Comparison of the Visual Outcomes and OPD-Scan Results of AMO Tecnis Toric and Alcon Acrysof IQ Toric Intraocular Lenses

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ABSTRACT

PURPOSE: To compare the visual outcomes and wavefront analyses of patients who underwent cataract surgery with the implantation of a Tecnis toric intraocular lens (IOL) (Abbott Medical Optics) with those patients who received an Acrysof IQ toric IOL (Alcon Laboratories Inc).

METHODS: The study included 40 eyes from 26 patients with regular corneal astigmatism between 1.00 and 3.00 diopters (D) who were undergoing phacoemulsification with implantation of a toric IOL. Patients were randomized into two groups (20 eyes in each group): one group received the Tecnis toric IOL (Tecnis group) and one group received the Acrysof IQ toric IOL (Acrysof group). Over a 2-month follow-up period, the main outcome measures were uncorrected (UDVA) and corrected distance visual acuity (CDVA), spherical equivalent refraction, residual astigmatism, rotational stability of the IOL, and higher order aberrations, measured with a dynamic retinoscopy aberrometer.

RESULTS: At 2-month follow-up, UDVA, CDVA, spherical equivalent refraction, and residual astigmatism showed no statistically significant between-group differences (P=.834, P=.178, P=.447, and P=.166, respectively). No eye had IOL rotation >10°. The toric IOL axis misalignment was similar in both groups (3.15°±2.62° in the Tecnis group and 3.25°±2.04° in the Acrysof group, P=.265). No statistically significant between-group differences were noted for all ocular aberrometry values, except for spherical aberration, which was higher in the Acrysof group (P=.029).

CONCLUSIONS: Both studied IOLs promoted good postoperative UDVA, CDVA, and refractive results. Rotational stability was excellent for both IOLs. Postoperative spherical aberration was higher for the Acrysof toric IOL; however, this difference did not seem to affect overall visual quality. [*J Refract Surg*. 2012;28(8):551-555.]
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Emmetropia is the objective of modern cataract surgery. Spherical refractive errors should be managed by accurate biometry. In addition, astigmatism correction should be a target of the surgery, providing independence from spectacles.

The prevalence of preoperative corneal astigmatism ⩾1.00 diopters (D) in patients undergoing cataract surgery is estimated to be between 30% and 37%.[1-3] Several techniques exist to correct corneal astigmatism, including limbal relaxing incisions,[4] opposite clear corneal incisions,[5] excimer laser refractive procedures,[6,7] femtosecond laser–assisted astigmatic keratotomy,[8] and toric intraocular lens (IOL) implantation.[9] Several studies have shown that toric IOL implantation is more effective and predictable than incisional corneal refractive techniques, although a recent study found this to be true only for higher degress of astigmatism.[10,11]

Several toric IOL models are available. The purpose of this study was to perform a comparative evaluation of the visual and refractive outcomes after phacoemulsification with implantation of two types of toric IOLs in patients with low to moderate corneal astigmatism.

PATIENTS AND METHODS

Patient Population

This prospective clinical study was performed at the Egas Moniz Hospital, Lisbon, Portugal. Patients undergoing phacoemulsification between August 2011 and December 2011 were randomly assigned to receive one of two types of toric IOLs. In one group, patients received the Tecnis toric ZCT150-400 (Abbott Medical Optics Inc [AMO], Santa Ana, California) (Tecnis group), and in the other group, patients received the

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Acrysof IQ Toric SN6AT3-6 (Alcon Laboratories Inc, Ft Worth, Texas) (Acrysof group). The characteristics of both IOLs are shown in Table A (available as data material in the PDF version of this article). The study was performed in accordance with the principles of the Declaration of Helsinki. All patients provided written informed consent.

Inclusion criteria were senile cataract and regular corneal astigmatism between 1.00 and 3.00 D. Exclusion criteria were irregular astigmatism, corneal dystrophy, tear-film or pupillary abnormalities, history of glaucoma or intraocular inflammation, macular disease or retinopathy, or neuro-ophthalmic disease. Patients were excluded from final analysis if they had any intra- or postoperative complications other than IOL rotation.

Preoperative Assessment

Preoperatively, all patients had a full ophthalmologic examination, including Snellen distance (4 m) UDVA and CDVA, subjective refraction, slit-lamp examination, Goldmann applanation tonometry, and dilated funduscopy in mydriasis.

Intraocular lens power was calculated using the Hoffer Q and SRK/T formulas. The goal was emmetropia. Hoffer Q was used for axial length <22 mm, and SRK/T was used for axial length ≥ 22 mm. Axial length values were obtained using the IOLMaster partial coherence interferometer (Carl Zeiss Meditec, Jena, Germany). Keratometry values were obtained using the Pentacam rotating Scheimpflug imaging device (Oculus Optikgeräte GmbH, Wetzlar, Germany).

