TRAUMATIC CATARACT WITH AN IRREGULAR PUPIL

Would surgical intervention improve vision?

BY BRANDON D. AYRES, MD; NATALIE CHEUNG, MD, MS; AND DEAN OUANO, MD

CASE PRESENTATION

A 54-year-old woman presents approximately 6 weeks after blunt trauma to her left eye. The patient states that she was attacked in a bar and struck in her left eye with an unknown object. She noticed an immediate reduction in vision in the injured eye and was taken directly to the emergency department by ambulance. At the hospital, she was diagnosed with a ruptured globe and taken to the OR for treatment of a primary rupture. She was monitored closely by both anterior segment and retina specialists after the repair but recovered little vision.

Upon presentation, BCVA is 20/20 in the patient's right eye and barely hand motions in her left. An afferent pupillary defect (APD) and irregular pupil are evident in the left eye. Slit-lamp examination of the right eye is normal. In the left eye, there is moderate conjunctival injection and a nasal limbal wound closed by multiple nylon sutures, several of which have exposed ends. The cornea is clear, and the anterior chamber has rare cells. The iris is irregular and peaked from tissue incarcerated in the nasal limbal laceration. A traumatic cataract is visible with irregular striations in the anterior lens capsule. No phacodonesis is evident, but mild hemorrhage is present on the lens capsule (Figures 1–4).

The patient asks if surgery can improve her vision. What factors must be taken into consideration in this case, and how would you proceed?

—Case prepared by Brandon D. Ayres, MD

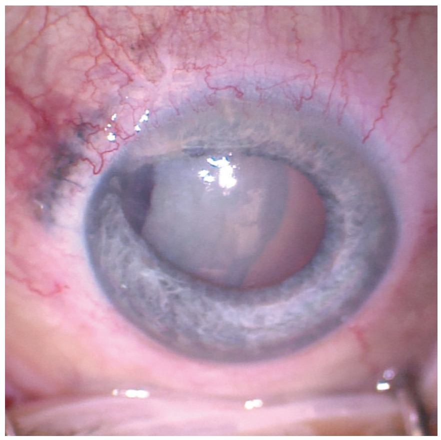


Figure 1. Nasal limbal laceration with iris incarceration and an irregular pupil in the left eye. The lens was cataractous with striations in the lens capsule and organized hemorrhage at the nasal aspect of the capsule.

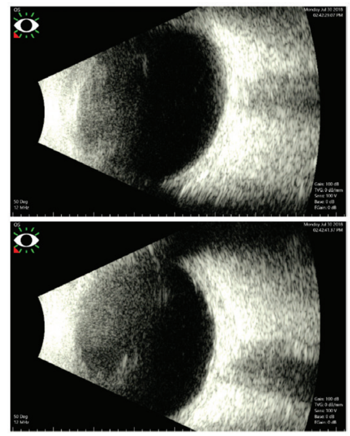


Figure 2. B-scan ultrasound images of the patient's left eye.

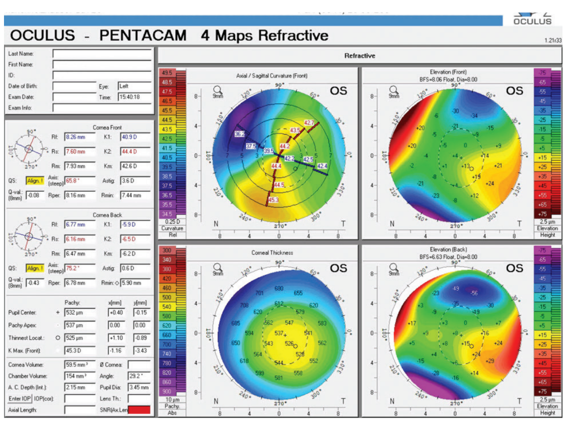
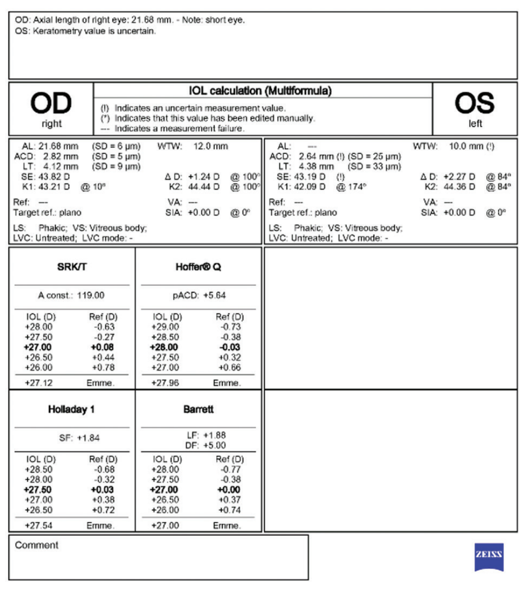


Figure 3. Tomography of the left eye showed flattening of the nasal cornea secondary to traumatic laceration.



