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Management of residual astigmatism after intraocular lens implantation

Manejo do astigmatismo residual após implante de lente intraocular

Faride Waked Tanos[1,2], Ícaro Silva Lopes[1,3], Allan Wagner[1,4], José Carlos Mendes[5,6,7], Sandra Rodrigues-Barros[8], Israel Rozemberg[1,9], Renato Ambrósio Jr.[1,2,10,11]

Abstract

We report a case of residual astigmatism after cataract surgery with toric intraocular lens (IOL) implantation (Acrysof Toric, Alcon, Frot Worth TX). Residual refraction (+1,25 -2,50 x 105º) and IOL positioning were correlated with total ray-tracing wavefront aberrometry integrated with anterior corneal surface Placido-based topography to calculate internal aberrations (iTrace, Tracey Technologies, Houston TX). The ideal IOL axis to minimize residual refraction was calculated with Berdahl & Hardten (astigmatismfix.com). IOL rotation to the indicated axis was successfully performed 5 months after initial surgery, reducing residual error to +0,25 -0,25 x 61º, promoting visual reabilitation, with final uncorrected distance visual acuity 20/20.

Keywords: *Intraocular lenses; Astigmatism; Phacoemulsification; Aberrometry; Case reports*

Resumo

Relatamos um caso de astigmatismo residual, após cirurgia de catarata com implante de lente intra-ocular (LIO) tórica (Acrysof Toric, Alcon, Frot Worth TX). A refração residual (+1,25 -2,50 x 105º) e o posicionamento da LIO implantada neste olho, foram correlacionados com a aberrometria total obtida por ray tracing de pontos individuais integrada à da face anterior da córnea obtida por topografia de Plácido, para cálculo das aberrações internas (iTrace, Tracey, Technologies, Houston TX). O cálculo do eixo ideal da LIO, para minimizar a refração residual foi realizado de acordo com Berdahl & Hardten (astigmatismfix.com). A rotação da LIO foi realizada com sucesso 5 meses após a cirurgia inicial para o eixo indicado, reduzindo o erro residual para +0,25 -0,25 x 61º e promovendo reabilitação visual sem correção de 20/20.

Descritores: Lentes intraoculares; Astigmatismo; Facoemulsificação; Aberrometria; Relatos de casos

[1] Rio de Janeiro Corneal Tomography and Biomechanics Study Group, Rio de Janeiro, RJ, Brazil.
[2] VisareRIO, Refracta Personal Laser, Rio de Janeiro, RJ, Brazil.
[3] Hospital da Piedade, Rio de Janeiro, RJ, Brazil.
[4] Oftalmoclínica São Gonçalo, Rio de Janeiro, RJ, Brazil.
[5] Hospital de Braga, Braga, Portugal.
[6] Instituto de Investigação em Ciências da Vida e Saúde, Universidade do Minho, Portugal.
[7] ICVS/3B's - PT Government Associate Laboratory, Braga/Guimarães, Portugal;
[8] Hospital Garcia de Orta, Almada, Portugal.
[9] Jardim de Alah Cirurgia Ocular, Rio de Janeiro, RJ, Brazil.
[10] Department of Ophthalmology, Universidade Federal de São Paulo, São Paulo, SP, Brazil.
[11] Department of Ophthalmology, Pontifícia Universidade Católica do Rio de Janeiro - Rio de Janeiro, RJ, Brazil.

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Introduction

Several advances in the areas of refractive surgery in the last decades have significantly increased patients' expectations for a refractive correction at the time of cataract surgery. In fact, cataract surgery has become the most common refractive procedure. New devices, formulas and materials allow surgeons to better measure and treat astigmatism. It is estimated that in about 74% of cataract cases patients have astigmatism equal to or greater than 0.50 cylindrical diopter (CD).[1,2] About 34.8 to 41.3% have astigmatism greater than or equal to 1 CD, 8 to 9.67% of cases greater than 2.0 CD, and 1.68 to 3.31% greater than 3.0 CD.[1-4] The IOL implant plays an important role for this, with results superior than those obtained with relaxing incisions.[5,6]

A correção cirúrgica do astigmatismo durante a cirurgia de catarata, tem como objetivo tornar o paciente menos dependente do uso de correção visual. The use of toric lenses presents good predictability and refractive and torsional stability, and is also a refractive solution in a single surgical act.6 A great advantage of this approach is the reversibility and adjustability of the procedure, since we can either rotate the IOL or replace it in case of need.