Intraocular lens cylinder power and axis placement were calculated using the online calculator for each IOL. For the Acrysof toric IOL, the Acrysof toric calculator (http://www.acrysoftoriccalculator.com) was used with an A-constant of 119.2; for the Tecnis toric IOL, the Tecnis toric express calculator was used (http://www.amoeasy.com/calc%28bD1lbiZjPTA1MA==%29/Default.htm) with an A-constant of 119.3. Surgically induced astigmatism of 0.50 D was assumed in all cases.

Surgical Technique

With the patient seated to prevent cyclorotation, the 0 to 180° meridian was marked using an Elies pendulum marker (E.Janach srl, Como, Italy). Intraoperatively, the implantation axis was marked using a Mendez degree gauge (Duckworth & Kent Ltd, Hertfordshire, United Kingdom) and an axis marker (Duckworth & Kent Ltd) based on the axis obtained from the toric calculator program.

One experienced surgeon (T.F.) performed all surgeries under topical anesthesia using a standard bimanual microincision phacoemulsification technique. The IOLs were implanted with an injector (Monarch III [Alcon] for the Acrysof and DK7786 syringe-style inserter [Duckworth & Kent Ltd] for the Tecnis) through an enlarged corneal incision (2.4 mm at 120°). After implantation of the IOL and complete aspiration of the viscosurgical device (Healon, AMO), the IOL was rotated to its final position by aligning the corneal axis marks with the reference marks on the IOL.

Postoperatively, patients were prescribed moxifloxacin 0.5% (Vigamox, Alcon Laboratories Inc), prednisolone acetate 1% (Frisolona forte; Allergan, Irvine, California), and ketorolac 0.5% (Acular, Allergan).

Postoperative Assessment

Postoperative examinations were performed at 1 day, 1 week, and 1 and 2 months after surgery using the same tests as for the preoperative examination. At 2-month follow-up, ocular aberrometry was performed with the Optical Path Difference (OPD)-III scan refractive power/corneal analyzer system (NIDEK Co Ltd, Gamagori, Japan). The system is a combination autorefractometer, Placido disk topographer, and wavefront aberrometer. It performs aberrometry with dynamic skiascopy with an acquisition of 1440 data points to produce a map of the optics of the entire eye. After subtracting corneal aberrations from total eye aberrations, internal aberrations are also determined.[12] The OPD-Scan automatically performs 3 measurements and yields the mean of these 3 measurements as an output. The parameters analyzed for a 4.0-mm pupil included the root-mean-square (RMS) of higher order aberrations, RMS of the total spherical aberration, RMS of the total coma, and RMS of the total trefoil, and point spread function (PSF), expressed as the Strehl ratio. The PSF expresses the effect of the aberrations on the retinal image and consequently the quality of the image. The Strehl ratio is a measure of optical quality and represents the ratio between the intensity of the real PSF and the intensity of the diffraction-limited PSF.

The IOL alignment axis was calculated from the OPD-Scan (toric IOL summary map) after pupillary mydriasis of at least 6.0 mm using tropicamide 1%.

Statistical Analysis

All data were collected in an Excel database (Microsoft Office 2010; Microsoft Inc, Redmond, Washington). All statistical analyses were performed using SPSS for Windows (version 16.0; SPSS Inc, Chicago, Illinois). The Mann-Whitney U test was used for between-group comparisons. The results are expressed as the mean±standard deviation. $P<.05$ was considered statistically significant.

RESULTS

This study included 40 eyes from 26 patients aged between 54 and 80 years. The Tecnis group included 20 eyes from 14 patients, and the Acrysof group included 20 eyes from 12 patients. No eyes were excluded from analysis due to intra- or postoperative complications. Table 1 shows the patients' demographics and IOL models used in both groups. Preoperatively, no relevant significant between-group differences were noted. All patients completed 2-month follow-up.

