Toric intraocular lens implantation in eyes with forme fruste keratoconus

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We describe 2 cases of hydrophobic aspheric toric IOL implantation following phacoemulsification in eyes with topographic evidence of keratoconus. Several modalities of keratometric measurement were used preoperatively. Postoperatively, visual acuity, manifest refraction, and toric IOL axis were examined. At 6 months, the corrected distance visual acuity in Case 1 was 20/25 (1.75 diopters refractive cylinder) and the uncorrected distance visual acuity in Case 2 was 20/20 (no refractive cylinder). These 2 cases demonstrate that toric IOL implantation at the time of cataract surgery can be a safe and effective method for correcting astigmatism in eyes with forme fruste keratoconus when the preoperative steep meridian can be identified.

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Although implantation of a toric intraocular lens (IOL) at the time of cataract surgery is an excellent treatment option for cataract patients with regular corneal astigmatism,1–6 few studies explore the role of toric IOL implantation in cataract patients with irregular astigmatism due to keratoconus.7–12 We report 2 eyes (2 patients) with topographic evidence of keratoconus that had toric IOL implantation at the time of cataract surgery.

CASE REPORTS

Case 1

A 63-year-old Hispanic woman presented with 3 months of floaters, flashing lights, and decreased vision in the right eye. Ocular history was significant for bifocal spectacle wear for 10 years, and the patient reported good vision in both eyes. She had no significant medical history, was taking a multivitamin, and used artificial tears as needed. She reported no known drug allergies. The corrected distance visual acuity (CDVA) was hand motions in the right eye and 20/30 in the left eye. The spectacle prescription was −0.75 C 2.75 C 136 and +1.25 C 0.75 C 27, respectively. In the right eye, light could be projected in 4 quadrants but a finger-counting visual field examination could not be performed. The visual field was normal in the left eye. Motility examination and pupil responses were normal. Slitlamp examination revealed a mature white cataract in the right eye and an anterior subcapsular cataract in the left eye. Applanation tonometry (Goldmann) was 10 mm Hg and 11 mm Hg, respectively. There was no view of the fundus in the right eye, but the left eye showed a 0.45 cup/disc ratio with an otherwise normal-appearing fundus.

Cataract surgery was discussed with the patient, and she elected to proceed. Corneal topography of the right eye showed a pattern consistent with pellucid marginal degeneration; minimum corneal thickness was 470 μm, and the thinnest portion of the cornea was decentered inferotemporally (Figure 1). Keratometry measurements by 3 devices are shown in Table 1. Corneal topography of the left eye showed oblique axis corneal astigmatism of 1.5 D (simulated K of 43.7/45.2 @ 43), with the thinnest area within 1.5 mm of the corneal apex.

Forme fruste keratoconus was diagnosed in addition to cataracts. The patient was given a guarded visual prognosis because of the inability to examine the retina (patient declined referral to a retinal specialist because of lack of insurance) and because of the keratoconus-like corneal topography. Despite the irregular corneal astigmatism, because there was good agreement between the 3 keratometry measurements (both magnitude and direction, particularly between the IOLMaster and Orbscan), the implantation of a toric IOL in the left eye was offered.

Sutureless small-incision (2.4 mm) cataract surgery (phacoemulsification) using trypan blue dye to aid in visualization of the capsulorhexis was performed. Surgery proceeded uneventfully, and a hydrophobic acrylic aspheric toric IOL (SN60T5, Alcon Surgical, Inc.) was implanted with the toric alignment markings aligned with the 148-degree meridian. At the 1-week examination, the CDVA was 20/25 with a manifest refraction of −0.75 +1.75 × 149 and the IOL was oriented along the 142-degree meridian.
Case 2

A 50-year-old man with a history of forme fruste keratoconus and cataracts presented with complaints of decreasing vision and problems with glare. Ocular history was significant for forme fruste keratoconus, first diagnosed in the right eye 2 years earlier by corneal topography (Figure 2, A). The patient was otherwise healthy and took no medications. The UDVA was 20/70 in the right eye and 20/50 in the left eye. The CDVA was 20/30 with a refraction of $\text{C}0^\circ \text{C}0.50 \text{C}0.75^\circ \text{C}2170^\circ$ in the right eye and 20/25 with a refraction of $\text{C}0.75 \text{C}0.25^\circ \text{C}289^\circ$ in the left eye. The acuity was reduced to 20/400 in each eye with brightness acuity testing. Keratometry and simulated Ks are shown in Table 1.

