



Secondary sulcus IOL implantation for presbyopia correction following Descemet Membrane Endothelial Keratoplasty

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ABSTRACT

Purpose: Report a case where the patient desired spectacle independence after phacoemulsification and Descemet membrane endothelial keratoplasty (DMEK) due to Fuchs' endothelial dystrophy.

Observations: A 52-year-old female presented with corrected distance visual acuity (CDVA) of 20/40 in both eyes with low ametropia. Slit lamp examination revealed corneal edema 1+/4+, guttae, and nuclear cataract 2+/4+ in both eyes. First, given the diagnostic suspicion of Fuchs' endothelial corneal dystrophy and cataracts, phacoemulsification with monofocal toric intraocular lens (IOL) implantation combined with DMEK was performed in both eyes. Postoperatively, the patient was not satisfied with her near vision. Therefore, a supplementary trifocal sulcus IOL was implanted into the right eye. At 30 days postoperatively, the uncorrected distance visual acuity (UDVA) was 20/20 and the uncorrected near visual acuity (UCNVA) was J1, with clear cornea, centered IOL.

Conclusions and importance: This is the first report of supplementary trifocal IOL implantation in a pseudophakic patient with a history of DMEK. This afforded spectacle-independence at all distances with high patient satisfaction. This procedure is safe, predictable, and reversible.

1. Introduction

Fuchs' endothelial corneal dystrophy (FECD) is a bilateral condition that affects the corneal endothelium, triggering edema and excrescences on the Descemet membranes (DMs); the latter are termed guttae. Currently, DM endothelial keratoplasty (DMEK) is the standard therapeutic option. For patients with visually significant coexisting cataracts, a triple DMEK procedure may be considered.^{1,2}

Gayton and Sanders were the first to describe sequential monocular implantation of two intraocular lenses in 1993 (IOLs).³ A supplementary IOL in the sulcus may either correct a residual refractive error^{4,5} or be used to address presbyopia in pseudophakic patients who desire spectacle-independence at all distances.^{6,7} Such secondary implants are safe, predictable, and reversible.⁷⁻⁹ Sulcus fixation lenses have been refined over the past decade.^{10,11}

Recently, a trifocal version of a supplementary lens has been introduced; the Sulcoflex Trifocal (Rayner Intraocular Lenses Ltd., Worthing, UK).¹² After conducting a literature review on April 18th 2024 utilizing PubMed, Google Scholar, and Cochrane Library using the key words:

sulcus IOL, Fuchs' endothelial corneal dystrophy, supplementary IOL and Descemet membrane endothelial keratoplasty, we did not find any prior reports of a similar case describing the implantation of a supplementary trifocal IOL after a combined triple procedure in a patient with FECD.

2. Case report

A 52-year-old female without any previous ophthalmological history was referred with progressively lower visual acuity that had developed over the prior 3 months in both eyes. The corrected distance visual acuity (CDVA) was 20/40 (both eyes); with low ametropia correction (-0.75 – $1.00 \times 45^\circ$ in the right eye and -0.50 – $0.50 \times 135^\circ$ in the left eye). Slit lamp examination revealed corneal edema of grades 1+/4+, guttae, and nuclear cataracts of grade 2+/4+ in both eyes (LOCS stage III).¹³ Fundoscopy within the normal limits, and the intraocular pressure (IOP) was 11 mmHg in the right eye and 10 mmHg in the left. Ancillary testing was performed. Corneal specular microscopy did not yield the endothelial cell counts (Fig. 1). Corneal topography (pachymetry)

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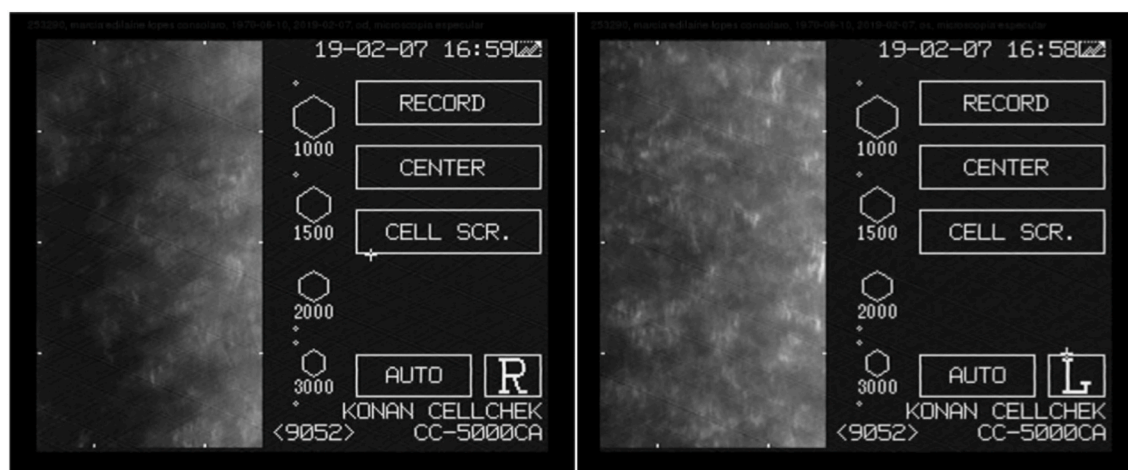


