

FEMTODELINEATION IN POSTERIOR POLAR CATARACTS

A new laser cataract technique is helpful in these challenging cases.

BY ABHAY R. VASAVADA, MS, FRCS, AND VAISHALI VASAVADA, MS



Posterior polar cataracts always present a challenge to the cataract surgeon due to their propensity to be associated with posterior capsular weakness and posterior capsular rupture (PCR). As techniques, technologies, and

surgeons' understanding of this problem have evolved, PCR rates have dropped from as high as 26% to 36% in the 1990s to between 7% and 8% more recently.¹⁻⁹

Since the advent of laser cataract surgery, the use of femtosecond laser technology is increasingly being reported in various challenging situations. In particular, we find this technology to be invaluable in dealing with posterior polar cataracts. Currently, the laser is widely used to create corneal incisions and lens capsulotomies and to perform nuclear division. We recently described the application of a cylindrical lens division pattern in posterior polar cataracts, a procedure we call "femtodelineation" (see *Femtodelineation: a New Surgical Technique*).¹⁰ This technique can enhance safety and reduce PCR rates in surgery for posterior polar cataracts.

The basic principles of emulsification in posterior polar cataract hold true for this technique

- preventing forward bulge of the capsular-zonular diaphragm
- mechanically cushioning and protecting the weak posterior capsule
- avoiding sudden, rapid buildup of hydraulic pressure inside the capsular bag

ADVANTAGES IN POSTERIOR POLAR CATARACTS

We performed a prospective, observational study in 45 consecutive eyes of 45 patients undergoing cataract surgery for posterior polar cataracts. Using the femtodelineation technique, our PCR rate was 4.4%; that is, two of the 45 eyes had a PCR. Of these, one involved accidental aspiration of the



Figure. Small air bubbles generated by firing of the femtosecond laser, which may not drastically increase intracapsular pressure.

posterior capsule into the aspiration probe during irrigation and aspiration, and in the other, the PCR was noted at the end of nuclear removal. In a previous study, we described the inside-out delineation technique for posterior polar cataract removal,⁹ and in that report, we had a PCR rate of approximately 9%. Thus, we find the femtodelineation technique offers a lower PCR rate and enhanced safety during surgery in these eyes.

In effect, femtodelineation creates multiple nuclear layers or zones that act as shock absorbers during surgery. These shock absorbers prevent the transmission of mechanical forces and fluidic turbulence to the weakest part of the posterior capsule until the end of surgery. Further, since no hydro-based procedures are involved, the risk for buildup of hydraulic pressure within the bag is eliminated.

One of the biggest advantages of using the laser to create nuclear delineation is that it produces extremely well-demarcated and predictable walls of division. These sharp vertical walls separating the layers from each other make removal easy, requiring minimal mechanical maneuvering with the second instrument.

FEMTODELINATION: A NEW SURGICAL TECHNIQUE

Once the laser interface is docked onto the patient's eye, the cylindrical pattern of lens division is selected. The laser is programmed to create three cylinders within the nucleus, with the diameter of the outermost cylinder generally set at 5.5 to 6 mm (Figure 1). The number, depth, and width of the cylinders can be customized depending on the characteristics of each eye. We prefer to leave a safety margin of at least 500 μm from the posterior capsule, guided by the live anterior segment optical coherence tomography incorporated in the laser (Figure 1).

As the laser fires, it first creates the capsulotomy, followed by the generation of the three cylinders within the lens, from inside out (Figure 2). This produces three distinct zones of demarcation within the nucleus, surrounded by a peripheral fourth zone of epinucleus.

The preset laser energy is determined depending on the presence and extent of associated nuclear sclerosis. Typically, posterior polar cataracts are not associated with a significant degree of nuclear sclerosis; therefore, an energy level of 11 mJ with a spot and laser separation of 14 μm is sufficient. However, in cases with associated nuclear sclerosis, higher energy of up to 14 mJ can be used.

Once the laser part of the surgery is completed, the phacoemulsification portion is begun. Immediately after the capsulotomy is removed, lens emulsification can start; no hydrodissection or hydrodelineation procedure is performed. Starting from the innermost layer, each of the sharply laser-demarcated zones is emulsified from inside out (Figure 3), within the cushion of the outer zones. Minimal ultrasound energy can be used, with an aspiration flow rate of 14 to 16 mL/min and a modest bottle height of 60 to 70 cm.