VISUAL ACUITY AND REFRACTION

Table 2 shows the postoperative visual acuity and refraction in both groups at 2-month follow-up. No statistically significant between-group differences were noted in any primary acuity or refractive outcome (P=.834 and P=.178, respectively). Uncorrected distance visual acuity was 0.3 logMAR or better (Snellen equivalent 20/40 or better) in 100% of eyes in the Tecnis group and 95% of eyes in the Acrysof group. All eyes in both groups achieved 0.10 logMAR or better (Snellen equivalent 20/25 or better) CDVA. Eleven (55%) eyes in the Tecnis group and 13 (65%) eyes in the Acrysof group were within ±0.50 D of the attempted spherical correction, and 19 (95%) eyes in the Tecnis group and 18 (90%) eyes in the Acrysof group were within ±1.00 D. Refractive cylinder was <0.50 D in 15 (75%) eyes in the Tecnis group and 17 (85%) eyes in the Acrysof group and <1.00 D in 20 (100%) eyes in the Tecnis group and 19 (95%) eyes in the Acrysof group. Postoperative spherical equivalent refraction was within ±0.50 D of the attempted correction in 14 (70%) eyes in the Tecnis group and 15 (75%) eyes in the Acrysof group and within ±1.00 D in 15 (75%) eyes in the Tecnis group and 18 (90%) eyes in the Acrysof group.

TABLE 1

Patient Demographics and Clinical Information

Parameter	Tecnis ZCT Group	Acrysof SN6AT Group	*P* Value
Eyes (n)	20	20	
Patients (n)	14	12	
Age (y)	65.85±4.16 (63 to 76)	67.4±11.9 (54 to 80)	.544
Male sex, n (%)	5 (35.7)	6 (50)	.343
Right eyes, n (%)	14 (70)	7 (35)	.029
CDVA (logMAR)	0.49±0.10 (0.7 to 0.20)	0.58±0.19 (0.88 to 0.30)	.219
Corneal astigmatism (D)	1.96±0.45 (1.02 to 2.64)	2.07±0.37 (1.14 to 2.91)	.685
IOL type (n)	225/300/400 (2/9/9)	3/4/5/6 (2/13/4/1)	
IOL power (D)	23.75±2.82 (17.50 to 24.00)	21.62±2.08 (15.00 to 24.50)	.052

CDVA = corrected distance visual acuity, IOL = intraocular lens

ROTATIONAL STABILITY

No eye required a second surgery to align the IOL axis during the 2-month follow-up period. No eye had IOL rotation >10°. Mean toric IOL axis rotation

TABLE 2

Visual Acuity and Refractive Results at 2 Months Postoperatively

	Mean±SD (Range)		
Parameter	Tecnis Group	Acrysof Group	*P* Value
UDVA (logMAR)	0.12±0.06 (0 to 0.2)	0.13±0.10 (0 to 0.4)	.834
CDVA (logMAR)	0.02±0.04 (0 to 0.1)	0.04±0.05 (0 to 0.05)	.178
Sphere (D)	−0.11±0.72 (−1.25 to +1.00)	0.06±0.64 (−1.25 to +0.75)	.528
Cylinder (D)	−0.56±0.35 (−1.00 to 0)	−0.41±0.32 (−1.25 to 0)	.166
SE (D)	−0.19±0.74 (−1.38 to +0.88)	−0.14±0.64 (−1.62 to +1.50)	.447

SD = standard deviation, UDVA = uncorrected distance visual acuity, CDVA = corrected distance visual acuity, SE = spherical equivalent refraction

TABLE 3

Ocular Aberrometry Analysis at 2 Months Postoperatively

	Mean±SD (Range)		
Parameter	Tecnis Group	Acrysof Group	*P* Value
HOA RMS	0.66±0.39 (0.15 to 1.22)	0.52±0.14 (0.346 to 0.766)	.098
Spherical aberration	0.08±0.07 (0 to 0.153)	0.12±0.07 (0.02 to 0.187)	.029
Coma	0.27±0.25 (0.06 to 0.672)	0.18±0.09 (0.09 to 0.29)	.585
Trefoil	0.52±0.26 (0.13 to 0.85)	0.34±0.22 (0.14 to 0.72)	.101
Strehl ratio	0.05±0.07 (0 to 0.18)	0.02±0.01 (0 to 0.04)	.411

HOA RMS = higher order aberration root-mean-square
All values in microns except Strehl ratio.

was 3.15°±2.62° in the Tecnis group (range: 0 to 10°) and 3.25°±2.04° in the Acrysof group (range: 0 to 8°) (*P*=.265).

Visual and Optical Quality

Table 3 shows the optical quality and ocular aberrometry values at 2 months postoperatively. No statistically significant between-group differences were noted for all ocular aberrometry values, except for spherical aberration, which was lower in the Tecnis group (*P*=.029).

DISCUSSION

Toric IOLs are becoming an increasingly used method to correct corneal astigmatism during cataract surgery. We compared the implantation of the Tecnis toric IOL with the Acrysof IQ toric IOL after phacoemulsification. To the best of our knowledge, this is the first study to directly compare these two types of IOLs.