OD: Axial length of right eye: 21.68 mm. - Note: short eye.
OS: Keratometry value is uncertain.

OD right | **IOL calculation (Multiformula)** | **OS** left

(!) Indicates an uncertain measurement value.
(*) Indicates that this value has been edited manually.
--- Indicates a measurement failure.

OD	OS
AL: 21.68 mm (SD = 6 µm) WTW: 12.0 mm	AL: --- WTW: 10.0 mm (!)
ACD: 2.82 mm (SD = 5 µm)	ACD: 2.64 mm (!) (SD = 25 µm)
LT: 4.12 mm (SD = 9 µm)	LT: 4.38 mm (SD = 33 µm)
SE: 43.82 D ΔD: +1.24 D @ 100°	SE: 43.19 D (!) ΔD: +2.27 D @ 84°
K1: 43.21 D @ 10° K2: 44.44 D @ 100°	K1: 42.09 D @ 174° K2: 44.36 D @ 84°
Ref: --- VA: ---	Ref: --- VA: ---
Target ref.: plano SIA: +0.00 D @ 0°	Target ref.: plano SIA: +0.00 D @ 0°
LS: Phakic; VS: Vitreous body;	LS: Phakic; VS: Vitreous body;
LVC: Untreated; LVC mode: -	LVC: Untreated; LVC mode: -

SRK/T		Hoffer® Q	
A const.: 119.00		pACD: +5.64	
IOL (D)	Ref (D)	IOL (D)	Ref (D)
+28.00	-0.63	+29.00	-0.73
+27.50	-0.27	+28.50	-0.38
+27.00	**+0.08**	**+28.00**	**-0.03**
+26.50	+0.44	+27.50	+0.32
+26.00	+0.78	+27.00	+0.66
+27.12	Emme.	+27.96	Emme.

Holladay 1		Barrett	
SF: +1.84		LF: +1.88 DF: +5.00	
IOL (D)	Ref (D)	IOL (D)	Ref (D)
+28.50	-0.68	+28.00	-0.77
+28.00	-0.32	+27.50	-0.38
+27.50	**+0.03**	**+27.00**	**+0.00**
+27.00	+0.38	+26.50	+0.37
+26.50	+0.72	+26.00	+0.74
+27.54	Emme.	+27.00	Emme.

Comment

IOLMaster 700 Version 1.70 Report dated 7/30/2018 3:43 PM; created by Administrator Page 1 of 6

Figure 4. Biometry of the right and left eyes. Optical biometry could not accurately measure the axial length of the left eye. A-scan ultrasound showed an axial length of 21.7 mm in the left eye.

NATALIE CHEUNG, MD, MS

The first step is to determine if surgery will improve this patient's vision. B-scan ultrasound did not show any vitreous opacity, masses, or retinal detachment that would preclude her from seeing well. An APD was detected, likely indicating traumatic damage to either the optic nerve or retina. Other tools to determine visual potential include a red saturation test, laser interferometry, and potential acuity meter testing. Given the severity of the cataract, vision will likely improve but will be limited; I would not expect it to return to the pretrauma baseline. Additionally, significant corneal astigmatism may require the patient to wear glasses or contact lenses to achieve her best possible visual acuity. Because she may be anisometropic after surgery, informed consent should include discussion of this possibility and the need for postoperative management of the condition.

A-scan ultrasound confirmed a short axial length. Tomography showed nasal flattening in the area of limbal laceration and significant corneal astigmatism that was different from that shown by optical biometry. For this reason and because of the increased risk of zonular instability, I would not select a toric IOL. Instead, I would plan to implant a one-piece monofocal IOL in the capsular bag, and I would have on hand as a backup a three-piece monofocal IOL that could be placed in the sulcus in the event that capsular rupture or mild zonular dehiscence became evident. An iris-fixated IOL would not be an appropriate option in this case because of the preexisting incarceration of the iris. If a scleral-fixated IOL were needed owing to complete capsular instability or loss during surgery, I would consider staging the procedure.

