

Phacoemulsification of posterior polar cataracts



Gary J.L. Foster, MD, Brandon Ayers, MD, Nicole Fram, MD, Richard S. Hoffman, MD, Sumitra Khandewal, MD, Gregory Ogawa, MD, Susan M. MacDonald, MD, Michael E. Snyder, MD, Abhay Vasavada, MD

Posterior polar cataracts present a unique challenge for the cataract surgeon. This review describes the steps a surgeon can take to overcome these challenges for the successful phacoemulsification of the posterior polar cataract. Proper preoperative examination and diagnostics will allow appropriate preoperative counseling and surgical planning to increase the likelihood of success. Specific techniques for each stage of the procedure are

described, all with the aim of protecting the posterior capsule and preserving intraocular lens (IOL) fixation options. Posterior polar cataracts present dilemmas in preoperative evaluation, surgical management, and IOL fixation.

J Cataract Refract Surg 2019; 45:228–235 © 2019 ASCRS and ESCRS

[▶ Online Video](#)

The incidence of posterior polar cataracts is difficult to confirm because many population studies did not include posterior polar cataracts as a standalone category. In addition, because the Lens Opacities Classification System does not include evaluation of posterior polar cataracts, researchers often categorize them in the posterior subcapsular category. Studies^{1,2} have shown that posterior polar cataracts make up 7% to 8% of non-traumatic pediatric cataract cases.

Posterior polar cataracts have an autosomal dominant inheritance pattern with sporadic nonfamilial mutations reported.³ Several genes that involve altered development of the anterior segment, including the paired-like homeodomain 3 gene (*PITX3*), have been associated with posterior polar cataracts.⁴ Studies describe a mutation in this gene that causes a variation in lens induction and development.⁵

Posterior polar cataract can be associated with or without remnants of the tunica vasculosa.⁶ These cataracts can be unilateral or bilateral, although a review of many case series showed the vast majority are bilateral.⁷ Spontaneous posterior polar cataracts associated with remnants of the tunica are more often unilateral, and the cataracts associated with genetic defects are more likely bilateral.

PREOPERATIVE EVALUATION

Careful preoperative evaluation is key to the recognition of posterior polar cataracts. Once recognized, further testing helps determine the clinical relevance of the finding and assists with patient education, risk stratification, and surgical planning.

One can easily confuse a posterior polar cataract with a posterior subcapsular cataract. However, proper identification of the posterior polar cataract is essential because it carries an increased risk for posterior capsule rupture during cataract surgery.^{8,9} The incidence of capsule rupture varies but can be as high as 26% to 36% of patients.¹⁰ The congenital nature and unique examination characteristics will suggest a posterior polar cataract, and this suspicion can be further confirmed with diagnostic testing.

Posterior polar cataracts are present at birth, although they commonly present to the ophthalmologist when patients are in their 20s or 30s. They have a discoid opaque mass located in the central posterior portion of the lens. The composition of this mass includes malformed and distorted lens fibrils, which might or might not adhere to the posterior capsule. These cataracts can be divided into the following 3 categories: (1) posterior polar cataract without capsule involvement, (2) posterior polar cataract with

Submitted: November 29, 2017 | Final revision submitted: August 28, 2018 | Accepted: September 2, 2018

From the Eye Center of Northern Colorado PC, (Foster), Fort Collins, Colorado, Ophthalmic Partners of PA (Ayers), Bala Cynwyd, Pennsylvania, Advanced Eye Care (Fram), Los Angeles, California, Drs. Fine, Hoffman, & Sims, LLC (Hoffman), Eugene, Oregon, Baylor College of Medicine (Khandewal), Houston, Texas, Perfect Lens LLC and Eye Corps Tufts University School of Medicine (MacDonald), Boston, Massachusetts, Eye Associates of New Mexico (Ogawa), Presbyterian Hospital, Albuquerque, New Mexico, Cincinnati Eye Institute (Snyder), Cincinnati, Ohio, USA; Iladevi Cataract & IOL Research Centre (Vasavada), Ahmedabad, India.

This paper represents the collective wisdom and experience of the Challenging and Complex Subcommittee of the Cataract Committee of the American Society of Cataract and Refractive Surgery in the management of posterior polar cataracts.

Corresponding author: Gary J.L. Foster, MD, 3191 Boundless Lane, Timnath, Colorado 80547, USA. Email: gjfos@gmail.com.

posterior capsule involvement, and (3) spontaneous dislocation.⁷

Posterior polar cataracts can be stationary or progressive. Stationary posterior polar cataracts present with an opacity at or close to the posterior capsule. This has been described as a hockey-puck appearance.^A The opacity in the lens will have a cone-like projection anteriorly from the posterior aspect of the lens. Progressive posterior polar cataracts have an initial appearance similar to that of stationary posterior polar cataracts; however, over time they will have concentric extensions of posterior subcapsular cataract around the original opacity, referred to as riders (Figures 1 and 2). The riders tend to be in the posterior cortex and do not extend as far into the lens as the primary posterior polar lens change.¹¹ In many of these cases, patients will become symptomatic as the cataract progresses and might need surgery at an earlier age.