However, the complete and perfect correction of astigmatism is not yet obtained in all cases. Whereas about 90% of cases present residual astigmatism of less than or equal to 1.0 CD, 91% of cases of toric IOL have an average rotation around 5°, and 99% have a rotation less than 10°.[7,8] The present report presents a patient who evolved with high residual astigmatism in one eye after toric IOL implant in the left eye, emphasizing the importance of complementary propaedeutics and advanced study with optical modeling for the management of correction through adjustment of the rotational position of the IOL in order to improve the visual quality of the patient.

Case Report

A 65-year-old female patient sought care complaining of poor visual acuity and blurred vision in both eyes. Ophthalmological history did not present anything worthy of note. She was in use of lubricating eyedrops. The ophthalmologic exam revealed visual acuity without correction of 20/50 in the right eye (RE) and 20/40 in the left eye (LE). The corrected acuity was 20/40 in the RE (+1.75 spherical -1.00 cylinder x 90°), and 20/30 in the LE (+2.00 spherical -2.75 x 80°). Biomicroscopy revealed cataract in both eyes, tonometry and fundoscopy of the eye showed no alterations. The study of astigmatism showed that this case was predominantly corneal, according to the topometric and tomographic findings (Figure 1), and also highlighted by other propaedeutic methods according to table 1. The axial length data is presented in Table 2. The IOL calculation was made with the Haigis and Hoffer Q formulas according to the IOL Master.

Cataract surgery was performed by right-eye phaco-emulsification with AcrySoft IQ toric +29.00 SN6AT4 at 37° intraocular lens implant (Alcon Laboratories, Fort Worth, USA). The procedure was uneventful, with IOL alignment according to marking performed on the slit lamp. One week after, the uncorrected visual acuity surgery was 20/20, with postoperative refractive plane -0.25 cylinder x 75°, which remained stable.

The left eye was subjected to the same procedure with AcrySoft IQ toric +29.50 SN6AT5 lens implant at 165°. On the first postoperative (PO) day, an increase in intraocular pressure was observed, with corneal compensated Intraocular pressure (IOPcc) equal to 27.3 mmHg as measured by the Ocular Response Analyzer (ORA; Reichert, Buffallo, USA). Decompression was performed by paracentesis, with reduction of IOPcc to 10mmHg.

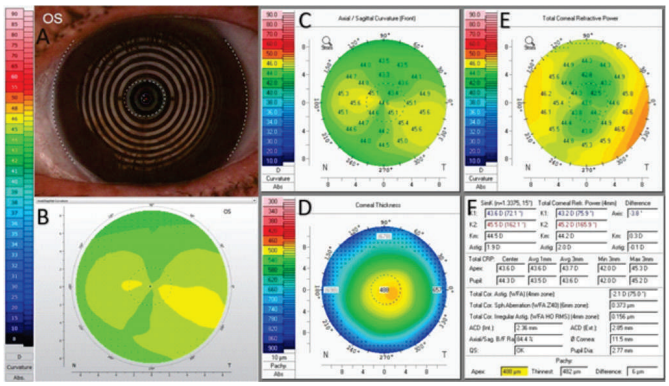

Figure 1: A. Placido Disc; **B.** Axial curvature of the topography based on the placid disc; **C.** Anterior axial topography by the scheimpflug image; **D.** Pachymetric map; **E.** Map of total corneal power by Pentacam; **F.** Advanced study of corneal optics by Pentacam;

Table 1
Comparative preoperative evaluation of the degree of astigmatism by different propaedeutic methods in the planning of toric intraocular lens implant

Preoperative evaluation	Corneal astigmatism	
	Right eye	Left eye
Pentacam® - Sim Value	1.1 @ 45º	1.9 @ 162º
Pentacam® - Total Corneal Refractive Power (TCRP)	1.0 @ 37º	2.0 @ 166º
Keratograph®SM	1.0 @ 37º	1.8 @ 167º
I-Trace®	0.9 @ 55º	1.98 @ 163º
IOL Master®	1.12 @39º	2.24 @ 170º
Lenstar®	1.0 @ 43º	2.0 @ 170º

Table 2
Comparative preoperative evaluation of axial length evaluated by different propaedeutic methods

Preoperative evaluation	Axial length RE Right eye	Axial length LE Left eye
Pentacam - AXL	21.336 mm	21.295 mm
IOL Master	21.18 mm	21.30 mm
Lenstar	21.35 mm	21.30 mm

In addition to the usual postoperative period using a fixed combination of fourth-generation quinolone and corticosteroids every three hours (Vigadexa, Alcon Laboratories), timolol maleate 0.5% was maintained twice daily until the fifth postoperative day, when the IOPcc remained at 11mmHg. Uncorrected visual acuity was 20/80 for far sight and J3 for near sight, with residual refraction in the left eye being +0.50 spherical -1.50 cylinder x 101°. Corticosteroids were reduced, and we started the use of non-hormonal anti-inflammatory once daily (Nevanac Uno; Alcon). Six

weeks after surgery, biomicroscopy evaluation under mydriasis revealed a position of the intraocular lens on the 133° axis with Imagecam software (Oculus; Wetzlar, Germany; Figure 2). The patient was advised about the possibility of a new repositioning surgical intervention by rotation of the IOL, and referred to the aberrometry exam.