In addition to the US Food and Drug Administration Clinical Investigation trials,[13,14] the Acrysof toric IOL has been tested in several randomized trials that confirmed its safety, efficacy, rotational stability, optical quality, and subjective patient satisfaction.[15-20] More recently, an aspheric version of this IOL (Acrysof IQ) was launched. The Tecnis toric IOL was recently launched in Europe, providing the cataract surgeon with another choice for the correction of astigmatism. Several communications in congresses attested its safety, efficacy, rotational stability, and subjective satisfaction.[21]

In our study, both IOLs provided excellent and comparable visual outcomes, with 100% of eyes in the Tecnis group and 95% of eyes in the Acrysof group achieving 0.3 logMAR or better (Snellen equivalent 20/40 or better) UDVA. The refractive outcomes were also comparable between the two IOLs. Rotational stability was evaluated with the OPD-III scanning system using the toric IOL summary map. This method is both fast and reliable for analyzing toric IOL alignment.[22] The postoperative rotational stability was excellent and similar for both IOLs.

Higher order aberrations were also evaluated using the OPD-III scanning system. This system has good repeatability for the wavefront measurement of total, corneal, and internal optical aberrations.[23-26] In our study, there were no statistically significant between-group differences for ocular higher order aberration RMS, coma, trefoil, and the Strehl ratio. Postoperative spherical aberration was lower in the Tecnis group (*P*=.029). Both the Tecnis toric and Acrysof IQ toric IOLs have aspheric anterior surfaces. Aspheric IOLs have been designed to compensate for the positive spherical aberration of the cornea. The benefits of using aspheric IOLs in cataract surgery have been extensively described in the literature. These IOLs provide higher vision quality than spherical IOLs in terms of retinal image quality, high-contrast visual acuity, and contrast sensitivity.[27-30] Although we did not perform preoperative aberrometry with the OPD-III scanning system, given the difference found postoperatively in spherical aberration, we retrospectively studied preoperative corneal aberration values from the Pentacam wavefront aberration map (Oculus Optikgeräte GmbH, Wetzlar, Germany). We are aware that both this retrospective approach and using different devices for pre- and postoperative aberration evaulation may be a potential limitation of our study. Nevertheless, preoperative corneal spherical aberration in our patients was similar in both groups (Tecnis group 0.41±0.13, AcrySof group 0.45±0.12; *P*=.190). These values are comparable to those found in other studies that measured spherical aberration in cataract patients.[31] We hypothesize that the total postoperative spherical aberration was lower in the Tecnis group because of the higher compensation of corneal spherical aberration with this IOL than with the Acrysof IQ (−0.27 µm for the Tecnis vs −0.20 µm for the Acrysof). However, this small difference did not seem to affect the overall postoperative optical quality, with total higher order aberrations and PSF being comparable between the two groups.

The results of our study show that the Tecnis toric and Acrysof IQ toric IOLs appear equally effective alternatives for the cataract surgeon in the correction of preexisting corneal astigmatism from 1.00 to 3.00 D during phacoemulsification.

AUTHOR CONTRIBUTIONS

Study concept and design (T.B.F., A.A.); data collection (T.B.F., A.A.); analysis and interpretation of data (T.B.F., A.A.); drafting of the manuscript (T.B.F., A.A.); critical revision of the manuscript (T.B.F.); statistical expertise (T.B.F.); supervision (T.B.F.)

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TABLE A

Characteristics of the Tecnis and Acrysof Intraocular Lenses

Characteristic	Tecnis Toric IOL Models ZCT100-400	Acrysof IQ Toric IOL Models SN6AT2-T9*
Optic characteristics		
Powers (D)	+5.00 to +34.00	+6.00 to +30.00
Cylinder powers (IOL plane) (D)	1.00 to 4.00	1.50 to 6.00
Cylinder powers (corneal plane) (D)	0.69 to 2.74	1.03 to 4.11
Diameter (mm)	6.0	6.0
Shape	Biconvex, anterior toric aspheric surface	Biconvex, anterior toric aspheric surface
Material	Acrylic – UV filtering	Acrylic – UV and blue light filtering
Refractive Index	1.40	1.55
Edge design	Square edge	Square edge
Biometry		
A-constant (mm)	118.8 (US); 119.3 (optical)	119.0 (US); 119.2 (optical)
Theoretical ACD (mm)	5.4	5.55
Haptic characteristics		
Overall length (mm)	13.0	13.0
Configuration	Modified C design, integral with optic	Modified L design, integral with optic
Material	Same as optic	Same as optic

IOL = intraocular lens, ACD = anterior chamber depth, US = ultrasound
**Only T3-T6 were used for this study.*