The Perfect Capsulorrhexis

This step in cataract surgery dwarfs many other steps in importance.

BY DAVID F. CHANG, MD

The capsulorrhexis, or continuous curvilinear capsulotomy (CCC), is generally considered the single most important step in cataract surgery and provides numerous surgical advantages. First, a continuous capsular edge renders the capsular bag more resistant to tearing during surgery. Like an elastic waistband, the capsulorrhexis will stretch in response to mechanical surgical forces rather than tear. Second, not only is a continuous edge necessary to perform cortical cleaving hydrodissection, but it also facilitates cortical cleanup and placement of both haptics into the capsular bag. Third, it converts the anterior capsule into a contingency platform for IOL support should the posterior capsule tear. Fourth, because the overall length of many foldable IOLs is too short for the ciliary sulcus, capturing the optic of a three-piece IOL with the capsulorrhexis is the best way to assure good IOL centration in this situation.

Failure to achieve an intact capsulorrhexis not only precludes these benefits but also increases the risk of posterior capsular rupture due to a wraparound tear.

**Properly Sized Capsulorrhexis**

The postoperative advantages of a properly sized capsulorrhexis are equally important. First, as the capsular bag contracts, a continuous capsulotomy edge prevents pea-podding, or escape of either haptic. Second, asymmetric capsular forces resulting from an eccentric CCC can cause delayed optic decentration. Third, continuous circumferential overlap of the IOL optic edge produces a capsular shrink-wrap effect, whereby the posterior capsule is kinked by the optic edge—a major factor in the prevention of posterior capsular opacification. That is, by sharply indenting the posterior capsule, the optic edge creates a mechanical barrier that blocks lens epithelial cells (LECs) from migrating behind the lens optic. Capsulorrhexis overlap may also help to reduce positive optic edge dysphotopsias as the anterior capsule opacifies over time. Finally, such continuous overlap of the optic edge is the only way to attain consistency in axial IOL position from case to case. Being able to accurately predict this effective lens position is a crucial factor in calculating the proper IOL power for emmetropia.

Achieving these advantages is all the more crucial for multifocal and presbyopia-correcting IOLs.

It follows that a capsulorrhexis with a diameter that extends beyond the optic edge in some or all areas forfeits these advantages. Posterior LEC migration occurs in any region where the posterior capsule is not kinked by the optic edge, and slight optic decentration may result from asymmetric capsular contractile forces over time. Furthermore, as the posterior capsule tenses postoperatively, it may displace the optic slightly more anteriorly wherever it is not restrained by a taut capsulorrhexis edge, resulting in a myopic shift.

**Disadvantages of a Small-Diameter Capsulorrhexis**

During phacoemulsification, a smaller capsulorrhexis is much more likely than an adequately sized one to be torn by the chopper tip or shaft or incised with the phaco tip. Surgeons should take a mental snapshot of the capsulorrhexis shape and diameter upon its completion, because its visibility will be subsequently lost following hydrodissection and nuclear rotation. This allows the surgeon to mentally picture the edges of the capsulorrhexis during emulsification. Aspirating the anterior epinucleus prior to phacoemulsification also facilitates this. Using bimanual instrumentation for cortical cleanup may overcome the specific hurdle of aspirating the subincisional cortex with a small-diameter capsulotomy.

In addition to impeding surgical steps, a CCC with a small diameter may create problems postoperatively. The increased load of LECs on the back of the anterior capsule can increase inflammation, cause anterior capsular fibrosis and opacification, and produce excessive contraction of the capsulorrhexis and capsular bag. This can lead to zonular damage or dehiscence and optic decentration.

Anterior capsular fibrosis and contraction are more likely
with silicone optic material than with hydrophobic acrylic materials. With weakened zonules, visually significant capsular phimosis or subluxation of the bag-IOL complex can occur.

Besides secondary capsulorrhexis enlargement (Figure 1), as described below, other techniques to reduce capsular contraction include aspiration of LECs from beneath the anterior capsule and creation of relaxing incisions in the anterior capsule with an Nd:YAG laser. Excessive anterior capsular opacification can impair ophthalmoscopic visualization of the peripheral retina and become visually significant for the patient. Finally, excessive overlap of the nasal optic edge with a capsulorrhexis may be a cause of temporal pseudophakic negative dysphotopsia.

Given the importance of attaining a proper capsulorrhexis diameter, it is ironic that, until recently, this is one of the only steps that had not been improved through the use of new technology. Most of us continue to employ the low-tech method of a manual tear performed with a needle and/or forceps with an intended diameter that is estimated visually. Parallax occurring with eye movement makes it difficult to judge the symmetry and centration of the evolving capsulotomy. One of the most appealing advantages of a femtosecond laser capsulotomy is the ability to reproducibly create a centered capsulotomy.
capsulotomy of a precise diameter. Other methods include the use of corneal markers and capsule forceps with etched millimeter markings to assist in gauging size, such as the Seibel Rhexis Ruler (MicroSurgical Technology).

SECONDARY ENLARGEMENT

**Strategy.** When performing a manual capsulotomy, my strategy is to plan on performing a two-stage capsulorrhexis as needed. As I make the primary capsulorrhexis, I err on the small side (Figure 1A). This is because the diameter can always be enlarged, but not reduced.

I take a moment to assess the appropriateness of the CCC diameter after IOL implantation. Frequently, the size and centration are fine; however, it is surprising how often the CCC is slightly eccentric to the optic center. Sometimes, a perfectly round CCC becomes ovoid following IOL implantation due to the directional stretch of stiff three-piece IOL haptics. Significant ovalization may indicate zonular laxity and insufficient centrifugal tension in the areas perpendicular to the haptic axis.