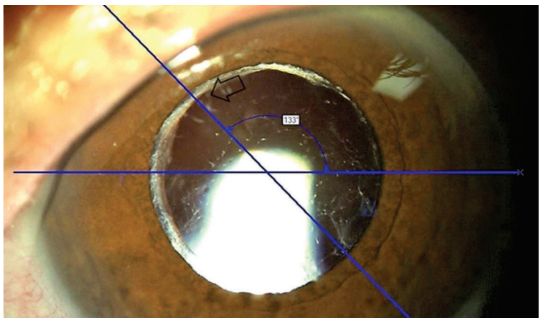

Figure 2: Biomicroscopy under mydriasis after phacoemulsification revealing position and axis of the IOL at 133 °.

O exame de aberrometria foi realizado com o iTrace (Tracey TechThe aberrometer exam was performed with iTrace (Tracey Technologies, Houston TX), which integrates the total aberrometry by ray tracing of 256 individual points and the corneal by Placido disc to calculate the internal aberrations. The wavefront analysis made it possible to correlate the findings of total aberrometry to residual refraction and internal aberrometry with the IOL positioning observed in the slit lamp image with the system Imagecam. The RMS of internal astigmatism (second order) is 0.783 x 44º, which corroborates the complementary axis of the IOL position at 133º (Figure 3).

The calculation of the ideal IOL axis was performed according to Berdahl & Hardten (astigmatismfix.com), which considers the characteristics of the IOL implanted, the axis on which it is positioned, and the residual manifest refraction. The software calculates the residual refraction according to the

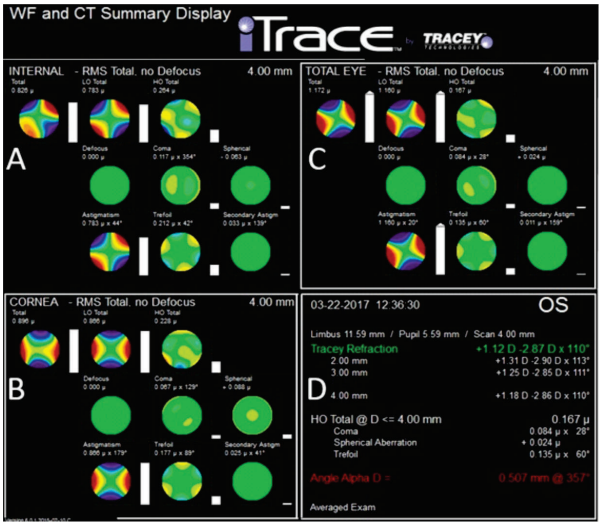

Figure 3: . iTrace: Postoperative evaluation with toric IOL (4mm scan). **A.** Aberrations of the internal optic system (total aberrations subtracted from anterior corneal aberrations); **B.** Corneal Aberrations; **C.** Total Aberrations; **D.** Average refractometry and anatomical study.

rotation of the IOL, determining its best position to minimize the residual refractive error, which in this case would be 169º (Figure 4A).

The repositioning of the lens was performed successfully 5 months after the initial surgery (Figure 4B), without intercurrences. After paracentesis, the capsular bag was dissected using high molecular weight viscoelastic Healon 5 (Johnson & Johnson Vision; Jacksonville, USA) in order to release the IOL from the adhesions to enable rotation to the planned position according to the marking performed.

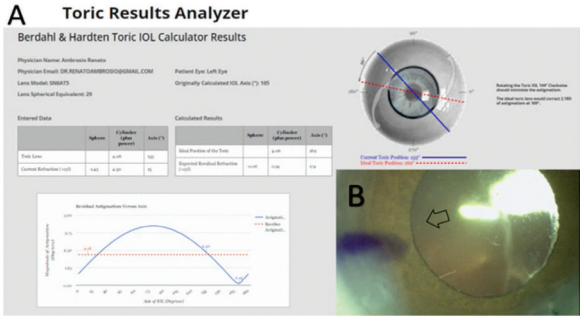

Figure 4: A. Calculation of the rotation of IOL according to the Toric Results Analyzer *John Berdahl MD and David Hardten MD determining the repositioning of the IOL to the 169° axis in order to neutralize corneal astigmatism; **B.** Perioperative image showing final IOL positioning on the marked axis.

