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Spectacle Independence after Cataract Extraction in Post-Radial Keratotomy Patients Using Hybrid Monovision with ReSTOR[®] Multifocal and TECNIS[®] Monofocal Intraocular Lenses

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Key Words

Post-radial keratotomy · Multifocal intraocular lens · ReSTOR · Monofocal intraocular lens · TECNIS

Abstract

Background: We report 2 patients who have undergone radial keratotomy (RK) preceding ReSTOR[®] multifocal intraocular lens (IOL; Alcon, Fort Worth, Tex., USA) implantation in their nondominant eyes and TECNIS[®] monofocal IOL (Abbott Medical Optics, Abbott Park, Ill., USA) in their dominant eyes. **Methods:** Retrospective review of 2 patients who underwent hybrid monovision with ReSTOR[®] multifocal and TECNIS[®] monofocal IOLs at the time of cataract surgery after a remote history of RK. **Results:** Implantation of the ReSTOR[®] multifocal and the TECNIS[®] monofocal IOLs was successful, with no reported adverse events. The patients were able to achieve spectacle freedom. **Conclusion:** We report a novel technique for the management of post-RK patients to optimize their chances for spectacle independence.

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Introduction

As for those patients who underwent radial keratotomy (RK) in the 1980s and 1990s, an increasing number will undergo cataract surgery now. This is a difficult subcategory of patients for several reasons: the intraocular lens (IOL) implant calculation can be inaccurate, the surgical procedure can be challenging, and the postoperative recovery can be prolonged or marked with a refractive surprise [1–3]. A further complication may be the patient's intolerance to refraction errors [4].

For this reason, multifocal IOLs, known to provide restoration of both near and far vision and therefore spectacle freedom, may be an option for this patient population. These IOLs have been repeatedly used for the treatment of loss of accommodation in a number of diseases (with great success). The AcrySof® IQ ReSTOR® multifocal IOL (Alcon, Fort Worth, Tex., USA) is an example of a multifocal IOL that provides an acceptable distance and near visual acuity, reduced dependence on corrective glasses, and a high level of patient satisfaction [5]. This may be an acceptable solution for those who express a desire to be free of spectacles in combination with a monofocal IOL in the dominant eye. The TECNIS® ZCB00 1-Piece Acrylic IOL (Abbott Medical Optics, Abbott Park, Ill., USA) is a good option for post-RK patients as it has been shown to reduce spherical aberration [6].

In the following, we present 2 patients with a history of RK who received a ReSTOR® multifocal IOL in their non-dominant eye and a TECNIS® monofocal IOL in their dominant eye following cataract surgery. In each case, we were able to achieve spectacle freedom and we believe this surgery represents an excellent option for patient management.

Materials and Methods

We calculated the emmetropic IOL power for each patient using the Holladay I and SRK-T formulas. Calculations were performed prospectively for all patients. For each patient, we used the keratometric (K) value obtained immediately prior to cataract surgery. To optimize the functional range of the intraocular lenses, K readings were taken at the midpoint of the typical waking hours of the patients. We calculated a true net power (TNP) K value by averaging the K values of the 21 central points of the cornea measured via OCULUS Pentacam (Oculus, Lynnwood, Wash., USA). TNP has proven to be a better approximation of the K value in patients with prior refractive surgery [7]. The IOLMaster (Carl Zeiss Meditec AG, Dublin, Calif., USA) has accurately measured the axial length (AL) in most patients [8]. For patients with an AL between 21.00 and 26.00 mm, measured via IOLMaster, the Holladay I formula was used. For patients with an AL greater than 26.00 mm and measured via IOLMaster, the SRK-T formula was used to calculate the IOL power. For the SRK-T calculations, we used the manufacturers' stated anterior chamber depths and A constants. For the Holladay formula, we used the surgeon factor, recommended for the given A constant. Finally, by overriding the K values for the IOLMaster, putting in the TNP K value and using the given anterior chamber depth and the A constant, we were able to generate the appropriate IOL power necessary for each eye.

In the nondominant eye, we used the ReSTOR® IOL to correct near and far vision, and in the dominant eye, we chose the TECNIS® monofocal IOL to correct the far vision. Eye dominance was determined by using the Miles test and the big E on a Snellen chart, placed at a distance of 20 feet. Standard phacoemulsification and lens implantation were performed.

Case 1

This patient was a 60-year-old woman who presented at the John A. Moran Eye Center at the University of Utah for her cataract evaluation. The patient complained of blurry vision, glare, and limited night vision. On examination, she was diagnosed to have a visually significant cataract in her right eye (OD; 2+ posterior subcapsular, 1+ nuclear sclerotic, 2+ anterior cortical) and a mild cataract in her left eye (OS; 1+ nuclear sclerotic). The patient's visual acuity without correction was 20/25–2 OD and 20/25–3 OS. With the brightness acuity testing, her visual acuity decreased to 20/50 OD and 20/30 OS. The patient did not appear to have any symptoms of refractive instability. Astigmatism was 1.5D OD as measured by Pentacam. The patient reported a history of RK bilaterally (OU) 16 years ago, which is seen as an 8-cut RK OU on slit-lamp examination. The patient desired to be spectacle-free and opted to undergo ReSTOR® multifocal IOL placement in the nondominant eye (+22.0 diopters) and TECNIS® monofocal IOL placement in the dominant eye (+23.5 diopters).