Stereopsis and color-vision testing were normal, as were external ocular examination, motility, and pupil responses. Slitlamp examination demonstrated 4 + anterior subcapsular and 2 to 3 + posterior subcapsular cataracts in the right eye and 3 + anterior subcapsular and 3 + posterior cortical cataracts in the left eye. Funduscopic examination was normal with a cup/disc ratio of 0.3 in both eyes.

The patient wanted to proceed with cataract surgery in both eyes, but management of the corneal astigmatism posed challenges. Because there appeared to be some agreement in the axes between the simulated Ks (normally our most reliable axis measurement) and the IOLMaster keratometry (Table 1), the decision was made to perform cataract surgery in the right eye with phacoemulsification through a 2.4 mm incision and implantation of an acrylic aspheric toric IOL (SN6AT3, Alcon Surgical, Inc.) with 1.5 D of cylinder correction at the IOL plane oriented in the 160-degree meridian. The procedure was performed uneventfully and at 6 months,
Figure 2. Case 2. Corneal topography showing inferior steepening, inferior displacement of the corneal apex, with thin pachymetry values (479 μm in the right eye, 474 μm in the left eye), suspicious for keratoconus.
the UDVA was 20/25 and Jaeger (J) 2. The left eye was treated 1 week after the right eye. Based on the keratometry measurements from the Orbscan (Figure 2, B) and the IOL-Master, an acrylic aspheric nontoric IOL (SN60WF, Alcon Surgical, Inc.) was implanted.

At the last follow-up (6 months postoperatively), the UDVA was 20/20 and J2 in the left eye. The CDVA was 20/20 with a refraction of /C0.25 in the right eye and 20/20 with plano in the left eye.

DISCUSSION

The preceding 2 cases show that toric IOL implantation at the time of cataract surgery in eyes with forme fruste keratoconus can result in low levels of postoperative refractive astigmatism and good uncorrected and corrected vision. The eyes presented were considered for toric IOL implantation because the keratoconus was nonprogressive by history, the spectacle-corrected vision had been good prior to cataract development, and the astigmatism axes were reproducibly measured preoperatively by different modalities. The agreement preoperatively of corneal astigmatism magnitude and axis as measured with different devices (ie, Orbscan, IOLMaster, and autorefractor in Case 1 and Orbscan and IOLMaster in Case 2) may have contributed to the success of this nontraditional treatment. The postoperative refractive astigmatism in Case 1 would likely have been lower if the toric IOL were closer to the intended orientation (6 degrees off axis).

Other investigators have also reported good results with similar treatment in keratoconic eyes. Sauder and Jonas’ were the first to report the use of a toric IOL at the time of cataract surgery in eyes with keratoconus. At the 6-month follow-up, both of the treated eyes had an improvement in refractive cylinder and no complications were reported. Navas and Suárez subsequently described results of clear lens extraction and implantation of a toric IOL in 2 eyes (2 patients) with astigmatism due to forme fruste keratoconus. They reported a dramatic improvement in refractive cylinder and stable vision at the 12-month follow-up, with no evidence of IOL rotation or keratoconus progression. Other investigators have reported similarly good efficacy of the toric IOL to improve refractive cylinder in eyes with keratoconus having cataract surgery or refractive lensectomy (Table 2).

