IOL Choice and Calculations in a Post-RK Patient

BY DAVID R. HARDTEN, MD; WARREN E. HILL, MD; WILLIAM B. TRATTLER, MD; R. BRUCE WALLACE III, MD; AND ROBERT T. CROTTY, OD

You are scheduling a patient for cataract surgery who has undergone eight-incision RK in both eyes. How do you advise the patient on IOL choice and accuracy, and what is your preoperative regimen for performing an IOL power calculation?

DAVID R. HARDTEN, MD

The complex scenario of cataract surgery in a post-RK patient is fortunately becoming less common. Many of these patients have already had cataract surgery, and the more common scenario is that of a patient's undergoing cataract surgery after LASIK or PRK.

My first step is to inquire about the stability of refractive error throughout the day. Instability is fairly uncommon for a medium-zone, eight-incision RK patient. However, those who have had optical zones of less than 3 mm, incisions all the way to the limbus, or crossing T-cut incisions may have fluctuation of refractive error throughout the day, which makes management at the time of cataract surgery much more complex. Some investigators have started to discuss corneal collagen cross-linking as a helpful procedure for stabilizing corneas in eyes that have a large amount of refractive fluctuation throughout the day.[1]

I evaluate the amount of irregular corneal astigmatism using corneal topography and tomography. If there is a significant amount of irregular astigmatism from the prior RK, then results will be more unpredictable (Figure 1). That information helps me to set realistic expectations for the patient.

My default position in patients with a history of RK is to suggest a monofocal IOL, typically targeted for distance vision. I implement the same formulas that I use to calculate IOL powers after LASIK, even though there are some theoretical reasons to use different methods. The post-LASIK formulas have worked well in my hands. I try several formulas and then select the one with the result that seems to make the most sense (Figure 2). I do not

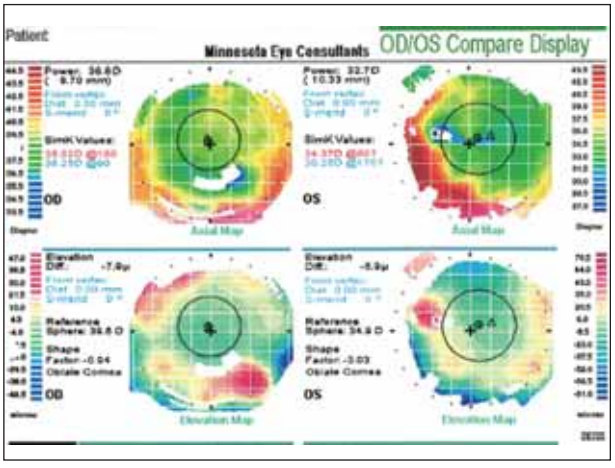

Figure 1. An eye with a significant amount of irregular astigmatism after RK has poor results with a toric IOL. It is difficult to correctly determine the axis of astigmatism when there is significant irregular astigmatism.

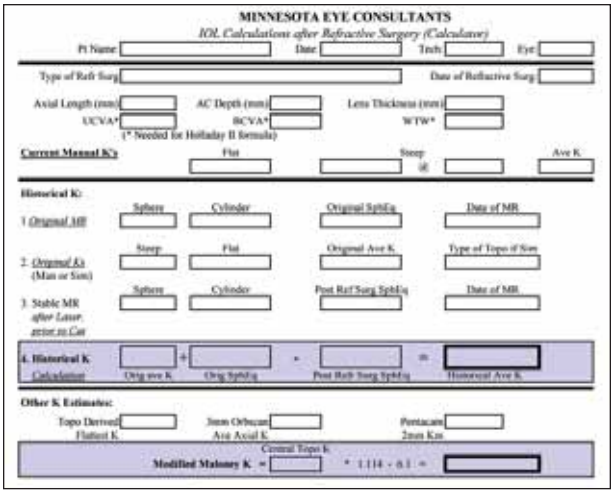

Figure 2. A worksheet used to simplify the analysis of IOL calculations after refractive surgery.

use formulas based on history, which is often unreliable in this subset of patients. Sometimes, a significant scar will render the results of the Orbscan topographer (Bausch + Lomb) or Pentacam Comprehensive Eye Scanner (Oculus Optikgeräte GmbH) less reliable. Typically, because there is poor agreement between the methods, selection of the IOL power is difficult, and significant ametropia is not uncommon after the cataract surgery.