A comprehensive slitlamp and posterior segment examination will often allow the accurate diagnosis of posterior polar cataract and help the surgeon determine whether there is posterior capsular involvement. The appearance of the target-like or bull's eye cataract can be enhanced by retroillumination. An oil droplet-like appearance of the anterior vitreous should increase suspicion of posterior capsule involvement in posterior polar cataract.¹² At times, the posterior capsule defect can be directly visualized at the slitlamp.⁷ Onion skinning of the posterior plaque can be present as a sign of capsule involvement.¹³

In addition to slitlamp examination, additional technology helps discern whether the posterior capsule is involved in the posterior polar cataract. Anterior segment optical coherence tomography (OCT) has proved helpful in diagnosing preexisting capsule defects.^{14,15} Scheimpflug photography has also been helpful in identifying posterior capsule defects in posterior polar cataracts that lead to a tear-drop sign along the posterior capsule.¹⁶ Ultrasound biomicroscopy can also be used to image the anterior segment. With ultrasound (US), the structures of the posterior capsule can be visualized even in the setting of dense media opacity.

Once the diagnosis of visually significant posterior polar cataract is made, counseling begins. Discussion with the patient or family must go beyond the typical cataract discussion.

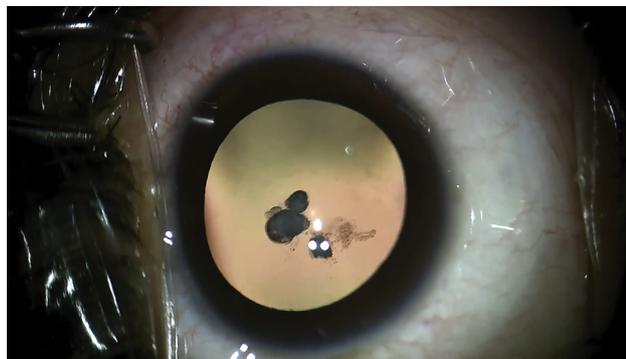


Figure 1. Progressive posterior polar cataract with riders.

The primary concern for any pediatric cataract is the prevention of amblyopia. The need for amblyopic therapy before and after surgery should be discussed with the families of pediatric patients. In one series of the outcomes of posterior polar cataract, amblyopia was the most common reason for patients not achieving ideal vision.¹⁷ A visually significant posterior polar cataract in a patient at the amblyogenic age range requires urgent treatment to prevent visual loss. The concern about amblyopia is heightened when the cataract is primarily unilateral or induces significant anisometropia.¹⁸ Special care must be taken when a progressive posterior polar cataract develops in a young patient because a cataract that does not significantly affect vision could become visually significant over time, causing amblyopia. It is often wise to comanage these patients with a pediatric ophthalmologist to help monitor and treat amblyopia. When evaluating an adult with posterior polar cataract, understanding the patient's visual potential is essential for proper counseling about postoperative visual expectations. It is helpful to know whether the patient had treatment for amblyopia in the past and whether good vision was ever documented in the affected eye or eyes. A history of strabismus or surgery should increase the suspicion of amblyopia.

Part of the preoperative counseling process is to discuss the increased risks patients face in having their posterior polar cataracts removed. These increased risks include a higher incidence of the following: (1) posterior capsule rupture, (2) need for vitrectomy, (3) need for alternative intraocular lens (IOL) fixation strategies, (4) need for multiple procedures, and (5) need for an intraoperative posterior capsulotomy or a postoperative neodymium:YAG (Nd:YAG). Patients have to understand that there might be a prolonged period of visual recovery.

INTRAOPERATIVE CHALLENGES AND TECHNIQUES

In standard cataract removal, surgical techniques assume an intact posterior capsule and that hydrodissection will easily and safely separate the posterior cortex from the posterior capsule. These assumptions are often not valid in

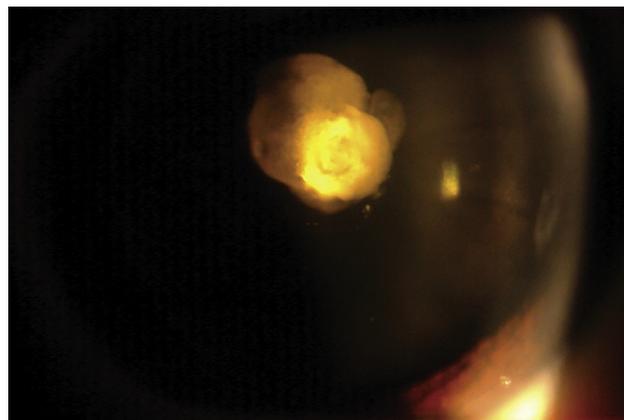


Figure 2. Progressive posterior polar cataract with concentric target appearance.

posterior polar cataract removal because the posterior capsule is often weakened and there might be tight adhesion between the posterior capsule and the cortex. Changes in surgical technique are required to account for these challenges. Although various approaches to remove a posterior polar cataract will be discussed, they all follow underlying principles aimed at minimizing stress, including torsional and tractional stresses, on the posterior capsule.¹⁹

A surgeon must determine whether the patient will be best served by having the cataract removed with phacoemulsification or by a posterior vitreoretinal approach and whether he or she is prepared for the extra risks these cases present. Factors that could influence this decision are the surgeon's comfort with the techniques discussed in this paper, the surgeon's comfort with anterior vitrectomy techniques if vitreous is encountered, the relative availability of vitreoretinal backup if nuclear fragments are lost into the vitreous, the presence of a posterior vitreous separation, and the preoperative assessment of the posterior capsule competency. Using phacoemulsification preserves all the advantages of phacoemulsification and reserves the risks for vitrectomy for those who need it.