In either of these situations, or if the overall diameter is too small (Figure 1B), I enlarge the capsulorrhexis by first making an oblique cut with scissors (Figure 1C) and then grasping the resulting flap with capsule forceps (Figure 1D). The cut should be oblique, rather than radial, to better incline the resulting flap to tear circumferentially.

The flap is then maneuvered with capsule forceps under a generous amount of ophthalmic viscosurgical device (OVD; Figures 1D through 1H). Curved Uthoff-Gills capsulotomy scissors with blunt tips (K4-5126; Katena Products) have the perfect shape for creating an initial curved cut to either side of the phaco incision. In some cases, I trim only a part of the remaining anterior capsular rim where it is excessively wide. Other times, I may retear the entire 360º circumference of the opening (Figure 1). If the pupil is small enough to conceal the optic edge, it can be locally retracted with a Lester hook or by maneuvering a Malyugin Ring (MicroSurgical Technology).

**Timing.** The safest time to enlarge the capsulorrhexis is after IOL insertion. This is true regardless of whether a capsular tension ring (CTR) is inserted. Executing the second-stage enlargement is generally easier than the primary capsulotomy for several reasons. First, following removal of the cataract, the red reflex is improved and there is no convexity to the anterior capsule to promote downhill radial extension of the tear. Second, the optic provides a perfect visual template for resizing the CCC diameter. Third, in eyes with weak zonules, the presence of stiff three-piece IOL PMMA haptics or a CTR increases outward tension on the capsular bag and improves control over the direction of the anterior capsular tear. It is reassuring that, should the tear escape peripherally, the risk of a posterior wraparound tear is negligible because all of the most forceful surgical steps have been completed. However, the IOL should not be rotated in the presence of a single anterior capsular tear because of this risk.

**Advantages.** Although enlargement of a small-diameter capsulorrhexis is not absolutely necessary in most cases, I encourage the mastery of this technique. With multifocal IOLs, achieving a symmetric capsulorrhexis that completely overlaps the optic edge is particularly important. There is even less margin for CCC diameter error with accommodating IOLs such as the Crystalens (Bausch + Lomb). Excessive variability in CCC diameter has a greater effect on effective lens position for a hinged IOL design. Initially erring on the small side, with the option to enlarge when and where necessary, is a reliable way to consistently manually obtain a perfectly sized capsulorrhexis diameter.

Comfort with the secondary enlargement maneuver is important if one is having difficulty steering the flap during the primary capsulorrhexis. Whether the cause is poor visibility, patient movement, a shallow anterior chamber, or weak zonules, one can make a smaller-diameter opening in order to increase control and reduce the risk of a peripheral extension. The capsule tear-out rescue maneuver described by Brian C. Little, MA, FRCS, FRCOphth, can be used to improve control or rescue an escaping tear.11

Because of the long-term importance of a properly sized capsular opening, the surgeon should secondarily enlarge a small-diameter capsulorrhexis following IOL insertion, when the surgical conditions are more favorable. For a video depiction of my technique, visit eyetube.net/?v=itote.

**Special indications.** There are two clinical situations in which it may be advantageous to enlarge the capsulorrhexis diameter out to or beyond the IOL optic edge (known as all off).

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**TAKE-HOME MESSAGE**

- Failure to achieve an intact capsulorrhexis not only precludes multiple benefits but also increases the risk of posterior capsular rupture.
- Surgeons should take a mental snapshot of the capsulorrhexis shape and diameter upon its completion because its visibility will be lost following hydrodissection and nuclear rotation.
- A two-stage capsulorrhexis technique ensures that the CCC is never too large; err on the small side and enlarge it if necessary after IOL implantation.
- In eyes with uveitis or weak zonules, it may be advantageous to enlarge the capsulorrhexis diameter out to or beyond the IOL optic edge.


**Eyes with uveitis.** Uveitic eyes with preoperative posterior synechiae have a strong tendency to develop iris adhesions to the anterior capsular edge postoperatively. Iris bombé, with full circumferential pupil seclusion and secondary angle-closure glaucoma, can occur and be refractory to Nd:YAG or surgical iridectomy. Some have suggested placing the IOL in the ciliary sulcus in uveitic patients so that the optic will prevent posterior synechiae from developing to the capsulorrhexis edge.\(^1\) As a better alternative, secondarily widening the capsulorrhexis following IOL insertion should achieve this goal and preserve the immunologic advantages of sequestration of the lens in the capsular bag.

**Eyes with weak zonules.** A second situation in which a larger-than-usual capsulorrhexis is advantageous is with weakened zonules. Because capsulorrhexis contracture is countered by centrifugal zonular tension, significant capsular phimosis always indicates severe zonular laxity. Capsulorrhexis contracture, in turn, further dehisces and weakens the zonules and increases the risk of late bag-IOL dislocation with pseudoexfoliation.\(^5,9,8\) Therefore, leaving a small-diameter capsulorrhexis in an eye with weakened zonules is particularly objectionable.

Because a larger-diameter capsulorrhexis has far less tendency to contract, my preference is to secondarily enlarge the capsulorrhexis diameter out to the optic edge in eyes with weak zonules. This is done after IOL insertion because of the enhanced control and visibility cited earlier. In pseudoexfoliation eyes where a CTR is not deemed necessary, I secondarily enlarge the capsulorrhexis diameter to reduce the zonular weakening potential of capsular contraction over time.

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