An IOL exchange or PRK enhancement 3 to 4 months postoperatively (after hyperopia from corneal edema resolves) may be an option if the targeted refractive outcome is not achieved. I have used presbyopia-correcting IOLs in RK patients, but the amount of postoperative work and the need for lesser expectations cannot be overemphasized.

WARREN E. HILL, MD

Cataract surgery in the setting of previous RK is always a challenge. The triad of uniformly absent prior records, variable amounts of hyperopic drift, and frequent cases of lens-induced myopia precludes the use of historical methods for estimating the central corneal power. Additionally, the flattening of the central cornea renders conventional methods for measuring corneal power inaccurate. Unmodified theoretical formulas uniformly underestimate IOL power, and the potential for inaccuracy looms large unless a specific approach is followed.

I begin the calculation process by averaging the 1-mm through 4-mm ring powers of the Atlas topographer (Carl Zeiss Meditec Inc.). Other methods have been published, but I find that this approach gives the most consistent results.

For the calculation of IOL power, a double-K modified formula is necessary to remove the calculation artifact of iatrogenically flat keratometry (K) readings. This can be done by checking the box on the Holladay II formula (Holladay Consulting, Inc.) that reads, "Prior Rk, Lasik, Alk, etc." Another method is to use the American Society of Cataract & Refractive Surgeons' online calculator at http://iol.ascrs.org, which employs an Aramberri double-K method, a modified version of the Holladay 1 formula. I select a refractive target of between -0.50 and -0.75 D for two reasons: (1) hyperopic errors are common and (2) if hyperopic drift continues, the refractive error will change toward something better (eg, emmetropia).

I place a small corneal incision between the eight radial incisions at the limbus. I use an aspheric IOL, with the addition of negative spherical aberration to offset a typically elevated value of anterior corneal spherical aberration.

Initially, the refractive error will shift from hyperopic to myopic but will then stabilize 6 to 12 weeks after surgery.

WILLIAM B. TRATTLER, MD

Patients with a history of RK who require cataract surgery are a challenge in regard to calculating the optimal IOL power. When I perform a consultation for a patient with RK, I carefully evaluate the ocular surface. Dry eye syndrome is very common in patients scheduled for cataract surgery, and it can affect my ability to get optimal K readings. I also perform corneal topography to determine whether there is any corneal asymmetry from the RK that may lead to reduced postoperative BCVA. In general, I avoid a multifocal IOLs in RK patients, because the corneal shape typically does not provide satisfactory optics for these types of lenses.

Unlike in LASIK, the cornea is not thinned by RK, so central keratometry is an accurate measurement that can be used in IOL calculation formulas. However, some IOL formulas (such as the SRK-T or SRK-II formulas) assume a relationship between keratometry and anterior chamber depth. Because RK patients were once myopic but now have flat corneas, they typically have a deeper anterior depth than patients with similarly flat K readings who do not have a history of myopic refractive surgery. Therefore, more advanced formulas may be more accurate for RK patients. For example, the Holladay II or Haigis formulas take into consideration measurements of the anterior depth and the final effective lens position in relation to the cornea.

Additionally, I find that the very central K values—in the central 2 mm, for example—are the most useful for IOL calculation formulas. The Atlas, Pentacam, and other similar technologies can provide this value.

Postoperatively, it is important to be patient, because the initial refractive results may be inaccurate. It is not uncommon for 2 months or more to elapse before the cornea reaches its final, stable shape after cataract surgery. Before reacting to an off-target result, it is therefore prudent to wait and reevaluate the patient. If the outcome remains off target, surface ablation or piggyback IOLs are safe and effective procedures for enhancing post-RK eyes.

R. BRUCE WALLACE III, MD, AND ROBERT T. CROTTY, OD

When counseling post-RK patients about cataract surgery, we point out the lack of predictability of IOL power calculations due to the alteration of the corneal curvature after RK. We also explain that variability in UCVA is common for weeks to months after cataract surgery due to the temporary expansion of the RK incisions. Once corneal stability returns, UCVA can be assessed. If the result is not as expected, a piggyback IOL may be more appropriate than an IOL exchange. We inform patients that this procedure, if needed, is not covered by insurance.

