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Topoguided laser as a reducer of optical aberrations after radial keratotomy and multifocal LIO

Laser topoguiado como redutor de aberrações ópticas pós ceratotomia radial e LIO multifocal

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Abstract

Cataract surgery with intraocular lens implantation is one of the most commonly performed surgeries in the world and, currently, patients who undergo this surgery can use the multifocal intraocular lens (IOL) implant as an alternative to wearing glasses. A great challenge for the surgeon are patients who have previously undergone radial keratotomy (RK), because in addition to having a more challenging biometric calculation, they also have important corneal optical aberrations, being a contraindication for the use of multifocal lenses for most patients. ophthalmologists. In this article, we report the case of a patient who underwent a RK in her youth and started to report an important visual discomfort after cataract correction with facectomy and multifocal IOL implantation. This patient underwent a photorefractive keratectomy (PRK) to reduce corneal irregularities with good clinical evolution and satisfactory visual result. This case draws attention to the alternative of topography-guided laser excimer in similar cases and warns of the risk of using this type of lens in irregular corneas.

Keywords: *Photorefractive keratectomy; Radial keratotomy; Refractive surgery; Multifocal intraocular lenses; Optical aberrations; Laser*

Resumo

A cirurgia de catarata com implante de lente intra-ocular é uma das cirurgias mais realizadas no mundo e, atualmente, os pacientes que se submetem a essa cirurgia podem utilizar o implante com lente intraocular (LIO) multifocal como alternativa ao uso de óculos. Um grande desafio para o cirurgião são os pacientes já submetidos previamente a ceratotomia radial (RK), pois além de terem um cálculo biométrico mais desafiador, apresentam importantes aberrações ópticas corneanas, sendo uma contra-indicação para o uso de lentes multifocais para a maioria dos oftalmologistas. Neste artigo, relatamos o caso de uma paciente que foi submetida, na juventude, a uma RK e passou a referir importante incômodo visual após a correção de catarata com facectomia e implante de LIO multifocal. Esta paciente foi submetida a uma ceratectomia fotorrefrativa (PRK) para diminuir as irregularidades da córnea com boa evolução clínica e resultado visual satisfatório. Esse caso chama a atenção para a alternativa do excimer laser topoguiado em casos semelhantes e alerta para o risco do uso desse tipo de lente em córneas irregulares.

Descritores: Ceratectomia fotorrefrativa; Ceratotomia radial; Cirurgia refrativa; Lentes intraoculares multifocais; Aberrações ópticas; Laser topoguiado

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Introduction

Radial keratotomy (RK) was an important surgical alternative in the 1970s and 80s after the publication by Fiodorov,[1] which led to a large number of myopia and astigmatism correction surgeries, worldwide. These patients had to live with the late complications of this procedure, for all these years, for instance: progressive hyperopia, refractive instability, incision opening and poor visual acuity resulting from significant high-order optical aberrations.

As time went on, patients who sought independence from their glasses faced presbyopia and cataracts, which brought along an even more challenging issue: calculation for intraocular lens (CIL) in previously myopic eye, cornea quite changed by incisions and patient's will. Several biometric formulas were tested and, nowadays, it is possible having a more predictable outcome, in most cases. The website of the American Society of Cataract and Refractive Surgery (ASCRS) makes available a quite effective on-line calculator that has been guiding many surgeons across the world.[2] Improvements in the surgical technique and the development of multifocal intraocular lenses have encouraged some surgeons to go on in an unknown field, i.e., using these lenses in eyes subjected to RK. Few publications addressing these approaches are available in the literature, but all of them are based on only few cases. Martín-Escuer at al. 1 reported a series of 17 eyes from 9 patients who recorded little satisfactory outcomes. Kim at al.[3] reported 2 patients subjected to RK who were happy with implantation of a asymmetric rotational refractive multifocal lens (LS313-MF30; Oculentis, Berlin, Germany). Therefore, there is not enough support in the literature to this practice.

The approach of previous RK patients with low visual acuity, even without cataract, is already a challenge. Glasses, different types of contact lenses and incision sutures can mitigate, but not ultimately solve, many cases. Management in face of many diversities is challenging and the overall prognostic is not good. Nowadays, given the development of the refractive surgery, Ophthalmology has advanced a little more in its therapeutic options. PRK based on excimer laser guided by aberrometry[4,5] or by topography[5,6], associated with the administration of mitomycin, allowed diminishing corneal irregularities and, consequently, high-order optical aberrations by significantly improving the visual function of these patients. It opened a new path for these patients.

To the best of our knowledge, there are no reports in the literature about a case similar to the present one. Patients unhappy with their visual acuity who were subjected to RK with diffractive multifocal lens in both eyes have few therapeutic options available. A lesser invasive approach than intraocular lens changing, or even than corneal transplantation, points out the relevance of the present article. Topography-guided ablation planning is a different chapter, because it is possible getting to undesired refractive outcomes in the post-operative period.

