

New Technology for Sizing the Continuous Curvilinear Capsulorhexis

Precise placement relative to the IOL's optics may reduce the risk of posterior capsular opacification.

BY H. BURKHARD DICK, MD, AND ADOLFO PENA, MD

The success of the continuous curvilinear capsulorhexis at reducing complications and providing satisfactory refractive outcomes depends on its centration, location, and size. Studies have demonstrated that the capsulorhexis' diameter should be small enough to overlap 360° of the IOL optic's periphery to reduce the risk of posterior capsular opacification (PCO)¹⁻³ and that the overlapping configuration may prevent PCO more effectively than the design of the IOL's edge.⁴

A prototypic system could help surgeons create optimally sized capsulorhexes and thus reduce the risk of postoperative PCO.

THE CAPSULORHEXIS' EFFECT ON PCO

Large capsulorhexes (6 to 7 mm in diameter) have been associated with greater rates of PCO and less acute visual outcomes than those with smaller diameters (4.5 to 5.0 mm).² Conversely, too small a capsulorhexis could cause phimosis of the anterior capsule,^{5,6} decrease vision, block the surgeon's view of the peripheral fundus, or neutralize the benefits of aspheric IOLs. At this time, the functional success and diameter of a continuous curvilinear capsulorhexis depends entirely on the surgeon's ability and experience. The risk of intraoperative complications arising from unsuccessful capsulorhexes increases for complicated cases (eg, intumescent cataracts, small or large eyes, intraoperative floppy iris syndrome, or weak zonules) performed by inexperienced surgeons.⁷

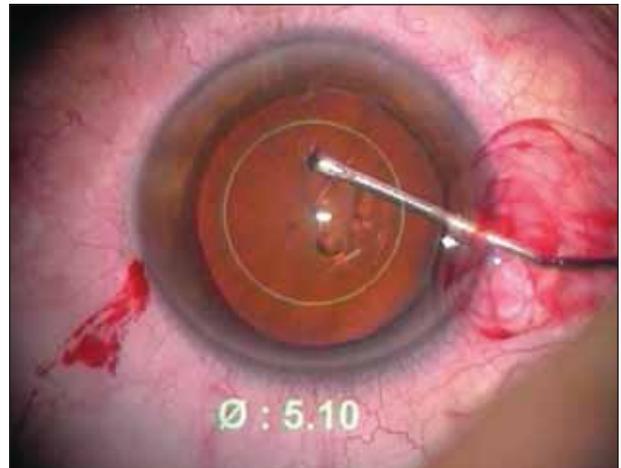


Figure 1. This intraoperative view shows a 5.1-mm-diameter green ring projected onto the anterior capsule by the DIS. An active eye tracker follows ocular movements and maintains the ring's proper position on the capsule.

IMPROVING THE CAPSULORHEXIS' FORMATION

To assist inexperienced surgeons and promote the consistent formation of the continuous curvilinear capsulorhexis, Michel Perez, MD, of Dijon, France, and Dr. Dick have developed in conjunction with Carl Zeiss Meditec AG (Jena, Germany) an interface-module (data-injection) system (DIS) that projects a reference ring through the operating microscope's light source onto the anterior capsule.^{8,9} Surgeons can use the projected image to guide their

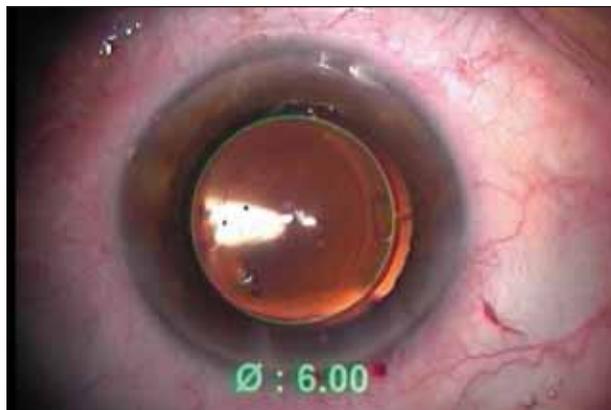


Figure 2. As the surgeon uses the foot pedal of the OPMI VISU 140 surgical microscope to zoom in on the eye, the DIS automatically verifies the projected ring's position and size. Here, a 6-mm ring is positioned exactly on the outer rim of a Tecnis silicone IOL's optic (Advanced Medical Optics, Inc., Santa Ana, CA).

placement and execution of the capsulorhexis (Figure 1).

The DIS consists of an OPMI VISU 140 surgical microscope (Carl Zeiss Meditec AG), the DIS module that projects the ring onto the capsule through the microscope, and a video camera mounted between the microscope's tube and the DIS module. The patient's preoperative biometric data (ie, axial length and anterior chamber depth) are stored on a personal computer, and a display control unit forwards the data to the DIS module. From the display control unit, surgeons can modify the operative parameters, including the planned diameter of the capsulorhexis, the corneal radius, and the anterior chamber depth. Other options allow users to change the size and color of the projected ring as well as the focal length of the main objective in order to increase depth of focus.