Because I expect the case to be complex, I would plan on a retrobulbar block with monitored anesthesia care. I would create a temporal clear corneal incision, stain the capsule with trypan blue dye, and place iris hooks rather than a Malyugin Ring (MicroSurgical Technology) because pupillary dilation will likely be poor and/or irregular. I would not reopen and resuture the nasal laceration if it is well sealed.

Zonular instability could make performing the capsulorhexis difficult, so, if it were present, I would make a small capsulotomy. In the event of zonular dehiscence, I would consider placing capsular hooks after completing a continuous curvilinear capsulorhexis (CCC), and I would insert a capsular tension ring (CTR) before or after cortical cleanup, depending on the situation. Other techniques to minimize zonular stress include thorough hydrodissection to facilitate cortical cleanup and horizontal or vertical chopping for nuclear disassembly.

If the capsule is centered and intact, I would place a one-piece monofocal IOL in the capsular bag. Next, I would instill triamcinolone acetonide (Triesence, Alcon) to ensure that no vitreous had prolapsed into the anterior chamber. After the IOL was in place, I would consider gently tugging on the incarcerated iris with intraocular forceps to see if I could free up the tissue. Alternatively, I would leave the iris in place and consider performing a nasal pupilloplasty using either a modified Siepser sliding knot or the McCannel suturing technique.

DEAN OUANO, MD

An APD, a scleral laceration, and retropupillary hemorrhage after a blunt force injury to the globe are clinically significant signs of either the presence or future risk of a retinal detachment. As much as anterior segment surgeons like to operate autonomously, working closely with a vitreoretinal surgical colleague would be in this patient's best interest. If the presence of a retained intraocular foreign body has not been ruled out, a helical or spiral computed tomography scan of the orbits with 3-mm axial and coronal cuts should be performed to rule it out.

There is an approximately 5-mm scleral laceration in the nasal quadrant, roughly parallel and 2 mm posterior to the limbus. The anatomic location of the scleral rupture likely corresponds to the iris root (or ciliary body, considering the eye's relatively short axial length). Because uveal exposure to the conjunctival circulation is a known risk factor for the development of sympathetic ophthalmia, this scleral wound must be revised. Uveal tissue incarcerated in the incision should be removed. Gentle ab interno pulling of the displaced pupillary margin with Snyder forceps (MicroSurgical Technology) may normalize the iris architecture, after which the wound can be properly sutured with 10-0 nylon with the knots buried.

After performing a three-port pars plana vitrectomy (PPV) and lensectomy with appropriate management of posterior segment injuries, I would implant a posterior chamber IOL (CZ70BD, Alcon) and secure it with PTFE sutures under superior and inferior Hoffman reverse scleral tunnels.

WHAT I DID: BRANDON D. AYRES, MD

The patient and I discussed at length the risks and benefits of cataract surgery and the increased complexity of the case, given her

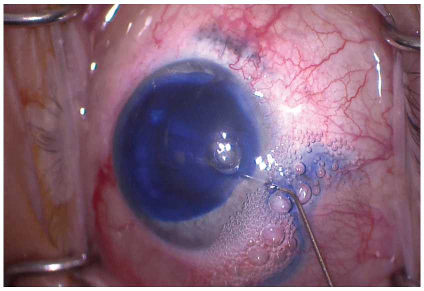


Figure 5. The anterior capsule was stained with trypan blue dye to improve visualization.

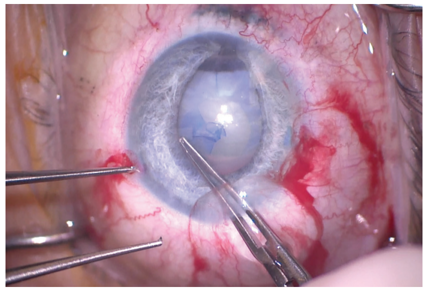


Figure 6. The surgeon used Utrata forceps to make the capsulorhexis. The irregular pupil made creation of a large capsulorhexis difficult.

