Samuel Masket, MD, in Los Angeles, to observe his technique with the LenSx. Additionally, I watched several videos of LenSx phaco procedures performed by different surgeons. The LenSx Provider Portal (lensxportal.com) community forum provides great resources for learning.

My preferences for the parameter settings on the LenSx at my center have been continually updated to accommodate my phaco technique. For example, my anterior capsulotomy size has changed from 4.9 to 5.2 mm to allow easier performance of a supranucleus phaco technique. My fragmentation pattern has also changed, to cylinder-only at a diameter of 3.5 mm, because I do not use a divide-and-conquer technique. Primary and secondary cataract incisions have been moved from the default location at the limbus to 1.0 mm outside the limbus to avoid corneal edema.

**ORIENTATION, DOCKING MANEUVERS**

Limbal relaxing incisions (LRIs) are carefully aligned with preoperative markings at 90° and 180°. The opening of the incisions can be adjusted on the operating table by using intraoperative wavefront aberrometry with the Optiwave Refractive Analysis System (ORA; WaveTec Vision) to tailor the quantity of cylinder power and ensure the correct axis.

The new, smaller cone of the patient interface (PI) has significantly increased the success of docking, particularly in small eyes. For successful docking, the patient’s cooperation is essential; the centration of the PI depends on patients’ fixation on the light source without excessive attempts to close their eyes. Positioning of the head level to the floor without tilt can help to achieve proper centration of the pupil. Docking should be accomplished quickly to avoid patient blinking. A speculum should be utilized to open the lid widely to give space for the PI to dock.

After all these elements are checked and the laser parameters are properly registered, the laser procedures can then be initiated and completed.

I prefer mild sedation such as oral diazepam given 30 minutes before the procedure, rather than midazolam intravenous injection. The latter tends to over-sedate quickly and induce paradoxical eye and body movement in some patients. Laser cataract surgery requires some degree of cooperation from the patient.

**DIFFERENCES IN PHACO**

Several differences can be noted in performing phaco after LenSx as opposed to traditional phaco.

Most of the time, the wound can be opened with a spatula (Slade Femtosecond Spatula; ASICO, LLC) or a Sinskey hook rather than the diamond blade used in conventional phaco. The capsulorrhexis can be easily completed by gentle teasing away from the laser cut without stressing the zonules. Hydrodissection is usually smoother than in conventional phaco because air bubbles (pneumodissection) are created by the laser behind the nucleus. Also, because of the presence of the air bubbles, the nucleus can be dislocated anteriorly for supranucleus phaco.

The adoption of the LenSx has not required me to change my supranucleus phaco technique. In fact, I have found that supranucleus phaco is easier and safer with the LenSx compared with a conventional phacoemulsification technique. The smooth dislocation of the nucleus, the reduction of damage to the endothelium with lower phaco energy use, and the well-protected posterior capsule all can help to decrease the complication rate and increase the rate of good visual outcome after surgery.

At the end of phaco with the use of the LenSx laser nucleus fragmentation, the posterior capsule is usually coated with a thin layer of cortex, which acts to protect the posterior capsule during phacoemulsification. However, it can be daunting to remove. I have developed a technique to safely remove the thin cortex without breaking the capsule by alternating polishing mode and I/A mode. The low flow and vacuum of polishing mode helps to dislodge the thin cortex, which is then aspirated in I/A mode. This technique has been described in a video that is available at eyetube.net/?v=fevof.

**CONCLUSION**

I am proud to be able to provide the top-notch technology of laser cataract surgery to my patients with
the LenSx. Laser cataract surgery is neither easier nor faster than conventional phaco surgery; however, it does provide better safety and outcomes.

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H. BURKHARD DICK, MD, PhD

Adoption of the Catalys Precision Laser System (OptiMedica Corp.) has enhanced my phacoemulsification technique. The results I can now deliver in a broad population of cataract patients are directly attributable to new techniques made possible with the Catalys.