Vitreous presentation and nuclear fragment loss are not inevitable in posterior polar cataract cases, even if the posterior capsule is already open, especially if the edges of the posterior capsule opening have fibrosed. On the other hand, if most of the nucleus is dropped, the cataract surgeon might wish, in retrospect, that a primary vitreoretinal approach had been chosen.

In higher risk cases, some surgeons advocate preplacing valved vitrectomy trocars. One advantage of this approach is that it creates easy access for support beneath the nucleus should it begin to slip posteriorly.

We acknowledge the advantages of the preplacement of trocars but in general prefer to place trocars only if a vitrectomy is inevitable or becomes necessary during the case to avoid the risks of trocar placement when possible. Most current phaco machines cannot handle a trocar smaller than a 23 gauge. Use of a 25-gauge trocar usually requires a vitreoretinal machine.

If the primary cataract wound is competent and nuclear dislocation is not an immediate threat, a trocar can be added at any time during the case by elevating the pressure and then placing the trocars. If the nucleus is threatening dislocation, elevating the intraocular pressure (IOP) would not be advisable and a microvitreoretinal blade could be used to enter the posterior segment if a posterior-assisted levitation technique or vitrectomy is contemplated.

Capsulorhexis

Capsulorhexis sizing, centration, and integrity are of greater importance in these cases to maintain the option for sulcus placement of the IOL with posterior optic capture through the anterior capsulotomy in cases in which posterior capsule failure occurs. A capsulorhexis larger than 5.0 mm is inadequate to guarantee sustained optic capture of a 6.0 mm 3-piece posterior chamber IOL (PC IOL). In contrast, with a capsulorhexis smaller than 4.0 mm, it can

be difficult to get the optic through without the risk for traction on the capsule. Obtaining adequate sizing is more difficult because posterior polar cataracts often present at younger ages when the anterior capsule is more elastic and harder to control. Some advocate using vital dyes such as trypan blue to reduce the elasticity of the anterior capsule in these younger patients.²⁰

Many technologies for reproducibly size and center anterior capsulotomies exist; these include manual capsulorhexis and a variety of thermal and laser approaches. If the surgeon is using an automated system to create the capsulorhexis, such as a femtosecond laser, ZEPTO capsulotomy system (Mynosys), or CAPSULaser, (Excel-Lens, Inc.), he or she should program the unit for a diameter smaller than the desired outcome because the natural elasticity of the capsule will result in enlargement as the peripheral capsule relaxes during the capsulotomy process to yield an aperture larger than the programmed size. This effect is most apparent in younger eyes.²¹

Lens Disassembly

Hydrodissection, viscodissection, hydrodelineation, and femtosecond laser delineation are all potential methods of separating nuclear layers for removal that require special considerations in posterior polar cataract cases. Irrespective of the methods of dissection used, it is important to maintain a constant anterior chamber depth and pressure throughout the case. The anterior chamber should be gently refilled with an ophthalmic viscosurgical device (OVD) before the phaco probe or irrigation/aspiration (I/A) hand-piece is removed because a sudden forward surge of the posterior capsule could cause a posterior capsule tear.

Hydrodissection

In hydrodissection, a wave of fluid is injected between the cortex and the posterior capsule. Most authors of this paper avoid hydrodissection in cases of posterior polar cataract and in general recommend avoiding hydrodissection. A skilled and experienced member of the ASCRS Cataract Committee obtains excellent results using modified hydrodissection techniques designed for the posterior polar cataract, which we will describe for those who choose to hydrodissect.

If one performs a wave of hydrodissection with the usual volume and force, this could create a posterior capsule tear before any nuclear material has been removed. On the other hand, very gentle, slow, and low-volume hydrodissection with short small pulses in which the wave is watched to gently creep across the posterior capsule can separate the cortex from the capsule except in the areas where adherence is tight. A gentle wave is unlikely to propagate fully across the entirety of the lens; thus, hydrodissection from multiple meridians is typically required (Video 1, available at <http://jcrsjournal.org>).

If a posterior capsule rupture does occur while the surgeon is still injecting fluid, the surgeon might notice abrupt cessation of fluid wave progress and stirring of the fluid in the anterior vitreous. Again, to avoid this possibility,

most of the authors of this paper recommend against hydrodissection.

Hydrodelineation

In standard hydrodelineation, the irrigation cannula is impaled through the cortex and epinucleus and fluid is injected in the plane between the endonucleus and the epinucleus, creating the golden-ring sign (Video 2, available at <http://jcrsjournal.org>). Many authors of this paper routinely hydrodelineate in posterior polar cataract cases, while others prefer to use the femtosecond laser to “femtodelineate” and avoid hydrodelineation altogether.

