Supplementary toric intraocular lens implantation for pseudophakic refractive error in Chinese eyes

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We report the outcomes of implantation of a supplementary toric intraocular lens (IOL) in 2 Chinese patients with high residual postoperative astigmatism. Both patients achieved a significant reduction in astigmatism and anisometropic symptoms, resulting in an overall improved visual quality and level of satisfaction. As an alternative to excimer laser procedures, a sulcus-placed supplementary toric IOL is a safe and effective alternative for patients with significant postoperative astigmatism, giving surgeons a valuable additional tool in the pursuit of achieving the best visual acuity for patients.

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Pseudophakic refractive error is a challenge and can be a frustrating issue for both the patient and the physician. It can occur after primary cataract extraction and intraocular lens (IOL) placement for a variety of reasons, including limitations of the precision and accuracy of biometric measurements, uncertainty of IOL power calculation formulas due to the unpredictability of the final effective lens position (ELP), phaco burns, or poor IOL placement. Penetrating keratoplasty (PKP) or lamellar keratoplasty in pseudophakic eyes can also result in secondary refractive errors.

Even with the best available measurements and formulas, refractive surprises still occur. Current options for the management of pseudophakic ametropia include glasses and contact lenses; however, such conservative approaches are usually limited to mild ametropia. Surgical intervention is typically required to tackle more severe levels of ametropia using corneal refractive surgery or lens-based procedures such as primary IOL exchange or placement of a supplementary IOL that is iris fixated, placed in the sulcus, or placed in the anterior chamber. The latter option is limited with toric models.

We report the outcomes of implantation of a supplementary toric IOL (Sulcoflex 653T, Rayner Intraocular Lenses, Ltd.) by the same surgeon (L.Y.) in 2 Chinese patients with high residual postoperative astigmatism. To our knowledge, these are the first 2 Sulcoflex toric IOLs to be implanted in Hong Kong and China.

CASE REPORTS

Case 1

A 79-year-old woman had phacoemulsification and IOL implantation in the right eye in 2000 at another hospital. Preoperatively, the right eye was noted to have abnormal keratometry (K) measurements, described as “distorted,” and the readings from her contralateral eye were substituted (44.5 diopters [D]) for IOL selection. It was not until 2008 that she was referred to our department for persistent blurring of vision. Clinical examination of the right eye showed corneal scarring and thinning in the superonasal area (Figure 1) and a 3-piece nontilted IOL in the capsular bag. Subjective
refraction in the right eye was plano \(-8.00 \times 110\) with an uncorrected distance visual acuity of 6/15 and a spherical equivalent (SE) of \(-4.0\) D. Her refraction in August 2010 was \(+1.50 \times 110\) (6/12). Repeated refraction in November 2013 showed \(+1.00 \times 110\) (6/18). Corneal topography showed a simulated K value of \(-8.2\) @ 105.

After discussion of the various options to neutralize the corneal astigmatism, the patient decided on secondary supplementary toric IOL implantation. The reason for her choice was the familiarity of this procedure and that it was deemed to be relatively pain free. For preoperative calculations, the subjective refraction with the corrected distance visual acuity (CDVA) in 2010 was used (plano \(-7.00 \times 110\) (6/12). A target postoperative refraction of \(-0.2\) D sphere \(-2.1\) D cylinder (Figure 2) was expected.

In view of the residual astigmatism, the axis was marked intraoperatively at 20 degrees and a 2.75 mm clear corneal incision was made on axis, with a further full-thickness limbal relaxing incision (LRI) diametrically opposite to the main entry site. A cohesive ophthalmic viscoelastic device (OVD) was injected into the anterior chamber and into the sulcus. Two corneal paracenteses were created. The integrity of the primary IOL was checked, and the supplementary IOL was implanted in the sulcus using the supplied injector and rotated to 20 degrees. The OVD was removed with thorough aspiration/irrigation above and below the supplementary IOL; the wounds were closed with stromal hydration.