ELIMINATE ULTRASOUND ENERGY

Safety in cataract surgery starts with a precise and fast capsulotomy, and I have achieved a 99% capsulotomy completion rate in my first 1,000 cases with the Catalys. Using a 350-µm grid-softening pattern automatically optimized to fill the lens volume in diameter and thickness (Figure 3), I have eliminated the use of ultrasound energy, with 0.0 effective phaco time in cataracts preoperatively graded as LOCSIII 3.2 ±0.9 (Figure 4).1-3

After lens softening with the Catalys, I use the Stellaris (Bausch + Lomb) with a standard microflow needle (inner tip diameter, 0.91 mm decreasing to 0.51 mm at the end of the tip; angulation, 30º at the opening). My bottle height is 100 cm, about 40 cm higher with laser-pretreated eyes than my standard technique. I skip through my initial phaco settings to Phaco2 with high vacuum and zero ultrasound, with maximum venturi vacuum at 600 mm Hg.

During phacoemulsification, I remove the supra-nuclear cortex with aspiration and perform a stop-and-chop technique along the laser segmentation with the Neuhann Manual Chopper (Geuder AG) inserted through one paracentesis. Initially, I aspirated the presoftened nucleus using only the phaco tip described above; I now use a bimanual technique. Residual cortex removal and posterior capsular polishing are also per-

formed through the nasal and temporal incisions using bimanual irrigation and aspiration.

SURGICAL ADVANTAGES, BETTER OUTCOMES

In my experience, lens presegmentation with the Catalys is more effective than prechopping. I have easier access to the nucleus and use fewer manipulations of the phaco probe, which seems to induce less zonular stress and is an important factor in cases of pseudoexfoliation and weak zonules. By eliminating ultrasound energy during lens removal, there is less stress on the cornea, endothelium, and incisions, and less risk for macular edema.

Another key difference is my ability to use high-resolution, full-volume optical coherence tomography (OCT) images to inform my intraoperative decision-making (Figure 5). For example, on OCT of a patient treated following an intravitreal injection, I noticed a small perforation of the posterior capsule before surgery. Thus, I avoided extension of the posterior perforation and implanted the IOL successfully with posterior optic buttonholing. In cases of mature morgagnian cataracts, I can observe the pressure of the lens so I can anticipate surgical challenges after I enter the eye. General awareness of the lens thickness and anterior chamber depth, especially in shallow chambers, allows me to dedicate more
attention to surgical technique, and lens softening provides extra visual indication when I am approaching the posterior region of the capsular bag during lens removal.

PNEUMODISSECTION AND CORTEX REMOVAL

Because laser lens softening creates gas, pneumodissection and easy rotation of the lens are possible. In about 20% of cases, I do not need hydrodissection to mobilize the lens for rotation. If it is needed, however, I use my standard technique but with less balanced saline solution. I have not experienced capsular block syndrome, possibly because specifications of the Catalys result in little gas being formed in the capsular bag, even with an extensive fragmentation pattern (video available at youtube.com/watch?v=2W3Exdt8oFY&feature=plcp).4

Cortex removal with bimanual irrigation and aspiration is the same as in my standard technique. I am able to reach under the anterior capsular surface and easily grab the cortex with good followability into the aspiration tip. For a related video, visit eyetube.net?v=bebeg.

NEW TECHNIQUE

I am able to eliminate ultrasound in many cases, so I can now perform small-incision surgery solely with bimanual irrigation and aspiration. The flexibility to individually customize corneal incisions with Catalys allows me to create two multiplanar paracentesis incisions (0.8 mm wide) for my bimanual approach and a separate multiplanar primary incision (2.75 mm) for IOL injection (video available at youtube.com/watch?v=jF8HbwN_X78&feature=plcp). I bluntly dissect small tissue bridges through the laser paracentesis, remove the completely cut capsulotomy, hydrodissect as usual, remove the presoftened nucleus with irrigation and aspiration, remove residual cortex, and polish, and then open the primary cataract incision for IOL injection with blunt dissection. This provides better surgical control and limits the wound trauma, as I do not need to enlarge the incision between phacoemulsification and IOL injection. Additionally, it may provide even more predictable surgically induced astigmatism.

I have designed a new aspiration device with a greater opening, as currently available aspiration tips often clog with laser-softened lens pieces. With a larger opening and different nonflare design, it allows me to more consistently aspirate presoftened nucleus.

CONCLUSION

In my first 1,000 cases with Catalys, I have been able to eliminate ultrasound energy during removal of cataracts of all densities and use a new surgical technique. Due to the effectiveness of lens fragmentation and softening with the Catalys, I have seen faster visual recovery after surgery and statistically significantly superior BCVA in the early postoperative period.