While neither of our 2 patients wore rigid gas-permeable (RGP) contact lenses, RGP lenses are a common treatment option for patients with irregular astigmatism/keratoconus. One unique risk with toric IOL implantation (particularly when higher toric powers are used) is that the IOL can limit the success of RGP fitting, if needed, following the IOL implantation procedure as the IOL’s toricity becomes manifest with an RGP lens.

The major challenge of toric IOL implantation in eyes with keratoconus is determining the true magnitude and direction of the corneal astigmatism. Devices that measure intraoperative aberrometry may improve the accuracy and reproducibility of this treatment method, although the accuracy of these measurements in eyes with irregular astigmatism has not been documented. Larger studies with longer follow-up are needed to effectively evaluate new approaches to managing keratoconus.

Table 2. Summary of prior studies examining pseudophakic toric IOL implantation for keratoconus.

| Study* | Year | Number of Eyes (Patients) | Preoperative Refraction and VA |
|--------|------|--------------------------|--------------------------------|
| Sauder7 | 2003 | 2 (2)                    | Case 1: +4.5 – 6.5 × 80 CDVA 20/50 Case 2: +14.0 – 24.0 × 95 CDVA 20/57 |
| Navas8 | 2009 | 2 (2)                    | Case 1: –6.50 – 3.00 × 135 UDVA 20/800; CDVA 20/30 Case 2: –5.00 – 3.00 × 85 UDVA 20/800; CDVA 20/30 |
| Visser9 | 2011 | 3 (2)                    | Case 1: –1.00 – 6.00 × 85 UDVA 20/400 Case 2 OD: –12.00 – 5.00 × 40 UDVA 20/40; CDVA 20/40 Case 2 OS: –8.00 – 2.50 × 170 UDVA 20/400; CDVA 20/30 |
| Jaimes10 | 2011 | 19 (13)                  | Mean cylinder 3.95 ± 1.30; mean UDVA 20/447 |
| Nanavaty11 | 2012 | 12 (9)                 | Mean cylinder 3.00 ± 1.00 D; mean UDVA 20/400 –3.25 – 4.0 × 98 UDVA 20/200 |
| Levy12 | 2012 | 1                      | |

CDVA = corrected distance visual acuity; IOL = intraocular lens; OD = right eye; OS = left eye; UDVA = uncorrected distance visual acuity; VA = visual acuity
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follow-up are needed to clarify which eyes with forme fruste keratoconus would be best suited for toric IOL implantation during cataract surgery.

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Table 2. (Cont.)

| Type of Surgery       | IOL Used                              | Postoperative Refraction and VA                           |
|-----------------------|---------------------------------------|----------------------------------------------------------|
| Cataract extraction   | MicroSil toric MS 6116 TU             | Case 1: CDVA 20/25; +0.75 – 2.5 × 80                      |
|                       |                                       | Case 2: CDVA 20/30; +1.0 – 2.0 × 90                       |
| Clear lens extraction | Acrysof toric IOL                     | UDVA 20/25 in both cases                                  |
|                       |                                       | –0.25 –0.50 × 140 and +0.25 –0.50 × 60, respectively     |
| Cataract extraction   | Case 1: Acrysof SN60T9                 | Case 1: 0.00 –1.50 × 120                                  |
|                       | Case 2 OD: Acrysof SN60T9             | UDVA 20/50, CDVA 20/30                                    |
|                       | Case 2 OS: Acrysof SN60T5             | Case 2 OD: –2.50 –1.50 × 85                               |
|                       |                                       | UDVA 20/130, CDVA 20/40                                   |
|                       |                                       | Case 2 OS: –0.25 –0.75 × 180                              |
|                       |                                       | UDVA 20/30, CDVA 20/25                                    |
| Clear lens extraction | AcrySof SN60TT (T3 to T9)             | Mean cylinder 1.36 ± 1.17 D; mean UDVA 20/39              |
| Cataract extraction   | AcrySof SN60TT (T3 to T9)             | Mean cylinder 0.70 ± 0.80 D; UDVA 20/40 or better in 75%  |
|                       |                                       | +0.75 – 1.5 × 125; UDVA 20/30                             |