The hydrodelineation maneuver should use as little fluid as possible and the anterior chamber should be left slightly shallower than usual before the fluid is added so that adding to the intralenticular volume will be less likely to put the fragile posterior capsule on stretch. Using a small amount of fluid also decreases the chance that the epinuclear fluid wave will jump to a deeper cortical cleaving plane with its attendant risk for posterior capsule rupture (Video 3, available at <http://jcrsjournal.org>).

An alternative strategy for posterior polar cataract cases is to first perform a small amount of central nuclear sculpting. The irrigation cannula is then directly inserted into the wall of the central space in the plane between the endonucleus and the epinucleus, and fluid is injected in an inside-out direction. Using the alternative method for hydrodelineation with some central sculpting before hydrodelineation might further increase the likelihood of the fluid wave staying in the proper plane (Video 4, available at <http://jcrsjournal.org>).

Hydrodelineation can separate the endonucleus from the epinucleus, which allows removal of the nucleus without manipulation of the vulnerable adherent posterior cortex. This transmits less mechanical forces to the posterior capsule, which is useful in cases of posterior polar cataract. It allows for removal of the nucleus with the epinucleus, acting as a barrier between the posterior capsule and the nuclear material and thus decreasing the chances of capsule tear extensions and dropped nuclear material. This approach delays the more dangerous separation of the posterior layers from the posterior capsule until the very end of the case.

Nucleus Removal

During aspiration of the endonucleus, the temptation to rotate the nucleus should be avoided because it could cause shearing forces on the capsule. A second instrument, such as a chopper or a spatula, can be used to gently separate the various layers of nuclear material. Feeding the lens material into the phaco tip with a side instrument can be helpful. Modest flow rates, US powers, and bottle heights might increase safety in eyes with a softer nucleus. If a surgeon uses an active infusion pump phaco machine and an IOP lower than the mid-20s is desired, the surgeon could use a gravity infusion phaco pack and select the gravity infusion option on the machine. This is because the mid-20s is the

minimum IOP setting available on some machines, whereas the gravity pole system can obtain lower IOPs.

In the event of a more dense central nucleus in which some form of sculpting or splitting is required, the surgeon should make efforts to avoid stretching of the posterior capsule. For a divide-and-conquer approach, the surgeon should make the groove reasonably deep and rather than separating the quadrant by centrifugal (inside-outside) forces, should pull a quadrant centrally (outside-in) to help avoid posterior capsule stretch.

Similarly, in a chopping procedure, in general a horizontal chop is less likely to stress the posterior capsule than a vertical chopping maneuver. This is because in vertical chopping, anterior-to-posterior forces are applied, which can put the posterior capsule under stretch.

In horizontal chopping, the chopper is passed under the capsule and around the equator of the lens and drawn centripetally (outside-in) toward the center while the embedded phaco tip holds the rest of the nucleus steady. In this maneuver, anterior-to-posterior forces are minimal if properly executed with horizontal vectors of force only. In softer nuclei, the quadrant where the phaco tip is embedded can be drawn centripetally (outside-in) directly with vacuum or OVD manipulation without applying lateral forces to separate the nucleus. In harder nuclei, it is often necessary to sculpt some central working space so there is no resistance to pulling a fragment or quadrant inward. Gentle horizontal separation forces might be necessary if the aforementioned techniques will not separate the nuclear quadrants. If one chooses to use vacuum to bring a fragment centrally, rotating the phaco tip so that the angled orifice is planar to the surface of the fragment (Figure 3) will maximize occlusion and yield maximum holding power on the fragment.²²

Once the first segment or quadrant has been emulsified, the surgeon might wish to avoid the temptation to rotate the remaining endonucleus. Such rotation can apply unpredictable forces to the posterior plaque and posterior capsule, even with careful hydrodelineation or viscodelineation. Using the second hand instrument to pull sequential pieces inward or using viscomanipulation to bring pieces inward can avoid the application of torsional forces to the capsule. Nagappa et al.²³ describe the use of two opposing phaco incisions for accessing the subincisional nucleus from the first incision with an incision on the opposite side of the globe as another way to minimize movement

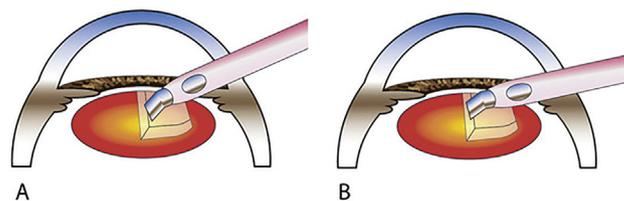


Figure 3. A. Phaco tip bevel is nonplanar to the nuclear fragment. B: Phaco tip bevel is held more planar to the face of the nuclear fragment to maximize occlusion and yield maximum holding power on the fragment.

of the remaining nucleus and to avoid rotational forces on the capsule.

There are reports of using OCT real time on the operating microscope to help during the removal of a posterior polar cataract. Optical coherence tomography can be used to monitor stages of the surgery, such as hydrodelineation and lens fragmentation.¹⁵ An OCT image taken after removal of the cataract nucleus can allow one to determine whether the posterior capsule has been violated and whether additional steps are warranted to safely remove the rest of the lens material.²⁴

There are 3 distinct levels of safety for endonucleus removal. At the first stage, nuclear material of a substance and size is still in the eye, and if it fell back into the vitreous, a 20-gauge vitrectomy system would be required to retrieve it. A higher level of safety is reached when the remaining material is small or soft enough that it can be removed through a 25-gauge vitrectomy system. An even higher safety level is reached when there is no nuclear material left which would require a vitrectomy if it fell posteriorly.