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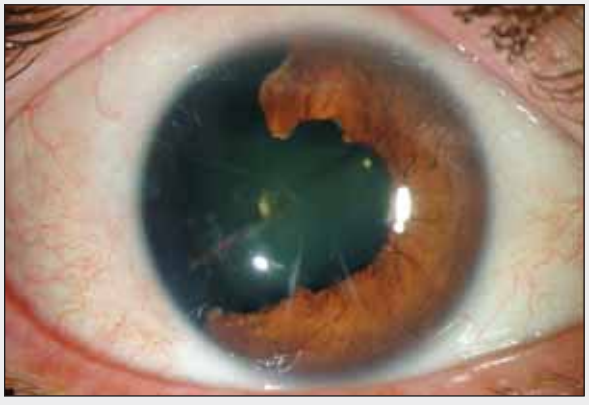
Cataract and Lost Iris Tissue After Trauma

BY KEVIN M. MILLER, MD; KENNETH J. ROSENTHAL, MD; MICHAEL E. SNYDER, MD; DIAMOND Y. TAM, MD; AND THOMAS OETTING, MS, MD

CASE PRESENTATION

A 50-year-old man with a history of RK 10 years ago presents about 6 months after suffering blunt trauma to the eye. Iris tissue was lost through an open RK incision at 9 o'clock. The surgeon repaired the open globe with a 10–0 nylon suture, which has been removed. During the subsequent 6 months, the patient has noticed a decrease in vision, with disabling glare from the loss of iris and cataract progression (Figure 1). The patient would like to undergo surgery for the cataract and, if possible, the iris defect. How would you proceed?



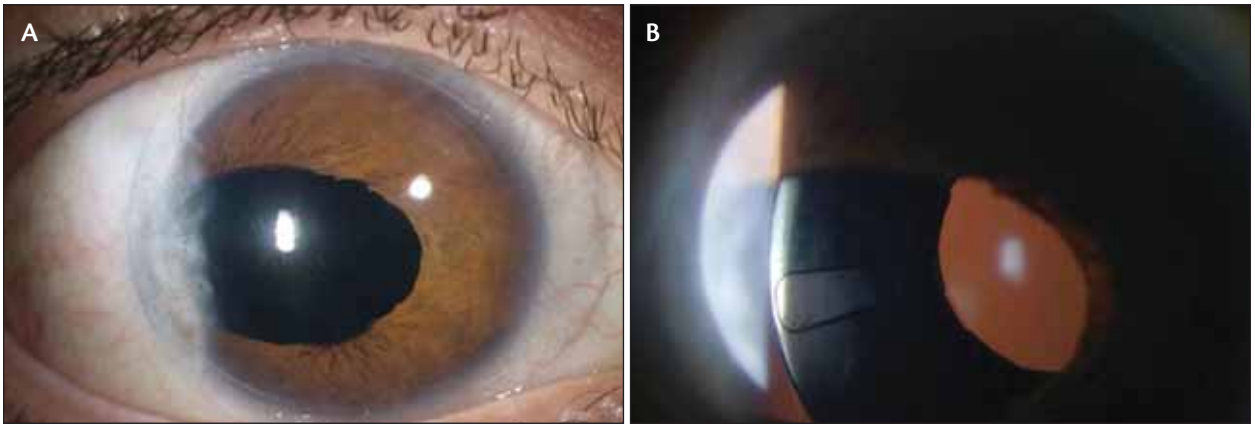
(Courtesy of Thomas A. Oetting, MS, MD.)

Figure 1. Evident at the slit lamp preoperatively are RK incisions, a cataract, and an area of missing iris from 7 to 11 o'clock.