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PAVEL STODULKA, MD, PhD

After becoming the first European user of the Victus laser (Technolas Perfect Vision GmbH and Bausch + Lomb), I have performed more than 1,000 laser cataract surgeries using the laser and the Stellaris PC (Bausch + Lomb) platforms. Videos of my surgical technique can be viewed at eyetube.net/?v=zugoo and eyetube.net/?v=hineg. The first difference in my surgical technique is that I use a limited amount of ophthalmic viscosurgical device (OVD)—just enough to not completely lose the chamber and to form a layer protecting the endothelium.

Another big change is that I no longer need to use capsulorhexis forceps to handle the anterior capsule. The quality of the capsulotomy enables me to remove the central capsule safely and reliably with the phaco tip, whether the central capsule is free-floating (Figure 6), free-lying, or still attached centrally. I enter the anterior chamber with a sleeved phaco tip through a 1.8-mm incision and aspirate the central anterior capsule, moving the tip circularly and pulling the capsule anteriorly. This is enough to detach the central capsule from the periphery, even in rare cases of capsular tissue bridges. The capsule is then aspirated through the phaco tip, sometimes with the help of a single ultrasound burst. I have rarely seen minor irregularities of the capsulotomy edge (Figure 7); however, these do not show a tendency to form a radial tear during the subsequent surgery.

The next step is aspiration of anterior cortex inside the capsulotomy area, after which I dip the phaco tip into the fragmented nucleus. Then, while I lift the nucleus with full aspiration (600 mm Hg), I perform limited hydrodissection through the sideport incision. Hydrodissection is facilitated by pneumodissection (ie, gas bubbles created during laser lens fragmentation).

I use a combination laser-fragmentation technique—a pattern of two cylinders and four radial arms—extending across up to 8.0 mm of the optical zone, but automatically limited by the patient’s pupil diameter. The fragmentation, therefore, extends beyond the capsulotomy diameter. Laser fragmentation can come as close as 200 µm to the posterior capsule thanks to online OCT monitoring of the entire procedure. The central nucleus is then lifted (Figure 8) and aspirated with a limited amount of ultrasound. Typically, I need about 50% of the phaco power I use with a conventional ultrasound technique. Removing the central cylinder of nucleus allows me to pull each of the four lens quadrants using little to no rotation. I then dip the phaco tip into one of the lower quadrants and pull it toward the center of the capsular bag, with full aspiration, to phacoaspirate it. The other quadrants follow.

After the nucleus and epinucleus have been removed, I
still like to aspirate most of the cortex with the phaco tip, as the material goes faster through the tip’s wider opening. The remaining cortex is aspirated with biaxial cannulas placed in the sideport incisions. After cleaning the posterior capsule, the eye is ready to receive the IOL. I usually inject the lens through an unenlarged incision using a wound-assisted technique with a biaxial cannula through a sideport incision. There is almost no need to aspirate the OVD from the eye.

Since implementing laser cataract surgery, I have begun to implant multifocal IOLs more frequently, as the precise circular capsulotomy decreases the risk of IOL dislocation due to asymmetrical capsular contraction. I prefer diffractive IOLs, including the Versario (Croma), EyeDiff (EyeolUK), Acriva Reviol (VSY), and the trifocal FineVision (PhysIOL). I implant few toric IOLs, as we treat astigmatism mostly by creating arcuate laser incisions on the cornea. The arcuate laser cuts are more precise compared with manual incisions in terms of position, shape, length, and depth. When these laser relaxing incisions are performed on stable corneas, the results seem to be accurate and reliable with up to 1-year follow-up.

Sometimes I read or hear advertising claiming that laser cataract surgery is superior to ultrasound surgery. However, I believe the emphasis should be on the combination of laser and ultrasound, as this technique is still a manual surgery vastly dependent on a surgeon’s skills. Nevertheless, it is possible to perform no-ultrasound cataract surgery on selected eyes with a special surgical modality called all-laser or dual-laser, no-ultrasound cataract surgery. In this technique, we perform incisions, capsulotomy, and lens fragmentation with the Victus and then emulsification with a disposable intraocular laser probe manufactured by ARC Laser (Figure 9). The laser hits a titanium target inside the probe and generates shock waves to facilitate emulsification. This method is suitable for cataracts up to grade 3 only.

High-volume laser cataract surgery has made my surgery more precise and safer.

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