The postoperative course was uneventful, with no observable increase in intraocular pressure and no pigment chafing. One week postoperatively, the patient’s refraction was \(0.50 \times 75\) (6/12), with an SE of \(-0.75\) D. Examination of the supplementary IOL showed that the axis remained aligned at 20 degrees with good stability in the sulcus (Figure 3), even at 8 months, with a refraction of \(0.50 \times 80\) (6/9.5).

Case 2

A 58-year-old sailor had uneventful phacoemulsification and IOL placement in both eyes approximately 7 years previously. The right eye had a known preexisting central corneal scar as a result of old trauma (Figure 4), and he had a PKP procedure in 2008, 1 year after cataract surgery.

He was followed at our clinic for persistent anisometropia, for which he found glasses and contact lenses intolerable. Clinical examination of the right eye showed a clear corneal graft with a 3-piece IOL (Acrysof MA30BA, Alcon Laboratories,
Inc.) in the capsular bag. Manifest refraction in the right eye showed a CDVA of $-5.50 \pm 6.00 \times 95$ (6/7.5) and an SE of $-8.50$ D. The left eye was $-0.50 \pm 0.50 \times 180$ (6/6). Corneal topography of the right eye measured a simulated K value of $-6.40 @ 102$. Multiple modalities of examination showed a consistent axis. Preoperative specular microscopy of the right eye showed a dangerously low endothelial cell count (ECC) of 598 cells/mm².

After discussion of the surgical options, the patient chose implantation of a supplementary toric IOL. The patient’s choice was dictated by the fear of the increased risk for corneal decompensation with other available methods, although other factors, such as familiarity with and ease of the procedure together with the predicted short surgical time, also weighed the balance in favor of supplementary toric IOL implantation. Preoperative online calculations estimated there would be some residual postoperative refraction of $-2.30 \pm 0.30 \times 95$, with an SE of $-2.5$ D. The patient was keen on monovision, using the distance eye to guide his boat and this eye for near vision to read his navigating maps.

The patient had surgery in June 2014 using the technique described above, paying attention to the graft, injecting the supplementary toric IOL directly into the sulcus, and deliberately reducing manipulation that might cause attrition to the ECC. The surgical incision was temporal and the toric IOL aligned to 5 degrees (Figures 5 to 8).

The patient’s postoperative course was uneventful. Examination 6 months postoperatively showed a clear corneal graft with the toric IOL showing minimal rotation (6 degrees). The ECC was 600 cells/mm². Manifest refraction showed a spherical error of $-2.00 \pm 1.50 \times 80$ (6/4.5; manifest refraction SE $-2.75$ D).

Slitlamp photography and ultrasound biomicroscopy confirmed good distance between the supplementary IOL and primary IOL, with no IOL–IOL touch (Figure 9).

Figure 3. The primary IOL with contracted anterior capsule 3 months postoperatively. The optic of the supplementary IOL is superimposed with a red dotted line. The blue arrows highlight the site of the toric axis marks on the IOL.

Figure 4. Scanning-slit corneal topography showing central steeping of the cornea with a slightly thicker pachymetry of 601 µm (comparable to that in contralateral eye).
DISCUSSION

To our knowledge, these are the first 2 reported cases in Hong Kong and China of supplementary toric IOL implantation using Sulcoflex IOLs to correct significant postoperative astigmatism. Both patients achieved a significant reduction in astigmatism, leading to reduction of anisometropic symptoms and overall improved visual quality and satisfaction.

All surgical treatments carry risks. Corneal refractive surgeries such as LRIs or arcuate keratectomy have a relatively unpredictable postoperative refractive outcome and can regress with time. Explanting a primary IOL carries risks that include posterior capsule rupture, zonular dehiscence, vitreous loss, secondary glaucoma, cystoid macular edema, and bullous keratopathy. Intraocular lens explantation performed years after the initial surgery has further risks, such as unpredictability of the ELP of the newly implanted IOL that is partly derived from the contracted capsule, which further complicates the precision of this surgery.

Supplementary IOL implantation offers advantages over IOL exchange, including better safety and predictability. Although it is possible to reopen a fibrotic capsule and explant an IOL even years after surgery, implanting a supplementary IOL in the sulcus does not require reopening the capsular bag or cutting and explanting the primary IOL, with the attendant risk to the capsule and the corneal endothelium.