When all three zones have been removed, a thick and uniform epinuclear cushion remains (Figure 4). At the end of this surgical phase, owing to the sharp vertical wall created by the laser circumferentially, removal of this epinuclear cushion is easy. It can be gently stripped from the capsular bag fornices in the two quadrants 180° directly opposite from the phaco tip using a low aspiration flow rate of 14 to

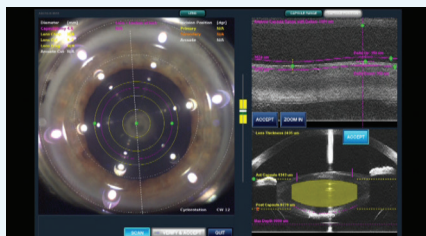


Figure 1. The laser is programmed to create three concentric cylinders in the lens. On the bottom right, anterior segment optical coherence tomography shows the thickness of the lens and the posterior capsule. Based on this information, the surgeon can choose the desired safety margin level so that no collateral damage occurs to the fragile capsule.

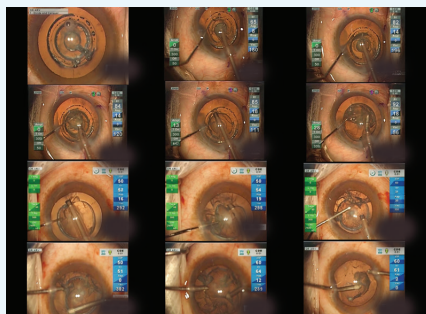


Figure 3. Each layer is emulsified and aspirated. The sharp, demarcated walls allow easy removal with little mechanical manipulation. At the end, a thick, uniform epinuclear layer remains, which is easy to detach.

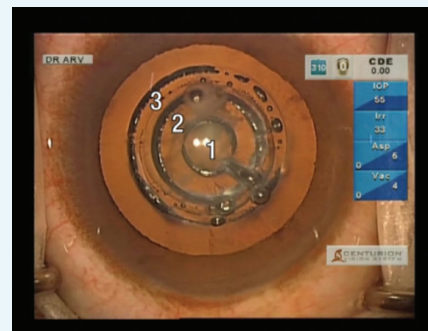


Figure 2. At the end of femtodelineation, there are four distinct zones in the lens: three cylinders protected by a thick, uniform cushion of epinucleus.

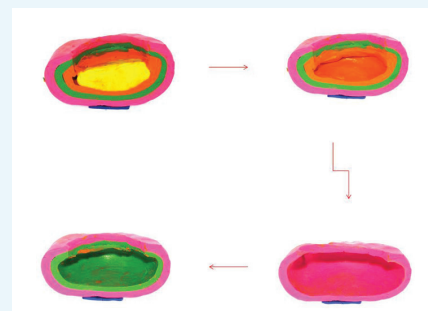


Figure 4. Illustration shows how, as each nuclear layer is removed sequentially, the epinuclear cushion remains, guarding the potentially dehiscent or weak posterior capsule.

16 mL/min, a vacuum of approximately 200 mm Hg and minimal ultrasound energy. At this stage, no attempt is made to completely aspirate the epinucleus.

A dispersive ophthalmic viscosurgical device (Viscoat; Alcon) is injected into the anterior chamber before removal of the phaco probe to prevent forward bulging of the capsular bag. The epinuclear cushion, which is already partially detached, is then detached in the subincisional quadrants using bimanual irrigation and aspiration (Figure 3, bottom row). Once the epinucleus is detached circumferentially, it can be aspirated with irrigation and aspiration; we prefer bimanual as it allows maintenance of a closed chamber at all times and makes removing subincisional epinucleus easier.



AT A GLANCE

- Femtodelineation creates multiple nuclear layers that act as shock absorbers during surgery.
- The customizable, sharp, predictable layers of cushioning protect the posterior capsule until the end of lens removal.
- The femtodelineation technique can also be useful in posterior polar cataracts with an associated dense nucleus, because there is no need for a mechanical division technique that could stress the capsular-zonular complex.