KEVIN M. MILLER, MD

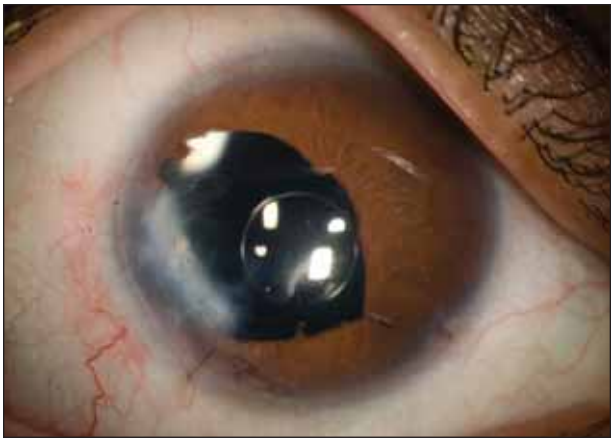
There are multiple ways to address this patient's cataract and partial aniridia using devices from Morcher GmbH, Ophtec BV, or HumanOptics AG. Not a single "pseudiridia" implant has been approved by the FDA. Ophthalmologists in the United States who wish to implant aniridia devices must obtain a compassionate use exemption from the FDA and the approval of a local institutional review board.

The surgeon could implant two Morcher 50F modified capsular tension rings (CTRs) in the capsular bag in front of a standard IOL. He or she would align the



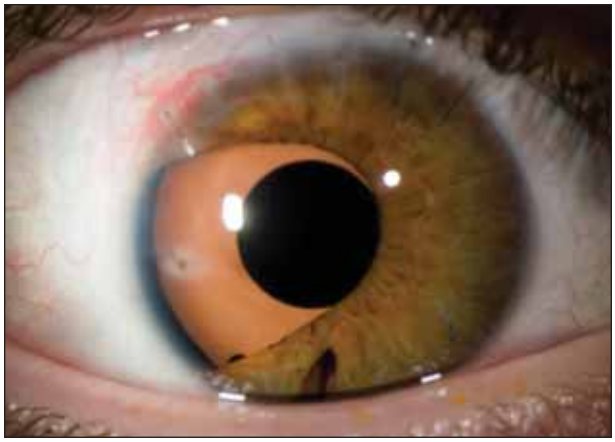
(Courtesy of Kevin M. Miller, MD.)

Figure 2. This partially aniridic eye received two Morcher 50F modified CTRs at the time of cataract surgery. Because the diameter of the capsular bag is smaller than that of the cornea, some light enters the eye peripheral to the rings.



(Courtesy of Kevin M. Miller, MD.)

Figure 3. This partially aniridic eye was treated by exchanging a standard posterior chamber IOL for a black Morcher 67B iris reconstruction lens in the ciliary sulcus.



(Courtesy of Kevin M. Miller, MD.)

Figure 4. This partially aniridic and preoperatively aphakic eye was treated by suture fixating a brown Ophtec 311 iris reconstruction lens to the sclera.

occluder paddles on one ring with the slits on the other to construct an artificial iris with a 4-mm pupil. One drawback to this approach is that it does not prevent light from entering peripheral to the capsular equator. Another problem is that the aniridic portion of the eye remains black (Figure 2).

Another solution is a Morcher iris reconstruction lens. My preferred Morcher device is the model 67B because of its 3-mm pupil. The device can be implanted in the capsular bag with difficulty or in the ciliary sulcus with ease. The 67B has three drawbacks: (1) it requires an 11-mm incision for implantation, (2) its 10-mm diameter is insufficient to completely block light from entering the eye peripheral to the artificial iris, and (3) the aniridic portion of the eye remains black (Figure 3).

A cosmetic alternative to this Morcher implant is the Ophtec 311 iris reconstruction lens, which is available in blue, green, and brown. This patient would be a good candidate for the brown model. Like the Morcher iris reconstruction lens, the Ophtec device can be implanted in the capsular bag with difficulty or in the ciliary sulcus with ease. Problems with this implant include its 4-mm pupillary size, the 9-mm diameter of the artificial iris, the lack of matching color and texture, and the size of incision required for the device's implantation (Figure 4).

The CustomFlex artificial iris manufactured by HumanOptics currently represents the best approach for eyes with cataract, intact zonules, and partial or complete aniridia. The device can be color matched to the patient's fellow eye and implanted through a 4-mm or smaller incision. This prosthesis can be placed inside the capsular bag in front of an IOL or in the ciliary sulcus. When implanted in the sulcus, the device does an

(Courtesy of Kevin M. Miller, MD.)

Figure 5. This partially aniridic eye was treated by placing a CustomFlex artificial iris into the ciliary sulcus anterior to a posterior chamber IOL.

excellent job of blocking out all light peripheral to the iris (Figure 5).