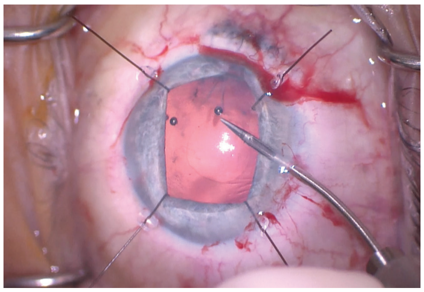


Figure 7. Flexible iris retractors were used to improve access to the anterior capsule, and microscissors were used to cut the edge of the capsulorhexis, allowing enlargement of the CCC.

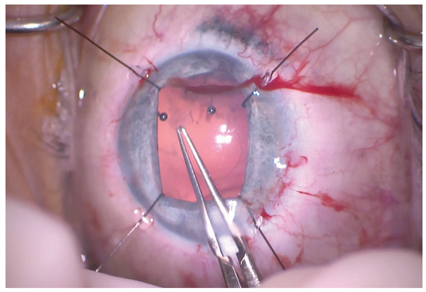


Figure 8. The Utrata forceps were used to enlarge the capsulorhexis.

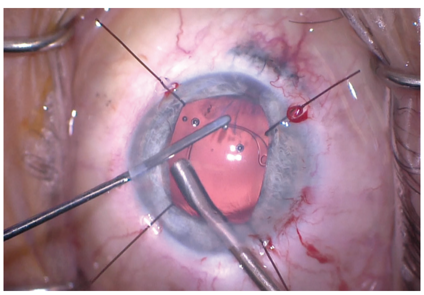


Figure 9. A CTR was inserted after enlargement of the CCC.

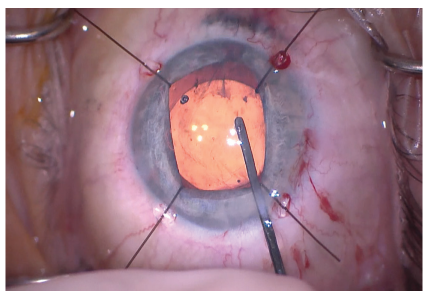


Figure 10. The IOL was inserted into the capsular bag. The stability of the capsular bag allowed excellent centration.

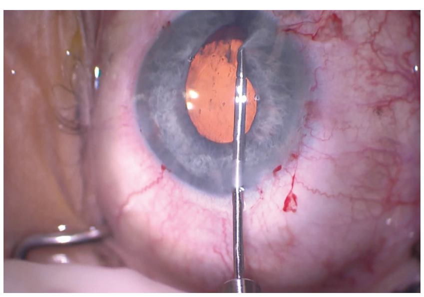


Figure 11. The surgeon used microforceps to check the elasticity of the iris tissue and to make sure an iridoplasty could be performed. Microforceps can also be used to show where a polypropylene suture should be placed to minimize the irregularity of the pupil.

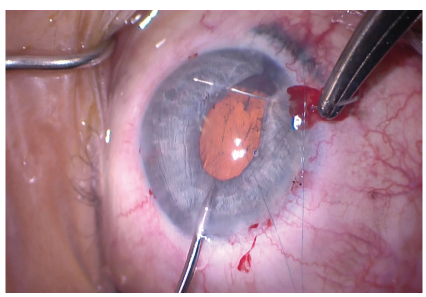


Figure 12. A 10-0 polypropylene suture on a curved needle was used to make an iridoplasty to re-create the pupillary border.

recent history of trauma. I explained the potential need for a PPV in the event of traumatically induced capsular or zonular damage. I also emphasized that her visual potential was uncertain because the presence of an APD indicated damage to the optic nerve, but I stated that the extent of the damage could not be estimated. The patient understood the increased complexity and risk of surgery but was highly motivated to improve her vision and agreed to surgery.

My plan was to remove the cataract, potentially requiring PPV, and to repair the iris, if possible. To improve visualization of the anterior capsule, I instilled trypan blue dye into the anterior chamber and then rinsed it with balanced saline solution (Figure 5). It subsequently became clear that the anterior capsule was intact, so I created a small CCC with a cystotome and Utrata forceps (Figure 6).

Next, I used bimanual I/A to aspirate the lens material; because of the softness of the lens, no phacoemulsification was necessary. The red reflex then allowed improved visualization of the capsular bag. No capsular defect was evident—a pleasant surprise—which meant that an IOL could be placed in the capsular bag. No vitreous prolapse or severe zonulopathy was encountered during the lens removal portion of the surgery.