Topography-guided PRK is an alternative oftentimes forgotten by cataract surgeons who are not experienced in refractive surgery. The present report reinforces the importance of overall Ophthalmologist deepening in up-to-date technologies, since they are the first ones to exam patients seeking a solution.

Clinical case

Female patient, at the age of 52 years, got to the outpatient service in April, 2017 with history of RK 30 years ago and of facectomy with multifocal intraocular lens implantation, approximately 8 ago. She reported discomfort and terrible vision away, intense photophobia and many nocturnal halos after the cataract surgery. She presented the following eye examination: RE – flat (20/30) and LE = +0.75 -2.50x165 (20/30). Although it was fully visible in the images (Figures 1 and 2), it was possible observing eight RK incisions in both eyes and two AK incisions (astigmatic keratotomy) in the left eye. There was a well-crystallized bilateral trifocal diffractive CIL (intraocular lens) (Panoptix, Alcon). RE had already been subjected to capsulotomy with YAG laser. The posterior segment in both eyes did not show alterations. The patient was subjected to topography-guided PRK in both eyes, without complications.

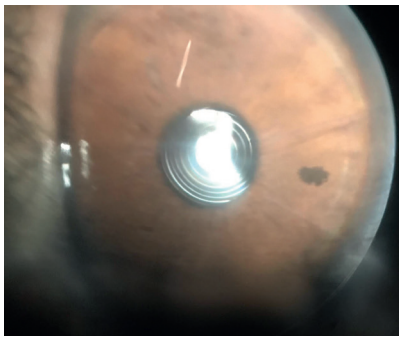

Figure 1: Biomicroscopy of RE showing eight RK incisions. RE: right eye; RK: radial keratotomy

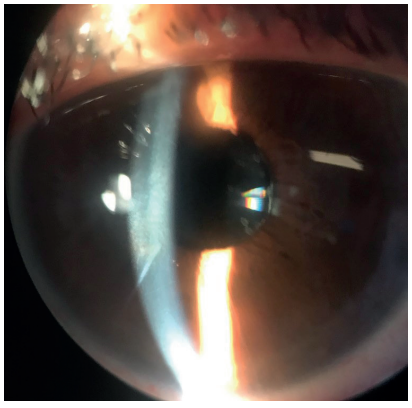

Figure 2: Biomicroscopy of LE showing 8 RK incisions and 2 AK incisions. LE: left eye; RK: radial keratotomy; AK: astigmatic keratotomy.

Corneal tomography carried out in Galilei device (Ziemer, Switzerland) was requested and showed flattened and quite irregular cornea with small optical zone in both eyes. Simulated keratometry showed positive cylinder of 2.41 in axis 172 in RE (which did not show up in the refractometry) and of 1.80 in axis 67 in LE (more compatible to the refraction) (Figure 3). Pachymetry in the thinner point was 498 and 487 microns in RE and LE, respectively. The spherical aberration in the map of corneal aberrations (wavefront map) was of -0.82 and -0.56, total RMS (root mean square) was of 2.95 and 2.48 in RE and LE, respectively.

Bilateral surgery was performed. At the same day, it was possible capturing at least 8 good-quality images in Topolyzer Vario (Alcon), which were exported through flash memory device to EX500 by Wavelight (Alcon). T-CAT in the Wavelight screen was selected and the cylinder was measured with clinical spherical and cylinder, based on the topographic images in the Topolyzer, which showed the ablation pattern of high-order optical aberrations.

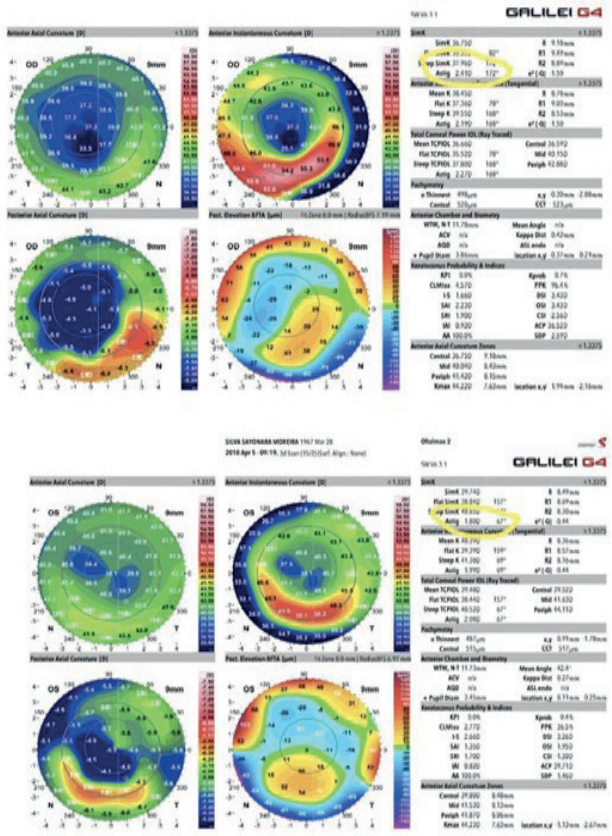

Figure 3: Tomography of the RE and LE corneas taken in Galilei device after facectomy with multifocal lens CIL implantation.