KENNETH J. ROSENTHAL, MD

This patient presents with a large iris defect and a cataract. Although the iris defect was caused by the iris' prolapse through one of the RK incisions, the "trampolining" of the lens might have caused an underlying zonular defect, which may need to be addressed by the insertion of a CTR. Because the iris defect is too large to permit a satisfactory primary closure, an iris prosthesis can be implanted. The Ophtec iris prosthetic implant is available as either a single-piece device that includes the IOL (model 311) or as a modular iris implant (Iris Prosthetic System) intended for placement in the capsular bag. The model 311 requires an incision

of approximately 9 mm. The advantage of the Iris Prosthetic System is that it can be inserted through a 4-mm incision.

A more aesthetically pleasing and minimally invasive approach would be to implant the CustomFlex. Made of a silicone elastomer, the device is hand colored based on a photograph of either the injured iris or the fellow eye's iris and closely matched to the existing iris. Once implanted, the prosthesis is virtually undetectable. An additional advantage of this device is that it can be delivered through a 2.7-mm incision via a Silver unfolder (Abbott Medical Optics Inc.). The prosthesis can be cut to size, implanted whole, and either placed in the sulcus or sutured to the existing iris.

In this case, I would most likely cut a CustomFlex implant to size, replace the missing section of iris, and leave the intact portion of the tissue without an iris prosthesis. I would suture the device to the edges of the iris defect with mattress-placed, double-armed 10–0 polypropylene sutures. This approach would allow the residual, functioning pupil to dilate and constrict.

The residual iris can be dilated, creating access to the posterior chamber. The patient's residual refractive error—frequently present in post-RK eyes undergoing cataract surgery—could therefore be treated by a sulcus-fixated IOL of a material dissimilar to the primary IOL in the bag. Alternatively, I have developed a technique in which a piggyback (or primary) IOL can be placed in the anterior chamber and the haptics sutured to the anterior surface of the iris.[1]

MICHAEL E. SNYDER, MD

Cataract surgery alone is unlikely to resolve all of this patient's complaints. The missing iris tissue would permit light to strike the edge of the implant's lens optic, and light would pass through the temporal aphakic space. This could result in a monocular, shadowed second image, a reduction in the contrast of the primary focused image, or both. Optical phenomena are particularly common in post-RK multifocal corneas. Although an iris repair might be attempted, closing a defect of nearly 4 clock hours with sutures alone is not likely to be fully successful. Moreover, the temporal location maximizes the likelihood of unpleasant optical symptoms in the event that the suturing technique fails.

Placing an iris prosthesis in such cases is likely to mitigate or alleviate photic symptoms. I prefer to use small-incision devices placed completely within the capsular bag when possible as opposed to devices with a large diaphragm, which call for incisions of between 9 and 10 mm. The Morcher 50 and 96 series of black PMMA devices can be placed through nearly phaco-sized incisions and can be very helpful in limiting light's access to the posterior segment. Cosmesis with these devices is unchanged.

In this case, I would prefer a CustomFlex device. The device is placed in front of the PCIOL within the bag. It would be necessary to adjust the IOL power by estimating a slight decrease in IOL effectiveness, because the optic will rest slightly more posteriorly within the capsular bag relative to the zonular plane. Capsular staining is crucial for the placement of any iris prosthesis within the capsular bag (Figure 6).

(Courtesy of Michael E. Snyder, M.D.)