The size of the original CCC had been limited by pupillary size, so the capsular opening was enlarged in order to prevent capsular phimosis. To improve visualization, I placed flexible iris retractors and then used microscissors and Utrata forceps to enlarge the CCC (Figures 7 and 8). After placing a CTR in the capsular bag, I implanted the IOL (Figures 9 and 10). With the implant securely located within the capsular bag, I removed the flexible iris retractors, allowing the iris to recover its original configuration. I administered a miotic agent to constrict the pupil. With microforceps, I tested the elasticity of the iris tissue to ensure that an iridoplasty could be performed without putting too much tension on the iris (Figure 11). I found that the iris had retained significant elasticity, and I placed a 10-0 polypropylene suture to create a more centered pupil (Figure 12).

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MULTIFOCAL IOLS CAN PROVIDE SPECTACLE INDEPENDENCE AND PATIENT SATISFACTION

Trifocals add clear intermediate vision to the benefits of these lenses.

BY TIAGO MONTEIRO, MD, FEBO, FEBOS-CR

Multifocal IOLs have been implanted since 1986, and over that time they have evolved and improved greatly. Modern multifocal IOLs can be considered as a surgical treatment not only for cataract but also for refractive purposes when implanted after clear lens extraction. These lenses can be used to correct presbyopia, hyperopia, myopia, and, with toric multifocal models, astigmatism.

The primary aim of multifocal IOL implantation is to restore visual function and provide spectacle independence with a good level of patient satisfaction. With proper IOL selection and successful surgical technique, spectacle independence can be expected not only at distance but also at intermediate and near.[1] In sports and other recreational activities, spectacle independence is desirable and can greatly improve a patient's quality of life.

Most patients expect good visual outcomes after surgery, and most modern multifocal IOLs can deliver good near, intermediate, and distance vision. This is an improvement compared with previous generations of bifocal IOLs, with which intermediate vision was frequently compromised. Now with trifocal IOL technology, the addition of the intermediate focus has expanded the indication for this type of surgery to younger patients with a clear but dysfunctional crystalline lens.[2]

PATIENT SATISFACTION

Obtaining a good surgical result and patient satisfaction depends on careful preoperative planning and individualized IOL selection based on the patient's preexisting conditions, visual needs, and realistic expectations. It also depends on the surgeon's knowledge of the optical designs and visual performance of the available multifocal IOLs, proper surgical technique, and a comprehensive strategy for complications management.

The main reasons for patient dissatisfaction following multifocal IOL implantation are dry eye, residual refractive error (mainly astigmatism), and night vision complaints such as glare and halos.[3,4]

TYPES OF MULTIFOCAL IOLS

In order to disperse the light entering the eye to two different foci simultaneously, to provide far and near vision, a multifocal IOL either refracts or diffracts the light, or it does both. Therefore, multifocal IOLs are classified as having a refractive, diffractive, or combined mechanism.

Refractive mechanism. The refractive models achieve multifocality using annular zones with different refractive powers, and they generally provide acceptable far and intermediate vision. Their optical systems are dependent on pupil dynamics and diameter, are sensitive to postoperative decentration, may cause halos and glare, and inherently reduce contrast sensitivity.

Diffractive mechanism. Diffractive IOL models use diffractive rings distributed in a concentric fashion that either get closer to each other further from the center (apodized diffractive) or do not (nonapodized). These IOLs generally provide good far and near vision, but intermediate vision may not be satisfactory with bifocal models.[5] They are not so dependent on pupil dynamics as refractive multifocals and are more tolerant to decentration, but they also can affect contrast sensitivity and can be associated with positive and negative dysphotopic optical phenomena.

Combined mechanism. Trifocal IOLs are a subtype of diffractive multifocal IOLs, designed to improve intermediate visual acuity by adding a third focus.[6,7] A recent systematic meta-analysis of patient outcomes following implantation of trifocal or bifocal IOLs demonstrated that patients can

Figure 1. The RayOne Trifocal IOL.

achieve better intermediate visual acuity with a trifocal IOL than with a bifocal IOL without any adverse effect on distance or near acuity.[8]

BENEFITS AND POTENTIAL SIDE EFFECTS OF MULTIFOCAL IOLS

The primary purpose of multifocal IOLs is to provide patients with spectacle independence thanks to good UCVA at all distances. In numerous studies,[1,8] implantation of refractive and diffractive multifocal IOL models has been shown to result in high levels of uncorrected distance and near visual acuity: mean uncorrected near and distance visual acuity was 20/25 or better in these studies, resulting in complete spectacle independence for about 75% of patients.