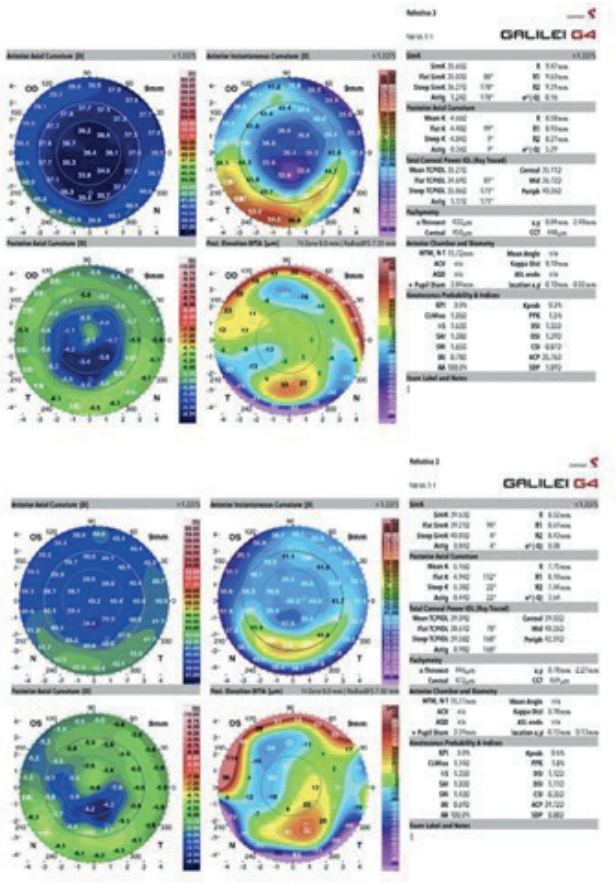

Figure 5: Tomography of the RE and LE corneas taken in Galilei device after topo-guided laser.

Refractive & Corneal details

Refraction	+0.00 D +0.00 D @ 0 ° / 12.0 mm				
Pupil/Medication	6.5 mm / keines				
Pachymetry	Superior	Temporal	Central	Nasal	Inferior
	481 µm	481 µm	481 µm	481 µm	481 µm
K1 / Q1	37.13 D @ 64 ° / ---				
K2 / Q2	38.84 D @ 154 ° / ---				

Treatment details

Measured	-0.62 D -1.59 D @ 64 ° / 12 mm		
Target	--- D --- D @ --- ° / --- mm		
Correction	-1.25 D -1.00 D @ 64 ° / 12 mm		
Target Q	---	Nomogram	S 101
Optical zone	6.50 mm	Planned flap	0 µm
Transition zone	1.25 mm	Cornea thickness	481 µm
Ablation zone	9.00 mm	Residual stroma	410 µm

Refractive & Corneal details

Refraction	+1.00 D -2.50 D @ 165 ° / 12.0 mm				
Pupil/Medication	6.5 mm / keines				
Pachymetry	Superior	Temporal	Central	Nasal	Inferi
	513 µm	513 µm	513 µm	513 µm	513 µ
K1 / Q1	39.11 D @ 154 ° / ---				
K2 / Q2	40.96 D @ 64 ° / ---				

Treatment details

Measured	-0.46 D -2.04 D @ 155 ° / 12 mm		
Target	--- D --- D @ --- ° / --- mm		
Correction	+0.75 D -2.00 D @ 155 ° / 12 mm		
Target Q	---	Nomogram	S 101
Optical zone	6.50 mm	Planned flap	0 µm
Transition zone	1.25 mm	Cornea thickness	513 µm
Ablation zone	9.00 mm	Residual stroma	457 µm

Figure 4: Refractive details of the cornea and of the treatment in RE and LE.