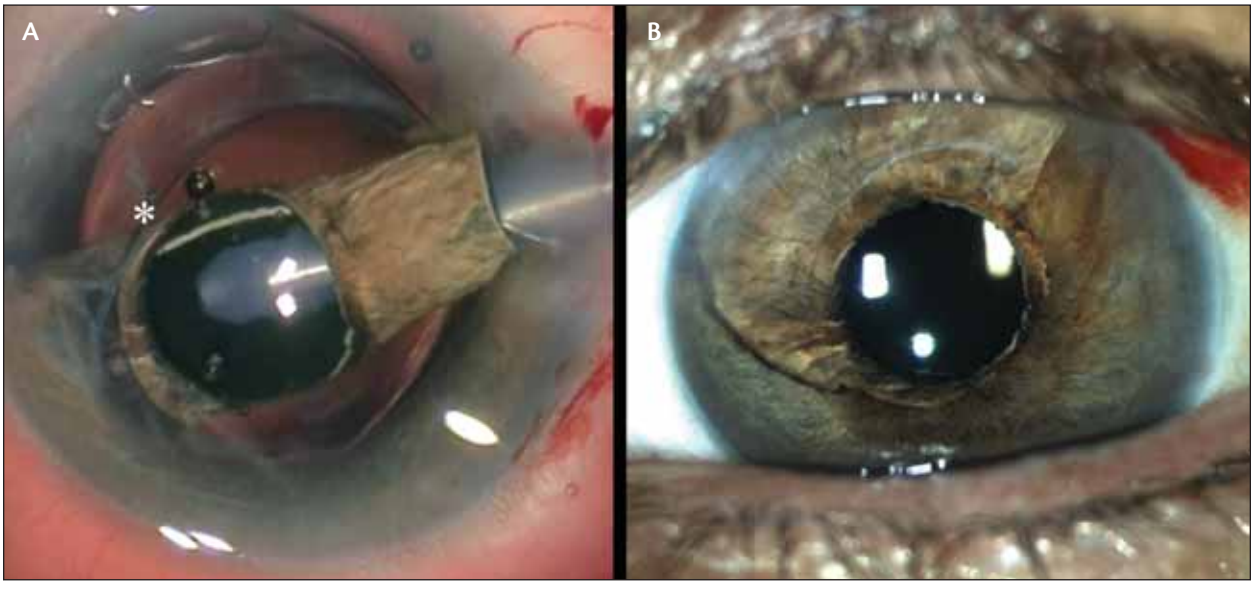
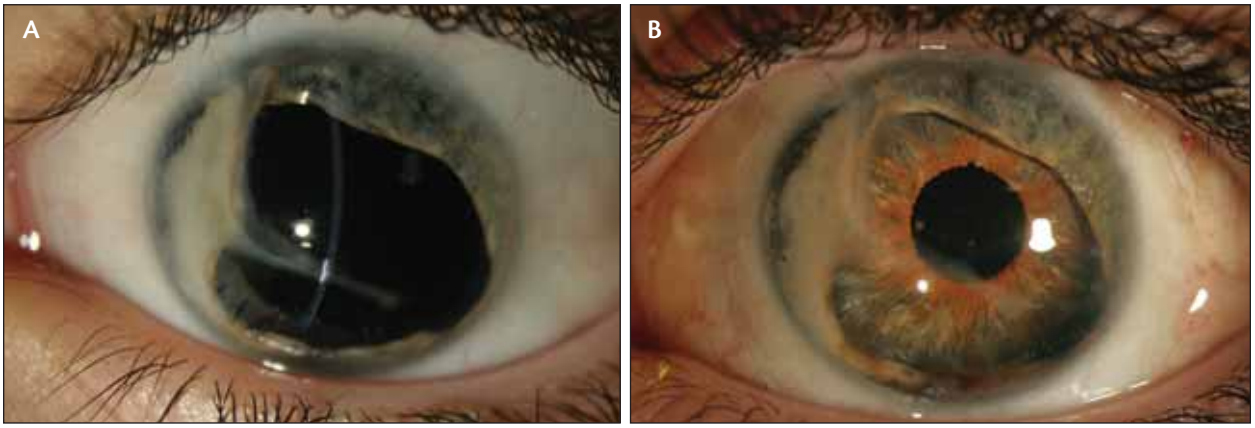


Figure 6. The CustomFlex device is injected into the capsular bag (A). Note the trypan blue staining of the capsulorhexis (asterisk) in front of the device. The device in situ (B).



(Courtesy of Diamond Y. Tam, MD.)

Figure 7. The preoperative (A) and postoperative (B) appearance at the slit lamp of the CustomFlex device implanted in the eye of a 10-year-old patient. The child previously suffered penetrating trauma with an extensive loss of iris tissue.