Epinuclear Removal

One useful technique for epinuclear removal is to strip the epinucleus from the periphery to the center, stopping when it reaches the central discoid plaque of the posterior polar cataract. Once all quadrants are stripped to the center, the epinucleus can be viscodissected from the posterior capsule and then aspirated above the OVD protective shell.

The epinuclear material can be removed by standard coaxial or bimanual techniques. Advocates of the bimanual technique point out that it allows easy access circumferentially to the capsular bag, causes minimal incision distortion, and allows the maintenance of a closed chamber. The aspiration probe should be placed in the fornices.

Cortex Removal

Similar to the epinuclear stripping described above, cortical removal should start in the periphery, stripping toward the center, and the central plaque should be left for last. Some surgeons prefer to viscodissect the cortex off the capsule

with a dispersive agent before cortical removal. Although the anterior chamber can be well maintained with a variety of OVD agents, a highly dispersive agent is more likely to achieve the desired cleavage while minimizing forces on the capsule or overly increasing bag volume.

Eventually, one must decide how to handle the white posterior plate. In most instances, it becomes free floating during cortical or epinuclear removal and can be easily aspirated. In other cases, it can remain adherent. In this circumstance, the surgeon must decide whether to try to remove the plaque, perform a primary posterior curvilinear capsulorhexis (PCCC), or leave the plaque and perform an Nd:YAG capsulotomy at a later date.

Removing the plaque is a definitive maneuver and is usually successful; however, it can result in a tear (Video 5, available at <http://jcrjournal.org>). Factors that could influence the surgeon's decision on the best approach include the following: (1) Would a tear prevent placement of the intended IOL (eg, toric)? (2) Is the patient of sufficient age and mental/physical ability to have an Nd:YAG? (3) Is the anterior capsule intact and of appropriate size to allow a sulcus-fixated IOL with anterior capsule optic capture in the event of a posterior capsule tear? (3) Is the surgeon prepared for and comfortable with performing a PCCC if a tear occurs? (4) Is a PCCC with a sulcus IOL with optic capture through the PCCC into Berger space the ideal remaining IOL fixation strategy?

If a PCCC is needed, it is more likely to be successful if the anterior chamber is pressurized with OVD to prevent vitreous prolapse.

Capsule Polishing After Plaque Removal

If the plaque has been successfully aspirated and there are a few wisps of cortical debris on the posterior capsule, it is usually wise to avoid the temptation to polish the debris. The stress placed on the posterior capsule by standard polishing techniques, even in the periphery of the capsule, will often overwhelm the weakened capsule in the previous area of the plaque. It is heartbreaking to break a capsule so close to the finish line.

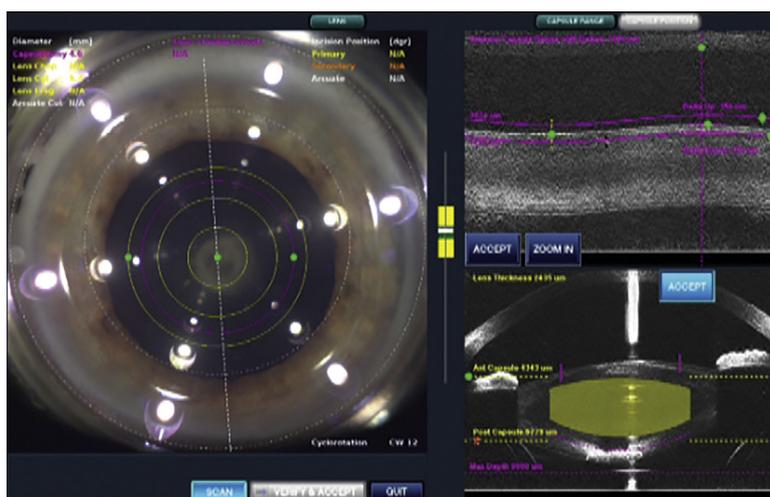


Figure 4. The femtosecond laser is programmed to create 3 cylinders within the lens. The depth and width of these cylinders is based on the anterior segment view.

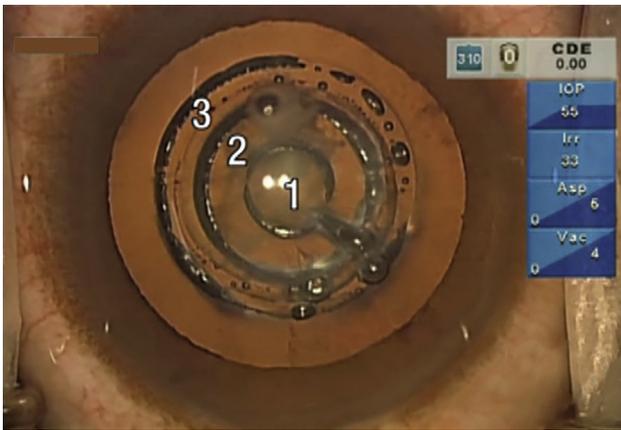


Figure 5. After the laser procedure, there are now 3 cylinders that divide the lens into 4 layers or zones that are sharply demarcated from one another.