Fig. 1. Title: Admission Corneal specular microscopy

Legend: Corneal specular microscopy with no possible endothelial cell count.

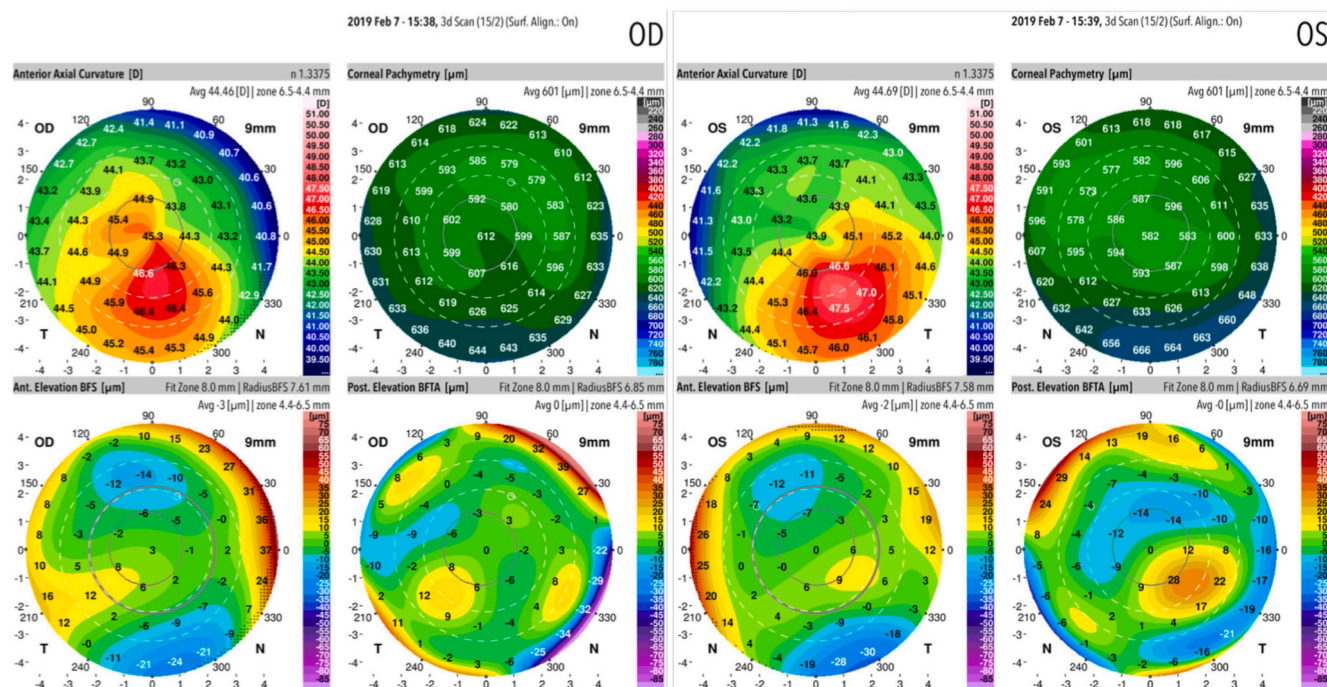


Fig. 2. Title: Admission Corneal tomography

Legend: Corneal tomography with thickened pachymetry, indicating edema.

indicated increased corneal thickness (edema) (Fig. 2), keratometry was 44.37×45.82 at 117 in the right eye and 44.39×45.05 at 99 in the left eye. Corneal confocal microscopy revealed the endothelial guttae and regions of stromal edema (Fig. 3), confirming FECD and cataracts.