In contrast, supplementary IOL implantation delivers a predictable refractive outcome while avoiding the risks associated with primary IOL explantation. The surgical time is much shorter than for IOL explantation and replacement. However, there are risks and benefits with different types of supplementary IOLs.

An alternative solution is a toric iris-claw fixated IOLs, which are generally approved as phakic IOLs only. Although there have been case reports of the

Figure 5. Marking of the limbus on a pseudophakic eye with existing PKP.

Figure 6. After toric marking of the cornea, paracenteses were made and a cohesive OVD was injected into the sulcus.

Figure 7. After insertion of the supplementary IOL, the OVD was removed below and above the optic; this was followed by wound hydration.
The use of such IOLs, anterior and retro iris use, iris-related complications, endothelial loss, and dislodging might compromise their suitability. In the past, classic piggyback IOLs were 1-piece acrylic and were implanted in the bag or in the sulcus, both of which are contraindicated in eyes with a shallow anterior chamber, narrow angles, known pigment dispersion syndrome, or uveitis. In addition, anterior chamber aphakic use of such IOLs, anterior and retro iris use, iris-related complications, endothelial loss, and dislodging might compromise their suitability.

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Previously, piggyback IOL techniques were associated with interlenticular opacification that could not be easily managed with a neodymium:YAG laser capsulotomy. Furthermore, iris chafing can lead to pigment dispersion, uveitis, and secondary glaucoma. The Sulcoflex IOL was designed to avoid these problems. It is a 1-piece hydrophilic acrylic IOL with a 6.5 mm optic and a 14.0 mm haptic-to-haptic length. The undulating haptics are posteriorly angled at 10 degrees, while the optic has a convex anterior surface and a concave posterior surface. The shape and angle of the haptics allow the Sulcoflex piggyback IOL to avoid contact with the primary IOL and the posterior iris, reducing the risk for interlenticular opacification and iris chafing. The large diameter haptic-to-haptic distance also increases rotational stability in the sulcus, an essential requirement for toric IOLs.

Recent studies examining the postoperative outcomes of several patient cohorts (the largest study involving 80 eyes) found no incidence of iris chafing, uveitis, or IOL instability. The first report of transscleral fixation of a toric IOL in an aphakic eye by Borkenstein et al. found an uneventful postoperative course with refractive stability over 2 years of follow-up.

There are improvements to be made to the Sulcoflex IOL. First, the toric markings are faint and difficult to visualize, particularly if there is opacity from the primary IOL or remnant cortical material. Second, the axis marks are peripheral on the larger-than-normal optic and thus are obscured by the iris if the eye is aphakic use of such IOLs, anterior and retro iris use, iris-related complications, endothelial loss, and dislodging might compromise their suitability. In the past, classic piggyback IOLs were 1-piece acrylic and were implanted in the bag or in the sulcus, both of which are contraindicated in eyes with a shallow anterior chamber, narrow angles, known pigment dispersion syndrome, or uveitis. In addition, anterior chamber aphakic use of such IOLs, anterior and retro iris use, iris-related complications, endothelial loss, and dislodging might compromise their suitability.

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not well dilated. Third, the supplementary IOL is much bigger than an ordinary IOL; during injection of the IOL, there is a tendency for the IOL to shoot out as it is compressed tightly in the provided injector. Last, there is discussion about whether a peripheral iridotomy is needed with a larger optic IOL and during cases in which pupillary block is a possibility. Neither case here required a peripheral iridotomy. The clinician should exercise sound judgment in this area.

Our experience so far with the Sulcoflex supplementary toric IOL has been positive. We found that inserting the IOL is a simple procedure well within the skill set of most cataract surgeons. Both our patients achieved good vision and significant correction of the postoperative residual refractive error and had good rotational stability of the supplementary IOL. Furthermore, there was no reduction in the ECC in the second case, although longer follow-up is needed to validate this finding. As an alternative to excimer laser procedures, a sulcus-placed supplementary toric IOL is a safe and effective alternative for patients with significant postoperative astigmatism, giving surgeons a valuable additional tool in the pursuit of spectacle independence for their patients.

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