We have anecdotally noted that when there are small white dots on the posterior capsule in the area of the previous plaque, it is often a sign of a particularly weakened capsule and worthy of extra caution. These white dots might be remnants of a previous tenacious connection between the plaque and the capsule.

Intraocular Lens

If an attempt at PCCC is unsuccessful, in-the-bag fixation of an IOL can be abandoned in favor of a 3-piece PC IOL placed in the sulcus with optic capture in the bag. Even in the setting of an intact posterior capsule, if one has selected an IOL that could place tension on the posterior capsule during or after insertion, such as an accommodating PC IOL, a primary PCCC to remove the vulnerable thin central posterior capsule preemptively might remove the risk for the capsule splitting during IOL insertion or with anterior chamber dynamic changes.

If the posterior capsule remains intact after successful IOL placement, it might still be vulnerable during I/A of the OVD if the anterior chamber dynamics are not managed. This is one instance in which wound hydration before OVD removal is wise.

Femtosecond Lasers for Posterior Polar Cataracts

The femtodelineation technique has been reported for posterior polar cataract removal. In a prospective interventional case series of femtodelineation in 45 consecutive eyes with posterior polar cataract,²⁵ posterior capsule rupture only occurred in 2 eyes (4.4%). This is the lowest reported rate of capsule rupture for posterior polar cataract; hence, the

technique is worthy of careful attention. We note that the lack of a control arm in the study makes it difficult to separate the exact contribution to safety provided by the femtosecond laser from the outstanding attention to sound posterior polar cataract removal principles exemplified by the reporting surgeon throughout the rest of the case.

Surgical Technique

In the reported femtodelineation technique,²⁶ the capsulorhexis is set at 4.6 mm and 3 nuclear cylinders are created within the lens, with a diameter of 5.5 mm for the outermost cylinder (Figure 4). This demarcates the lens into 3 distinct layers surrounded by an outermost layer of epinucleus (Figure 5). The preset laser energy is adjusted to match the density of the lens with a bias toward lower energy settings. The highest possible spot and layer separation is used. The nuclear cylinders are set to stop 500 μ m above the posterior capsule if the live OCT on the femtosecond laser shows the posterior capsule is intact. If the live OCT on the laser shows a breach in posterior capsule integrity (eg, preexisting posterior capsule defect), an offset of 700 to 800 μ m is selected to afford a thicker shell of epinuclear protection.

The patient is shifted to the operating room, where the rest of the procedure is performed under the operating microscope. The uniqueness of this technique is that no hydrodissection or hydrodelineation is performed.

The preplaced delineation patterns created by the femtosecond laser allows the surgeon to use very low fluid, US, and bottle height settings throughout the case (Table 1). Starting from the innermost layer, each of the sharply delineated layers is emulsified from inside-out within the cushion of the outer layer²⁶ (Figures 6 and 7). A thick and uniform epinuclear cushion remains after the nuclear removal.

Some of us have found that femtosecond laser delineation is also useful in posterior polar cataracts with associated dense nuclei. Because the nucleus is already predivided, it is often easily debulked without the use of mechanical division techniques, which could create stress on the posterior capsule. With femtosecond laser delineation, a thick, uniform, and sharply delineated epinuclear layer is left behind. Studies are needed to test these anecdotal observations to determine whether they are, in fact, statistically or clinically relevant.

There is a theoretical concern about an increase in intralenticular pressure caused by the bubbles generated by the femtosecond laser application. If this were significant, it

Table 1. Ultrasound and fluidic parameters used during different phases of surgery.

| Phase | Preset US Energy (%) | Vacuum (mm Hg) | Aspiration Flow Rate (cc/Min) | Bottle Height (cm) |
|--------------------------------|----------------------|----------------|-------------------------------|--------------------|
| Nuclear layer removal | 20 to 30 | 200 to 250 | 14 | 60 to 70 |
| Final epinuclear layer removal | 10 to 20 | 200 | 14 | 60 to 70 |
| Bimanual I/A | — | 300 to 400 | 18 | 60 to 70 |