Biometry data was performed using IOL Master 700 and Barrett Toric Formula, targeting -0.50 diopters. The anterior chamber depth at admission was 3.84 mm in the right eye and 3.76 mm in the left eye. Phacoemulsification with monofocal toric IOL implantation and DMEK were performed for the right eye (IOL SN6AT4 $+17.50$ diopters) and after 3 months, for the left eye (IOL SN6AT3 $+19.50$ diopters). The size of the DMEK was 8.00 mm in both eyes. Inferior iridotomies (both eyes) were performed intraoperatively to avoid pupillary blocks. Postoperatively, 8 weeks after the procedure in the second eye, the endothelial cell counts were 1371 and 1821 cels/mm² (Fig. 4), without corneal edema (Fig. 5); the uncorrected DVA (UCDVA) was $20/20$. The

anterior chamber depth after the triple procedure was 5.04 mm in both eyes. Then refraction was $+0.25-0.50 \times 140^\circ$ in the right eye and $+0.50-1.00 \times 14^\circ$ in the left eye.

However, the patient was not satisfied with the near vision. Therefore, a Sulcoflex Trifocal supplementary IOL (Rayner Intraocular Lens Ltd., Worthing, UK) was implanted into the ciliary sulcus of the right eye. Given that the patient's spherical equivalent was close to zero at this time, it was decided to implant a trifocal IOL with zero diopters for distance vision, designed with $+3.50$ D near add at 37.5 cm reading plane and $+1.75$ D intermediate add at 75 cm reading plane.

Thirty days later after this secondary sulcus IOL implantation, she presented with a UCDVA of $20/20$ and UCNVA J1, clear cornea, and centered IOLs (Fig. 6). The endothelial cell counts were 1251 cels/mm² and the intraocular pressure was 13 mmHg in the right eye. Concerned about pigment chafing, gonioscopy did not reveal pigment deposition in