When the last layer of epinucleus is finally removed, gently stripping it off the fornices around 180° creates a plane of separation between the lens material and the posterior capsule. Because a cleavage is created between the epinucleus and the posterior capsule, passage of fluid into this space will not lead to buildup of hydraulic pressure. Therefore, even if there is a preexisting or intraoperative PCR, there is no or minimal enlargement of this rupture. If there is a PCR, the final goal of being able to implant an IOL in the capsular bag can be achieved by converting this small rupture into a continuous posterior capsulorhexis.

Further, unlike with manual techniques, with femtodelineation, the size, number, and depth of the delineated cylinders can be customized by the surgeon depending on the size of the pupil, the size of the capsulorhexis, or surgeon's preference.

The femtosecond laser platform is integrated with a live anterior segment OCT that not only shows the status of the posterior capsule but also allows the surgeon to keep a safety margin from the posterior capsule. This ensures that there is no inadvertent damage to the posterior capsule due to collateral effects of the photodisruption created by the laser.

We have found that femtodelineation is also useful in posterior polar cataracts with an associated dense nucleus. As the nucleus is already predivided by the laser, it is easily debulked without the need for any mechanical division techniques, which could otherwise cause stress on the capsular-zonular complex.

An added benefit with laser cataract surgery is the ability to achieve a well-centered capsulorhexis of a desired size. This helps to ensure better effective lens position; it can also be useful in the event that ciliary sulcus IOL implantation must be performed.

POTENTIAL CONCERNS

There is a concern regarding elevation of intralenticular pressure due to the bubbles generated during laser application. However, we have found that, with the use of

“Unlike with manual techniques, with femtodelineation, the size, number, and depth of the delineated cylinders can be customized by the surgeon.”

low energy settings and greater laser and spot separation, the bubbles generated are small (Figure). These compliant bubbles may not have the capability to produce a dramatic rise in intralenticular pressure.

Capsular block syndrome, resulting in rupture of the posterior capsule, has been reported in the past with laser cataract surgery. However, as understanding of the technology has improved, surgeons are now more cautious when performing hydrodissection, and recently there have been no more reports of this syndrome.

SUMMARY

Laser technology is especially useful in posterior polar cataracts, as it helps to avoid hydro-based procedures and yet provides customizable, sharp, predictable layers of cushioning that protect the posterior capsule until the end of lens removal. ■

1. Osher RH, Yu BC, Koch DD. Posterior polar cataracts: a predisposition to intraoperative posterior capsular rupture. *J Cataract Refract Surg*. 1990;16:157-162.
2. Vasavada A, Singh R. Phacoemulsification in eyes with posterior polar cataract. *J Cataract Refract Surg*. 1999;25:238-245.
3. Fine IH. Cortical cleaving hydrodissection. *J Cataract Refract Surg*. 1992;18:508-512.
4. Masket S. Consultation section. *J Cataract Refract Surg*. 1997;23:819-824.
5. Allen D, Wood C. Minimizing risk to the capsule during surgery for posterior polar cataract. *J Cataract Refract Surg*. 2002;28:742-744.
6. Fine IH, Packer M, Hoffman RS. Management of posterior polar cataract. *J Cataract Refract Surg*. 2003;29:16-19.
7. Lee MW, Lee YC. Phacoemulsification of posterior polar cataracts— a surgical challenge. *Br J Ophthalmol*. 2003;87:1426-1427.
8. Hayashi K, Hayashi H, Nakao F, et al. Outcomes of surgery for posterior polar cataract. *J Cataract Refract Surg*. 2003;29:45-49.
9. Vasavada AR, Raj SM. Inside-out delineation. *J Cataract Refract Surg*. 2004;30:1167-1169.
10. Vasavada AR, Vasavada V, Vasavada S, et al. Femtodelineation to enhance safety in posterior polar cataracts. *J Cataract Refract Surg*. 2015;41:702-707.

Abhay R. Vasavada, MS, FRCS

- director, Raghudeep Eye Clinic, Iladevi Cataract & IOL Research Centre, Gujarat, India
- member, CRST Europe Global Advisory Board
- icirc@abhayvasavada.com
- financial disclosure: research support from Alcon

Vaishali Vasavada, MS

- consultant ophthalmologist, Raghudeep Eye Clinic, Iladevi Cataract & IOL Research Centre, Gujarat, India
- vaishali@raghudeepeyeclinic.com
- financial disclosure: research support from Alcon