Case 2

The second patient was a 61-year-old male who presented at the John A. Moran Eye Center at the University of Utah for cataract evaluation. The patient complained of decreased visual acuity and strain as well as limited night vision. On exam, he was found to have a visual acuity of 20/40 OD and 20/40 OS. With brightness acuity testing, his visual acuity decreased to 20/50 OD and 20/40–2 OS. The patient did not appear to have any symptoms of refractive instability. Astigmatism was 1.5D OS as measured by Pentacam. The patient reported a history of RK OU 28 years ago, which is seen as a 16-cut RK OD and 12-cut RK OS on slit-lamp examination. In addition, the patient underwent postrefractive keratectomy OU 12 years prior to his presentation. The patient desired to be spectacle-free and opted to undergo ReSTOR® multifocal IOL placement in the nondominant eye (+18.5 diopters) and TECNIS® monofocal IOL placement in the dominant eye (+20.0 diopters).

Results

In both patients, there were no reports of significant side effects or adverse events including cell-, wound- or flair-complications. The patients reported a high satisfaction level and were able to achieve spectacle freedom.

Case 1

The patient was seen 2 weeks postoperatively and her manifest refraction was $-1.25 +0.75 \times 180$ 20/25–1 and $-2.00 +0.75 \times 125$ 20/20–1. At 6 months postoperatively, the manifest refraction was $-0.50 +0.50 \times 180$ 20/20 OD and $-1.50 +0.50 \times 120$ 20/20 OS. Postoperative near acuity was recorded as 20/20 OU. Intraocular pressure throughout was measuring around 17 mm Hg OD and 19 mm Hg OS.

Case 2

The patient was seen 2 weeks postoperatively and his manifest refraction was plano spherical 20/20 OD and his visual acuity was 20/70 OS. At 3 months postoperatively, his visual acuity was 20/20 +2 OD and 20/40 OS; the manifest refraction was not recorded at this visit. Postoperative near acuity was recorded as 20/20 OU. Intraocular pressure throughout was measuring around 15 mm Hg OD and 12 mm Hg OS.

Discussion

We have presented 2 patients with a history of RK who then required ReSTOR® multifocal IOL implantation in their non-dominant eyes, and TECNIS® monofocal IOL placement in their dominant eyes, secondary to cataract interference. The outcomes of these procedures were favorable: a successful removal of cataracts and an improved visual acuity without any significant injury or adverse effects.

Cataract removal in patients with previous RK presents a challenging situation. This is an important discussion as an increasing number of patients with a history of RK are now developing visually significant cataracts [2]. RK was extremely popular in the 1980s and early 1990s as it was the primary form of refractive surgical correction. It has been well documented that these patients tend to have prolonged healing times and that some of the initial incisions never healed [2]. Because of the resultant irregular cornea, even small lens opacifications may cause dramatic visual aberrations, which may lead to an inability to tolerate these small visual changes and thus the patients necessitate cataract removal at younger ages.

Patients tend to experience significant corneal flattenings following RK. Postoperative corneal flattening is a known cause of hyperopic shifts and poses an additional challenge in accurate preoperative IOL power calculation. Corneal flattening is due to a combination of factors including corneal edema and swelling, which is further compounded by an irregular cornea with radial incisions. Additionally, as the time between RK and cataract removal increases, the amounts of corneal flattening as well as the degree of hyperopia increase.

Obtaining accurate corneal measurements in these patients can be difficult because irregular corneal surfaces may make conventional K measurements irrelevant. These methods tend to overestimate corneal power and therefore underestimate lens power. The corneal topography of an eye where RK was performed is drastically different than that of a native eye, hence K evaluation before cataract surgery is highly imprecise. The center of the cornea is the steepest and flattens peripherally in the unaffected eye; however, the inverse is true after RK. Overall, these corneas tend to be flatter in the middle. Because a keratometer measures in a ring surrounding the central cornea, it measures from the steeper periphery and thus overestimates corneal power. TNP has proven to be a more reliable method of calculating K in patients with refractive surgery [7]. In this method, the central 21 K values are averaged.

In our cases, both patients were highly motivated for spectacle independence. After appropriate counseling, a strategy of hybrid monovision was pursued. In the nondominant eye, we used a ReSTOR® multifocal IOL. This lens allows the correction of both near and far vision with a high satisfaction rate. In the dominant eye, we chose to use TECNIS® monofocal IOL, which improves far vision. This lens is particularly suited to correct spherical aberration, which is important, given the interference of the radial corneal incision scars (post RK). With the addition of Restor's apodized zones and the enhanced spherical aberration correction and near effectivity of the TECNIS, there is some long-term 'buffer' to compensate for future hyperopic shifts. Of note, progressive long-term hyperopic shifts may compromise the near effectiveness of the multifocal lenses over the course of many years. The multifocal lenses were inserted in eyes with minimal or regular astigmatism. If necessary, astigmatic keratotomy or compression sutures can be used to address corneal astigmatism to reshape the corneal surface contour.

Given the difficulty of preoperative IOL calculation in patients with RK and the desire for spectacle freedom, we propose the use of a combination of multifocal and monofocal lenses.

To determine the appropriate IOL power, we propose the use of TNP K value, AL as measured via IOL, and the use of the Holladay I or SRK-T formulas.

In patients with rapidly progressing hyperopic shifts, it would be inadvisable to pursue cataract surgery with high refractive expectations until the corneas stabilize. If corneas do not stabilize over time, collagen crosslinking may be an emerging modality that promotes corneal refractive stability in corneas with prior aggressive RK [9].

While there have been few case reports discussing IOL placement in patients with preceding RK, we believe that our approach to IOL calculation is an excellent option for patients desiring to be cataract- and spectacle-free and therefore achieve emmetropia.

Disclosure Statement

None of the authors have a financial or proprietary interest in a product, method, or material presented here.

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