One week after surgery, excellent refractive correction and re-vision correction were observed with no correction for 20/20 and manifest refraction of +0.50 spherical -0.25 cylinder x 70°. A new aberrometry test was performed and correlated with the clinical findings (Figure 5), observing the IOL axis (positive cylinder) in the internal aberrations at 167º.

Figure 5: iTrace: Post-rotation evaluation with toric IOL (4mm scan). **A.** Aberrations of the internal optic system (total aberrations subtracted from anterior corneal aberrations); **B.** Corneal Aberrations; **C.** Total Aberrations; **D.** Average refractometry and anatomical study.

Discussion

The clinical case shows the management of the refractive error after toric IOL implant by IOL rotation according to the

findings of ocular aberrometry integrated to Placido Topography and the calculations described by Berdahl & Hardten. The repositioning was successfully performed with IOL rotation five months after surgery. Acrysof IQ toric SN6AT5 IOL with +29.5 diopter power was implanted without intercurrences with its axis oriented at 165º. In the fifth PO month, we observed a manifest refraction of +1.25 spherical -2.5 cylinder x 105º, and the IOL axis was oriented at 133º at the slit lamp exam. No digital guidance or intraoperative aberrometer systems were used, which are technologies to increase the predictability of the IOL position. However, the increased IOP in the initial postoperative period was possibly related to the presence of viscoelastic material that could have remained in the capsular bag in order to make it difficult to adhere to the IOL, allowing rotation in the immediate postoperative period.

The poor positioning of the toric IOL according to its axis, either by postoperative rotation or by error in implant time, can be corrected with IOL rotation in a new surgical intervention. However, rotation planning should be done according to the characteristics of each case, including the power of the IOL implanted, its position, and the residual refractive error. According to Euler's theorem, a deviation of the respective 5, 10 or 15 axis would result in a reduction of 17, 33 and 50% of the magnitude of their effect, respectively. In an toric IOL, when the cylinder axis is off the correct axis without altering its magnitude, there is hypocorrection up to a limit from which residual astigmatism is induced. The effect of the misalignment of the cylinder is essentially the same, which is observed in the crossed oblique cylinder. For simplicity in terms of calculations, it is assumed that a magnitude of 3.5% occurs per each 1° of lens of the, and at 45° of rotation its influence is neutralized, and above 45° additional astigmatism is induced.[9]

In 2008, Chang described 3 cases of more than 15 degrees of target off-axis and toric IOL, who underwent surgical repositioning.[10] To understand how the off-axis toric IOL could affect the reduction of astigmatism, Filipe et al. proposed to analyze the residual refractive error according to the variation of the toric IOL axis.[11] In response, Berdahl and Hardten described a clinical case of a toric IOL with postoperative refraction of +1.00 spherical +1.75 cylinder x 175° subjected to a vector analysis program described on the website astigmatismfix.com,[12] which is made available on the ASCRS website for free. More recently, Berdahl, Hardten et al. [12] retrospectively reviewed the data entered on the website. They estimated 12,812 cases in which the IOL was oriented >5º of the ideal axis, corresponding to less than 1% of all toric IOLs implanted in the world. Most cases were offset in an anti-clockwise direction. The average postoperative refractive astigmatism was 1.89 diopters (D). Interestingly, 30% of the IOLs that were not on the ideal axis were oriented according to the indications of the preoperative toric calculation. Rotations performed according to the platform results would allow an average reduction in the residual cylinder of 50% ± 31%, and 37% of post-rotation cases would have a final residual astigmatism magnitude at <0.5D.[13,14]

The data was entered on the platform astigmatismfix.com, in order to understand if the readjustment of the axis could benefit the final refraction. The platform simulated the magnitude of astigmatism according to the orientation axis of the toric IOL, suggesting that centralization at 169º would result in an optimized astigmatism value in the magnitude of 0.12D (Figure 4A). The objective study of ray tracing aberrometry (iTrace) corroborated the planning, as well as the evaluation of the final result.

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Corresponding author:
Renato Ambrósio Jr
Rua Conde de Bonfim 211/712 – Rio de Janerio, RJ –
ZIP Code: 20.520-050, Brasil
Phone/fax +5521 2234-4233
E-mail: dr.renatoambrosio@gmail.com;