The final treatment was changed by taking into consideration the spherical aberration induced by equalization between C4 and C12, it avoided hyper or hypercorrection of the spherical component. The measured cylinder in RE was -1.59 in axis 64 and the final treatment was -1.25-1.00x64. The measured cylinder in LE was -2.04x155 and the treatment was +0.75-2.00x155 (Figure 4). After the laser, the patient was administered with 0.002% mitomycin for one minute, with extensive irrigation with cold BSS and with the apposition of the therapeutic contact lens at the end. Vigadexa (6/6 hs), Acular LS (8/8 hs) and Optive (4 to 5 times a day) were administered during the post-operative period. The patient had good evolution, full epithelialization within a week, when she had the contact lens removed and Vigadexa was replaced by Flutinol in decreasing design, for 20 days. Forty days after surgery, she was subjected to capsulotomy with YAG in LE.

The patient reported substantial improvement in her visual acuity within the first 20 days after surgery and 9 months after it, her exams showed RE = flat (20/20) and LE = -0.75-1.00x40(20/25). The tomography showed well-regular cornea, with broadening of the optical zone, and one positive residual cylinder in the simulated keratometry (simK) of 1.24 x 178 and 0.84 x 4 in RE and LE, respectively (Figure 5). She was quite happy with the outcome and the night complains had significantly improved.

The present report was appreciated and accepted by the ethical committee in research at Plataforma Brasil. The patient has signed the Informed Consent Form to authorize this report.

The current case initially highlights the importance of a careful selection of patients for multifocal lens transplantation. The tomographic analysis of the cornea through root-mean-square wavefront error (RMS) generated in Galilei device showed high indices either of spherical aberration or of total corneal aberrations. Mirzajani et al. reported a study with 197 normal eyes in topography, they were analyzed in Pentacam device (system similar to that of Galilei). Mean total RMS of the cornea was 0.3699± 0.0107, whereas the herein reported patient recorded 2.95 and 2.48 in RE and LE, respectively.[7] Even without looking at the numbers, Galilei images would be enough to discourage the recommendation for diffractive lens in eyes with such a corneal standard. However, regardless of the reason for the choice for this lens type, it was necessary getting to a solution.

The first hypothesis lied on replacing CIL, but the capsulotomy with YAG laser previously performed in the right eye would increase the possibility of glassy loss and of subsequent issues. Dissatisfaction with the multifocal lenses was the second cause (18.7%) of intraocular lens replacement in 109 eyes between January/2010 and December/2015 in a tertiary reference center in the United States[6]. Although the majority of patients presented good outcomes, complications are not rare, such as the case of macula cystoid edema, which reached 10.3% of the eyes. The change of an intraocular lens, even in experienced hands, demands careful evaluation of risks and benefits – the option for excimer laser must be taken into consideration.

Proper planning is the next step in the treatment and it depends on reliable images in the Topolyzer Vario (Alcon), which sometimes are not possible to get. Little experience by the examiner, bad lubrication or little exposure of the cornea hinder the quality of the exam and may make surgery infeasible. This scenario sometimes forces procedure canceling. Data in the EX500 Wavelight software allowed assessing the likely refractive effect from the correction made in the measured aberrations. The equalization between spherical aberration components (C4 and C12) became essential, besides the comparison of clinical astigmatism to that measured in the topographic device. Although there was a flat refraction in the right eye during the post-operative period, the chosen treatment was -1.25-1.00x64, i.e., 2/3 of the topographic astigmatism was taken into consideration (-1.59x64). A possible secondary hyperopic induction was taken into account. The opposite was observed in RE, there was +0.75-2.50x165 and the total found in the topographic device was treated (+0.75-2.00x155). The chosen axis was the topographic one and there was no need of adjustments in the spherical of RE. Yet, there is no precise way to calculate this adjustment and, so, it is possible having variations in planning, depending on the experience of the surgeon and on the excimer laser equipment available. However, it is possible getting good outcomes through technical consultants of the system to be adopted. Based on such a statement, it is important emphasizing the need of deep knowledge on refractive surgery and on its updates or, at least, to have the assistance of an expert before thinking about implanting multifocal lenses (diffractive, or not), even in cases lesser challenging than the current one.

The stability of the recorded outcome is a concern in eyes subjected to post-radial keratotomy PRK. Only few series were published, but all of them suggest effect maintenance in the long-term. Ghanem et al. followed-up 71 eyes subjected to PRK after RK with significant improvement in visual acuity, with and without correction of the total optical aberrations for two years. Only three eyes presented significant peripheral haze, but without visual improvement loss.[4] Filev et al. assessed 18 eyes for 41 months (minimum of 9 and maximum of 96) subjected to PRK after RK with refraction stability in all patients.[8] Although there was no scientific evidence, the inflammatory reaction and corneal tissue healing after PRK was managed with the administration of mitomycin. It can also be a factor reinforcing preexisting incisions, since ablation is bigger in the hyperopia treatment. However, this theory still needs to be proven.

In conclusion, the current report provides a little invasive alternative to similar cases and reinforces the care to be taken at the time to recommend diffractive intraocular lenses for eyes with many optical aberrations.

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