The downside of multifocal IOLs is that they are generally associated with more photic phenomena and decreased contrast sensitivity function in comparison with monofocal IOLs. Bifocal multifocals also tend to provide decreased visual acuity at intermediate, in comparison with far and near distance acuity.

Halos and glare are reported more often by individuals with a multifocal IOL compared to those with a monofocal IOL,[3] and refractive multifocal IOLs appear to be associated with more photic phenomena compared with diffractive multifocal IOLs.[3]

CLINICAL STUDIES

We have been using trifocal technology since this type of multifocal IOL became available in Europe in 2012. Our practice has vast experience with almost every trifocal model available, including the AT LISA tri 839MP (Carl Zeiss Meditec), the FineVision POD F (PhysIOL), the AcrySof IQ PanOptix (Alcon), and, most recently, the RayOne Trifocal (Rayner, Figure 1).

At the 2018 ESCRS meeting in Vienna, we shared our preliminary results with the RayOne Trifocal in 20 eyes of 10 patients. In terms of refractive outcome, all patients were within ±0.50 D of spherical equivalent target at 3 months postoperative. The safety and efficacy index was above 1.0 for all patients; mean binocular UCVA (logMAR) in these 20 eyes was 0.00 ±0.04 for distance, -0.10 ±0.07 for intermediate, and 0.10 ±0.08 for near (Figure 2).

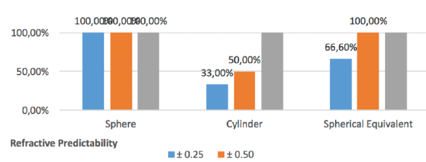
The defocus curve also showed excellent visual outcomes at all distances at 3 months, even slightly improving the results compared with other trifocal IOLs previously studied in our department (Figure 3). In our initial series, because of the higher percentage of light transmission (89%) associated with the RayOne Trifocal when compared to other IOLs (86% with FineVision, 84% with AT LISA, and 88% with PanOptix), we also observed a significantly higher contrast sensitivity level under mesopic conditions (Figure 3).

PATIENT SATISFACTION

A recent meta-analysis of peer-reviewed publications revealed evidence of high levels of patient satisfaction in general with multifocal IOLs.[9] Spectacle independence 80% or more of the time was reported by 91.6% of patients for distance vision, 100% for intermediate vision, and 70% for near vision among the different study populations.

Taking into consideration all the patients included in the studies, a binocular uncorrected visual acuity of 0.30 logMAR or better was achieved by 100% for distance, 96% for intermediate, and 97.3% for near visual acuity.

N=20	Preop Mean ± SD	Postop Mean ± SD
Sphere (D)	0.21 ± 3.18 (+5.00, -7.50)	0,0 ± 0.08 (+0,00 to -0.25)
Cylinder (D)	-1.82 ± 1.82	-0.50 ± 0.26 (0.00 to -0.75)
Spherical equivalent (D)	-0.23 ± 3.06 (+6.00, -8.00)	-0.25 ± 0.09 (-0.125 to -0.375)



LogMar Scale	Distance	Intermediate	Near
Uncorrected Monocular	0,1 ± 0,07	0,0 ± 0,06	0,1 ± 0,07
Uncorrected Binocular	0.0 ± 0,04	-0.1 ± 0.07	0.1 ± 0.08
Distance Corrected Monocular	0.0 ± 0,06	0.0 ± 0.08	0,1 ± 0.05
Distance Corrected Binocular	-0.1 ± 0.05	0.00 ± 0,00	0.1 ± 0.05

Figure 2. Preliminary results with the RayOne: All patients were within ±0.50 D of spherical equivalent target, and the safety and efficacy index was above 1.0 for all patients at 3 months postoperative.