I/A = irrigation and aspiration; US = ultrasound

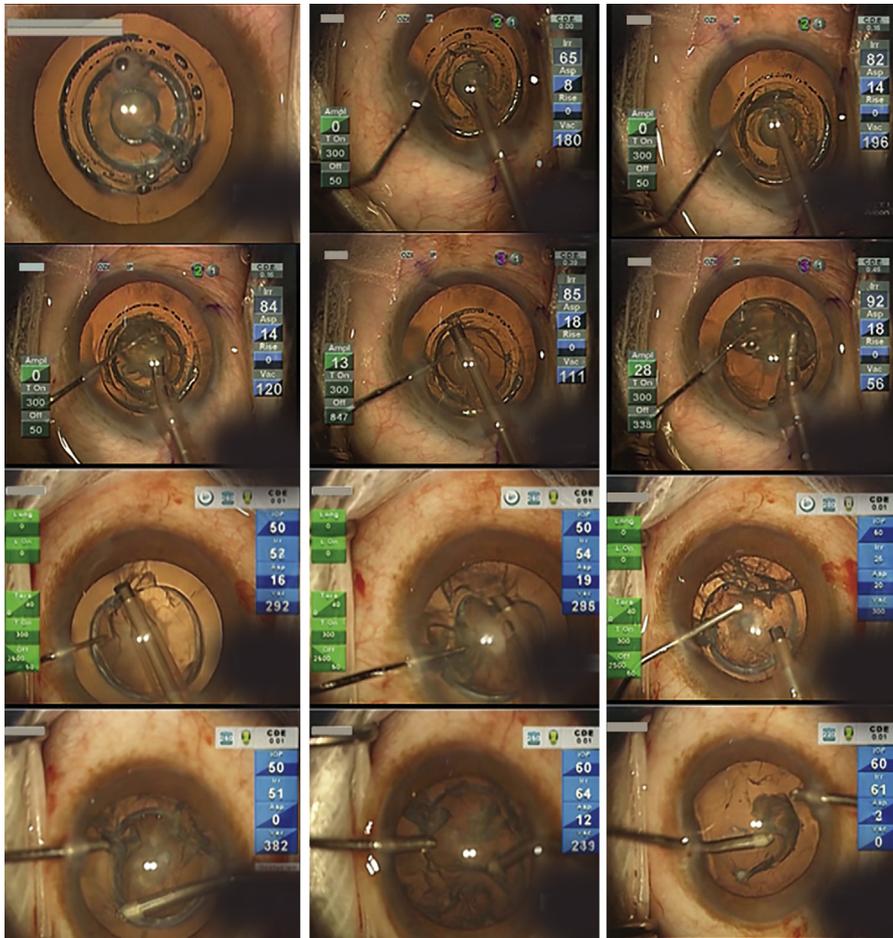


Figure 6. Representative images showing how each layer is removed within the cushion of the other. Finally, a sharply demarcated epinuclear layer is left behind, which is removed with bimanual irrigation/aspiration

could cause a rupture in the weakened posterior capsule of a PCCC. This theoretical concern did not appear to be a practical one in the reported study. Perhaps this is because the lower energy settings and large layer and spot separation settings used by the author of the study had the effect of generating small compliant bubbles that prevented a clinically significant elevation in intralenticular pressure.

DISCUSSION

Posterior polar cataracts can be daunting for a cataract surgeon. Yet, they can be well managed with proper preparation. Surgeons should counsel patients appropriately and

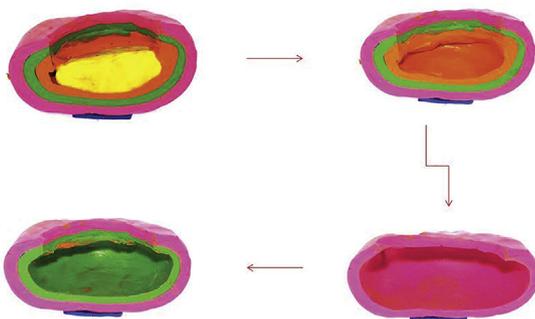


Figure 7. A clay model depicts how each femtosecond laser delineated layer of the lens is removed while the outer layer still provides a mechanical cushion until the very end of nucleus removal; this protects the weak part of the posterior capsule.

recognize comorbidities. Although posterior polar cataracts remain a surgical challenge, the risks can be minimized with proper preoperative evaluation, surgical techniques, and recognition of intraoperative challenges and complications.

REFERENCES

1. Mistr SK, Trivedi RH, Wilson ME. Preoperative considerations and outcomes of primary intraocular lens implantation in children with posterior polar and posterior lentiglobus cataract. *J AAPOS* 2008; 12:58–61
2. Forster JE, Abadi RV, Muldoon M, Lloyd IC. Grading infantile cataracts. *Ophthalmic Physiol Opt* 2006; 26:372–379
3. Tulloh CG. Hereditary posterior polar cataract with report of a pedigree. *Br J Ophthalmol* 1955; 39:374–379
4. Addison PKF, Berry V, Ionides ACW, Francis PJ, Bhattacharya SS, Moore AT. Posterior polar cataract is the predominant consequence of a recurrent mutation in the PITX3 gene. *Br J Ophthalmol* 2005; 89:138–141
5. Berry V, Francis PJ, Prescott Q, Waseem NH, Moore AT, Bhattacharya SS. A novel 1-bp deletion in PITX3 causing congenital posterior polar cataract. *Mol Vis* 2011; 17:1249–1253
6. Luntz MH. Clinical types of cataracts. In: Tasman W, Jaeger EA, eds. *Duane's Ophthalmology*. Philadelphia, PA, Lippincott Williams & Wilkins, 2013; volume 1; chapter 73
7. Vasavada AR, Raj SM, Vasavada V, Shrivastav S. Surgical approaches to posterior polar cataract: a review. *Eye* 2012; 26:761–770
8. Lee MW, Lee YC. Phacoemulsification of posterior polar cataracts – a surgical challenge [letter]. *Br J Ophthalmol* 2003; 87:1426–1427
9. Vasavada A, Singh R. Phacoemulsification in eyes with posterior polar cataract. *J Cataract Refract Surg* 1999; 25:238–245
10. Osher RH, Yu BC-Y, Koch DD. Posterior polar cataracts: a predisposition to intraoperative posterior capsule rupture. *J Cataract Refract Surg* 1990; 16:157–162
11. Kalantan H. Posterior polar cataract: a review. *Saudi J Ophthalmol* 2012; 26:41–49