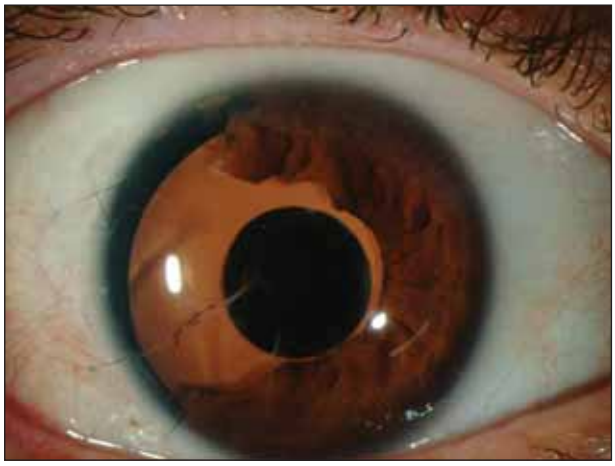
DIAMOND Y. TAM, MD

The surgeon must remove the cataract, implant an IOL, and address the missing iris tissue. A careful preoperative evaluation of zonular integrity and the corneal endothelium would be required. Intraoperatively, the surgeon would have to be prepared to use a device to support the zonules such as a CTR or a scleral-fixated Ahmed Capsular Tension Segment (Morcher GmbH; distributed in the United States by FCI Ophthalmics, Inc.) with the assistance of iris or capsular retractors. Once the cataract had been removed and an IOL securely placed, the surgeon could turn his or her attention to addressing the iris.

When repairing iris defects, I prefer to use as much of the native tissue as possible. I find that this approach typically provides the patient with the most cosmetically satisfying outcome, and it may allow me to avoid challenges such as color matching to the other eye with iris prosthetic devices. In this case, it might be possible to combine suture-mediated reapposition of the iris' edges with multiple iridodialysis mattress sutures to close the relatively large defect. That determination, however, usually cannot be made until the time of surgery with borderline large iris defects. In the event that adequate repair were impossible using the patient's own iris, an iris prosthetic device would be indicated. Of the current options, I prefer the CustomFlex, which can be injected through a cataract surgery incision, implanted in the capsular bag or unfolded in the sulcus and fixated to the sclera with Prolene sutures (Ethicon, Inc.) (Figure 7).

THOMAS OETTING, MS, MD: HOW THE CASE WAS MANAGED

The patient was admitted into a phase 3 study for the Ophtec 311 iris reconstruction IOL. I created a peritomy from about the 7- to the 11-o'clock position. Then, I made a 9-mm groove in the sclera but made sure that a thin strip of scleral tissue was present between the groove and the cornea to protect the RK incisions from separation. In the center of the groove, I used a keratome to make an initial incision of 3 mm into the anterior chamber. Next, I instilled a viscous dispersive ophthalmic viscosurgical device (OVD) into the area of missing iris tissue. The subsequent placement of a cohesive OVD over the lens pushed the dispersive OVD into the area of missing iris (sideways Arshinoff shell).



(Courtesy of Thomas A. Oetting, MS, MD.)

Figure 8. The appearance of the eye from Figure 1 at the slit lamp after implantation of an Ophtec 311 iris reconstruction IOL in the sulcus.

The capsulorhexis was uneventful. I removed the lens with a chopping technique and observed mild generalized weakness of the zonules. After placing a 13-mm CTR, I extended the wound to the right and left with corneoscleral scissors to about 9 mm. I then implanted a brown Ophthec model 311 prosthesis in the ciliary sulcus. I closed the wound with a 10–0 nylon suture. Fortunately, the RK incisions remained intact throughout the case (Figure 8). ■

Editor's note: both Dr. Miller and Dr. Rosenthal helped to develop the Morcher 50F CTR. Visit www.morcher.com for details.

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For IOL calculations after RK, we have employed many different methods. For the past few years, we have been using one introduced to us in an article written by Dr. Hill.[2] In it, he stressed understanding the ratio between the posterior and anterior corneal radii. This ratio decreases in corneas that have undergone ablation for myopic keratorefractive surgery, but it increases in eyes that have undergone RK. The ratio may allow us to use elevation data to estimate central corneal power. With the Atlas, we are able to use an average of the 1-, 2-, 3-, and 4-mm ring values to determine an estimated central corneal power to be used in our IOL power formula. Using the Holladay II formula, we enter the surgeon's K value for the IOL power calculations. This method of finding the central corneal power has proven to be the most successful in our clinic. ■

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