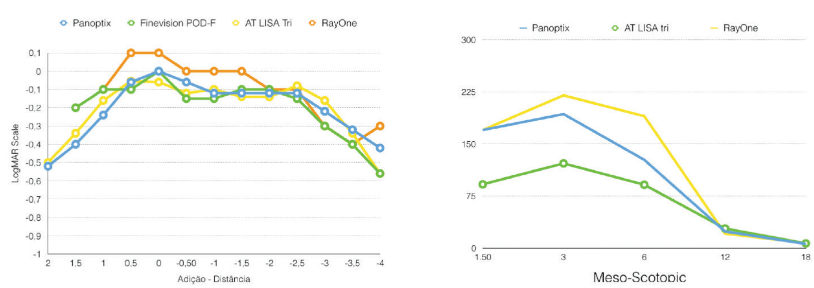


Figure 3. Preliminary results with the RayOne: Full spectacle independence and a significantly higher contrast sensitivity level under mesopic conditions was found at 3 months postoperative.

CONCLUSION

Multifocal IOLs are good options to surgically correct presbyopia. Patients achieve spectacle independence in the majority of cases, with high levels of satisfaction. The visual needs of each patient should be carefully analyzed to choose the multifocal model that best fits each one's lifestyle.[2,3,5]

As with all refractive procedures, appropriate patient selection and counseling are required, along with proper and accurate preoperative measurements. With recent advances in intraoperative techniques and multifocal IOL technology, these lenses can provide excellent outcomes with minimal risk of complications. ■

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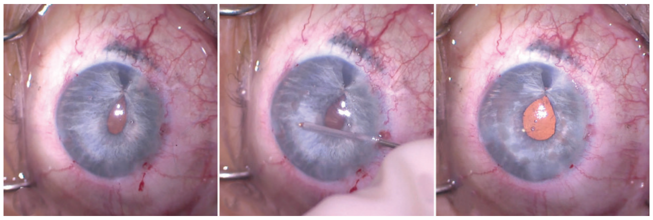

Figure 13. The shape of the pupil after placement of an iridoplasty suture. Note the peaking of the pupil at the site of the suture (left). Intraocular diathermy was used to shape the pupil (center). Pupillary shape is shown immediately after use of cautery to round out the pupillary margin. Small transillumination defects were visible in the areas of the iris where cautery was used (right).

(Continued from page 24)

Placement of a single iris suture often leaves the pupil looking quite peaked. The irregular shape may be cosmetically insignificant when the color of the tissue is dark, but a misshapen pupil is highly noticeable in an eye with a blue iris. To help shape and center the pupil, I used intraocular diathermy on a very low setting (10%–15% of maximum bipolar coagulation) to cauterize and sculpt the pupil. The thermal constriction of the iris fibers rounded out and centered the iridoplasty (Figure 13). I removed the OVD from the anterior chamber with the I/A unit and ensured that the incisions were watertight.

The patient tolerated the surgery very well, and the postoperative course was uneventful. One day after surgery, UCVA in the left eye had returned to 20/40, and it has remained stable over the past 3 months (Figure 14). ■

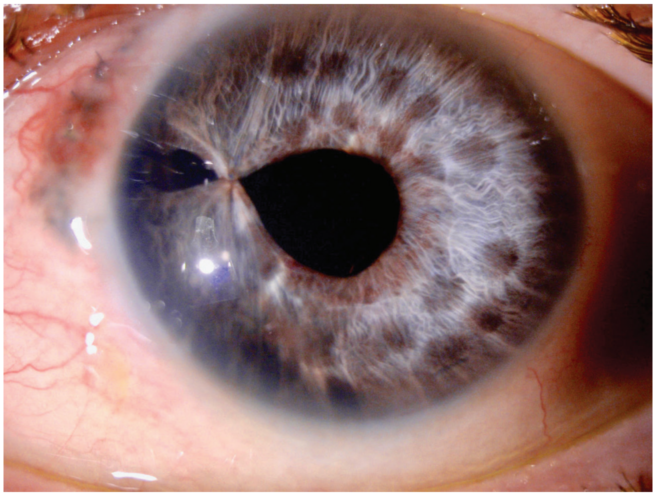

Figure 14. Three months after surgery, a slit-lamp examination of the left eye showed the iridoplasty suture and several round areas of depigmentation from iris cautery. Note the stability of the thermal damage from immediately after surgery (Figure 13) to 3 months postoperatively. Several nylon sutures from the patient's previous ruptured globe repair were visible at the nasal limbus.

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