If the surgeon decides to magnify the microscope's image intraoperatively, the DIS' program automatically maintains the projected ring's correct size (Figure 2). The DIS also employs an active eye tracker that captures 12 to 25 images per second. These images are sent to the module to keep the projected ring in the correct position on the anterior capsule. After the capsulorhexis' creation, pushing a button on the display screen discontinues the projected ring.

THE DIS IN ACTION

To evaluate the effectiveness of the DIS, investigators at the University Eye Clinic of the Knappschafts-Krankenhaus in Bochum-Langendreer, Germany, randomized 96 eyes of 96 patients to undergo unilateral clear corneal cataract surgery with and without the device (data on file at the Study Coordination Center, Ruhr University Eye Hospital, Bochum, Germany). The capsulorhexis' targeted size in both groups was 5.1 mm.¹⁰

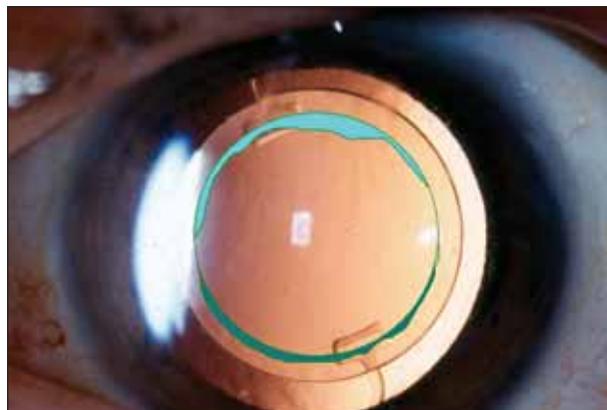


Figure 3. The bright blue area in this analysis of a pseudophakic eye with the Evaluation of Posterior Capsule Opacification 2000 system indicates that the capsulorhexis is smaller than its targeted diameter. The dark green area indicates that the capsulorhexis is larger than the targeted diameter.

In addition to using an Engel spatula (Geuder AG, Heidelberg, Germany) to measure the capsulorhexes' horizontal and vertical diameters intra- and postoperatively, the investigators evaluated the size of the openings with the computer-assisted Evaluation of Posterior Capsule Opacification 2000 system (available from Manfred Tetz, MD, in Berlin). They also measured subjects' UCVA, BSCVA, manifest refraction, keratometry, axial length, and anterior chamber depth pre- and postoperatively. The investigators analyzed these data to determine if the difference in the capsulorhexes' diameter or scatter around the target diameter was statistically significant.

The eyes in both groups had similar baseline and postoperative UCVA, keratometric readings, spheres, astigmatism, refractions, and axial lengths, and they received comparably powered IOLs. The mean depth of the anterior chamber was 3.15 and 3.38 mm in the DIS and control groups, respectively (Wilcoxon rank-sum test [$P=.079$]). The investigators did not find statistically significant differences in the capsulorhexes' mean diameters or in the deviation from the targeted size (5.1 mm) between the groups.

The scatter around the diameter of the capsulorhexes differed between the groups. Intraoperatively, more capsulorhexes in the DIS group (92%) had horizontal diameters within the reference zone's normal range (4.9 to 5.3 mm, $P<.001$ [Fisher's exact test]) than in the control group (27%). Postoperatively, 83% of the capsulorhexes in the DIS group were within the reference zone's normal range (4.9 to 5.3 mm) versus 21% in the control group.

Although the capsulorhexes' diameters changed postoperatively, mostly due to smaller values, the differences in scatter between the treatment groups were smaller. The same tendency, however, persisted ($P=.002$ for horizontal and

$P \leq .001$ for vertical diameter [Fisher's exact test]). Furthermore, after dividing the groups according to whether the anterior chamber depth was less than or greater than 3 mm, the same tendency in scatter persisted between both groups intra- and postoperatively for the capsulorhexes' horizontal and vertical diameters (Mantel/Haenszel method [$P \leq .002$]). The Evaluation of Posterior Capsule Opacification 2000 system showed no difference between the treatment groups in terms of the capsulorhexes' area (Wilcoxon rank-sum test [$P = .344$]) (Figure 3).

CONCLUSION

The diameters of the capsulorhexes created by experienced surgeons using the DIS were more accurate in relation to the scatter around the reference zone than those created without the DIS. We believe that the DIS, which is scheduled to be incorporated into the next generation of OPMI Lumera Surgical Microscopes (will be available in Europe and the US; Carl Zeiss Surgical, Oberkochen, Germany), could be useful for training residents and fellows, and it could be a helpful tool for optimizing postoperative outcomes after phacoemulsification. The DIS will enlarge the surgical portfolio of every cataract surgeon. ■

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