12. Gifford SR. Congenital anomalies of the lens as seen with the slit lamp. *Am J Ophthalmol* 1924; 7:678–685
13. Vajpayee RB, Sinha R, Singhvi A, Sharma N, Titiyal JS, Tandon R. "Layer by layer" phacoemulsification in posterior polar cataract with pre-existing posterior capsular rent. *Eye* 2008; 22:1008–1010
14. Kymionis GD, Diakonis VF, Liakopoulos DA, Tsoulnaras KI, Klados NE, Pallikaris IG. Anterior segment optical coherence tomography for demonstrating posterior capsular rent in posterior polar cataract. *Clin Ophthalmol* 2014; 8:215–217
15. Das S, Kummell MK, Kharbanda V, Arora V, Nagappa S, Shetty R, Shetty BK. Microscope integrated intraoperative spectral domain optical coherence tomography for cataract surgery: uses and applications. *Curr Eye Res* 2016; 41:643–652
16. Arora R, Mehta S, Goyal JL, Jain S, Gupta D. Tear-drop sign of posterior capsule dehiscence on Scheimpflug imaging [letter]. *Eye* 2010; 24:737–738
17. Hayashi K, Hayashi H, Nakao F, Hayashi F. Outcomes of surgery for posterior polar cataract. *J Cataract Refract Surg* 2003; 29:45–49
18. Ceyhan D, Schnall BM, Breckenridge A, Fontanarosa J, Lehman SS, Calhoun JC. Risk factors for amblyopia in congenital anterior lens opacities. *J AAPOS* 2005; 9:537–541
19. Kamoi K, Mochizuki M. Pre-surround division technique: precise cracks surrounding the posterior opacity prior to phacoemulsification in posterior polar cataract surgery. *J Cataract Refract Surg* 2014; 40:1764–1767
20. Dick HB, Aliyeva SE, Hengerer F. Effect of trypan blue on the elasticity of the human anterior lens capsule. *J Cataract Refract Surg* 2008; 34:1367–1373
21. Dick HB, Schelenz D, Schultz T. Femtosecond laser-assisted pediatric cataract surgery: Bochum formula. *J Cataract Refract Surg* 2015; 41:821–826
22. Seibel BS. *Phacodynamics; Mastering the Tools and Techniques of Phacoemulsification Surgery*, 4th ed. Thorofare, NJ, Slack, 2005; 128–131
23. Nagappa S, Das S, Kurian M, Braganza A, Shetty R, Shetty B. Modified technique for epinucleus removal in posterior polar cataract. *Ophthalmic Surg Lasers Imaging* 2011; 42:78–80
24. Ehlers JP, Goshe J, Dupps WJ, Kaiser PK, Singh RP, Gans R, Eisengart J, Srivastava SK. Determination of feasibility and utility of microscope-integrated optical coherence tomography during ophthalmic surgery: the DISCOVER Study RESCAN Results. *JAMA Ophthalmol* 2015; 133:1124–1132
25. Vasavada AR, Vasavada V, Vasavada S, Srivastava S, Vasavada V, Raj S. Femtodelination for enhanced safety in posterior polar cataract. *J Cataract Refract Surg* 2015; 41:702–707
26. Vasavada AR, Raj SM. Inside-out delineation. *J Cataract Refract Surg* 2004; 30:1167–1169

OTHER CITED MATERIAL

- A. Masket SF. What should I do differently with a posterior polar cataract? [Hello curbside consultation]. Available at: <https://www.healio.com/ophthalmology/curbside-consultation/%7B0911aa8e-6600-4653-b884-2905d738ff4a%7D/what-should-i-do-differe>. Accessed October 30, 2018

Disclosures: *Dr. Foster reports financial interests in Acufocus, Inc., Alcon Laboratories, Inc., Alphaeon Corp., Bausch & Lomb, Inc., Ivantis, Inc., LeGrande, and Thru-Focus Optics LLC. Dr. Fram reports financial interests in Accutome, Alcon Laboratories, Inc., Allergan, Bausch & Lomb, Inc., Johnson & Johnson Vision, Notal Vision, Ocular Science, Omeros, RxSight, Inc., Shire, SightLife Surgical, and Sun Pharmaceuticals Industries Ltd. Dr. MacDonald reports financial interests in Perfect Lens LLC and lantech, Inc. Dr. Snyder reports financial interests in Alcon Laboratories, Inc., Bausch & Lomb, Inc., Glaukos Corp., Humanoptics AG, Icon Bioscience, Inc., Microsurgical Technology, Reata Pharmaceuticals, Inc., Sun Pharmaceutical Industries Ltd., W.L. Gore and Associates, Inc., and Xigen SA. None of the other authors has a financial or proprietary interest in any material or method mentioned.*



First author:

Gary J.L. Foster, MD

Eye Center of Northern Colorado PC, Fort Collins, Colorado, USA