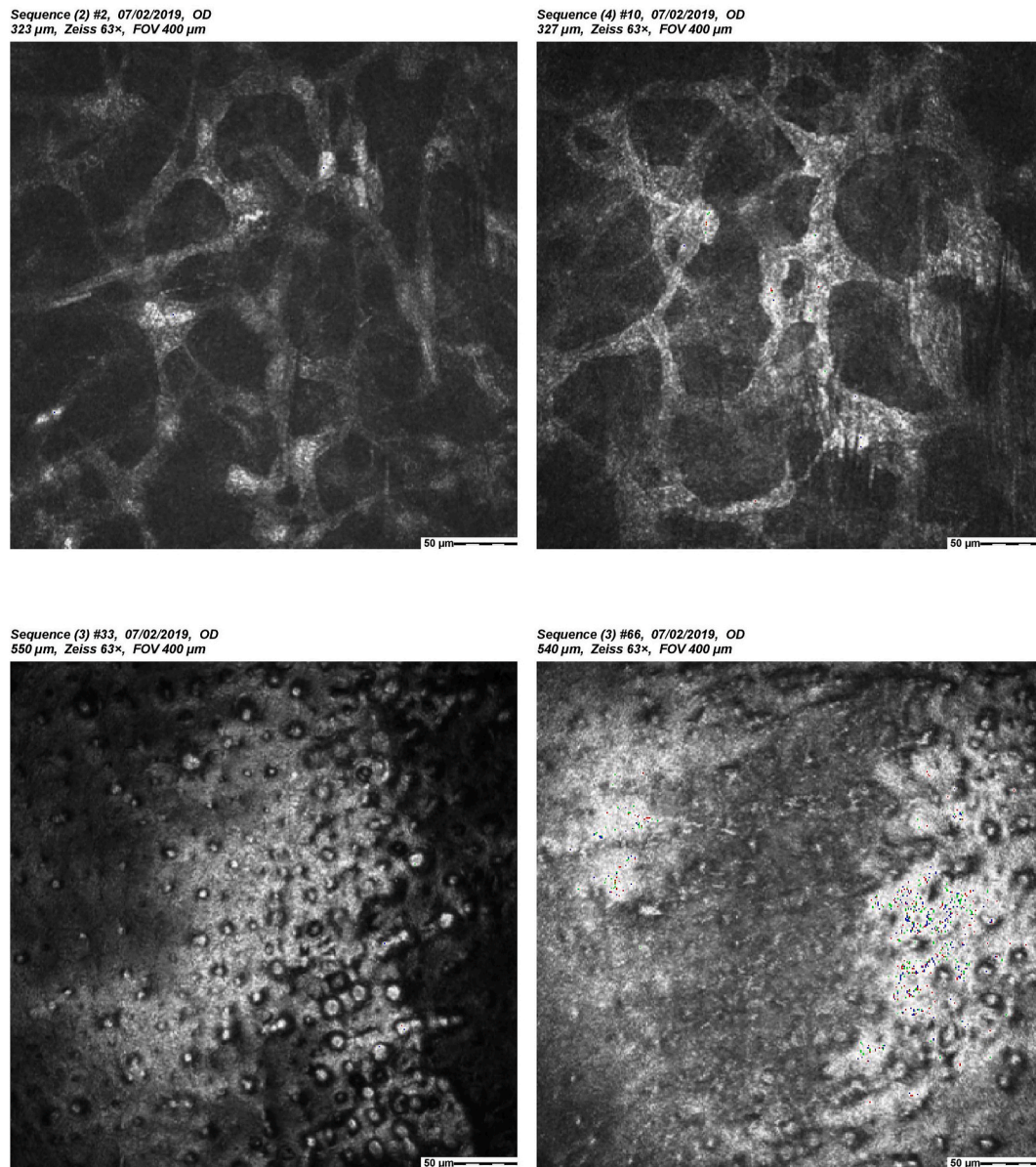


Fig. 3. Title: Admission Corneal Confocal Microscopy OD
 Legend: Upper: Stromal edema. Lower: Diffuse endothelial Guttae.

trabecular meshwork after 6 months of the sulcus implantation procedure. The patient was greatly satisfied.

3. Discussion

The cornea can be affected by conditions that compromise transparency and thus visual acuity. Of such diseases, FECD is one of the most common. First described in 1910,¹⁴ FECD is a hereditary progressive disease that affects the posterior cornea. Patients are usually in their fifth and sixth decades of life and typically report visual blurring that is worse in the morning.¹⁵ The characteristic findings include DM excrescences termed corneal guttae, decreased endothelial cell counts, corneal edema, and in the final stages of the disease, epithelial bullae and corneal opacity.^{14,15} Currently, DMEK is the gold standard surgical procedure to treat FECD.^{1,15} This is associated with no or minimal refractive changes. DMEK can be combined with cataract extraction and IOL implantation, affording rapid visual recovery that decreases risk for graft rejection and additional endothelial damage associated with the use of two separate procedures.¹

After transplantation, corneal function is near-normal, thus, premium IOLs can be considered for patients undergoing combined surgeries.² FECD patients who have recently undergone combined procedures have received toric IOLs and even multifocal lenses.¹ To achieve an ideal outcome, thorough preoperative examination and surgical planning is required. Preoperative corneal power and astigmatism measurements are critical and may be challenging in some patients with advanced FECD; corneal edema compromises corneal transparency and could render unreliable keratometry data.¹⁶ It is nonetheless possible to obtain a satisfactory refractive outcome even when the changes in corneal power and astigmatism after DMEK cannot be fully predicted.

In patients with early FECD and in those for whom data obtained prior to stromal edema are available, IOL power calculation can be more reliably performed. It is appropriate to perform biometry before any need for surgery, thus before clinical edema develops. When corneal decompensation and low visual acuity appear, reliable biometric data are already available, facilitating precise biometric calculations.

During the initial clinical examination, the patient of this report

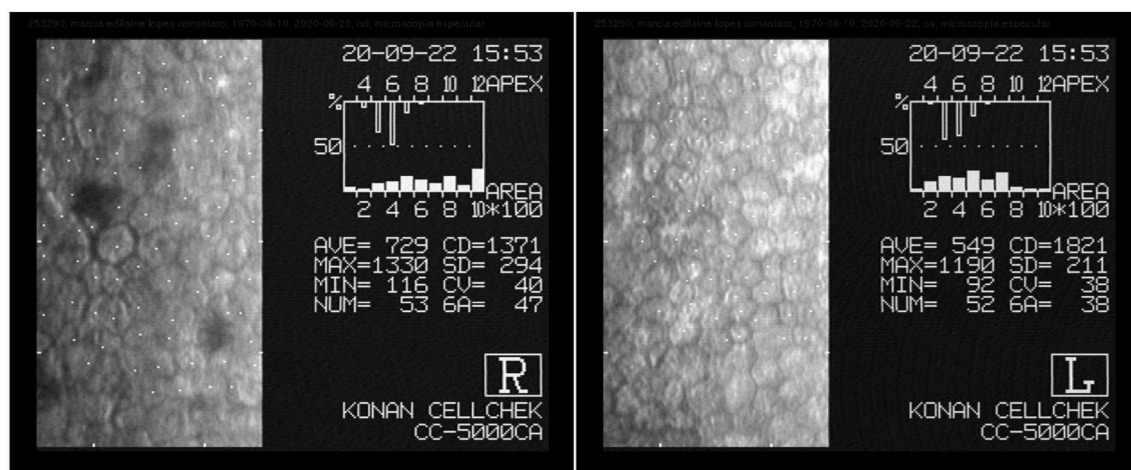


Fig. 4. Title: Post-operative Corneal specular microscopy Legend: Corneal specular microscopy after PHACO-DMEK in both eyes, with adequate endothelial cell counts.

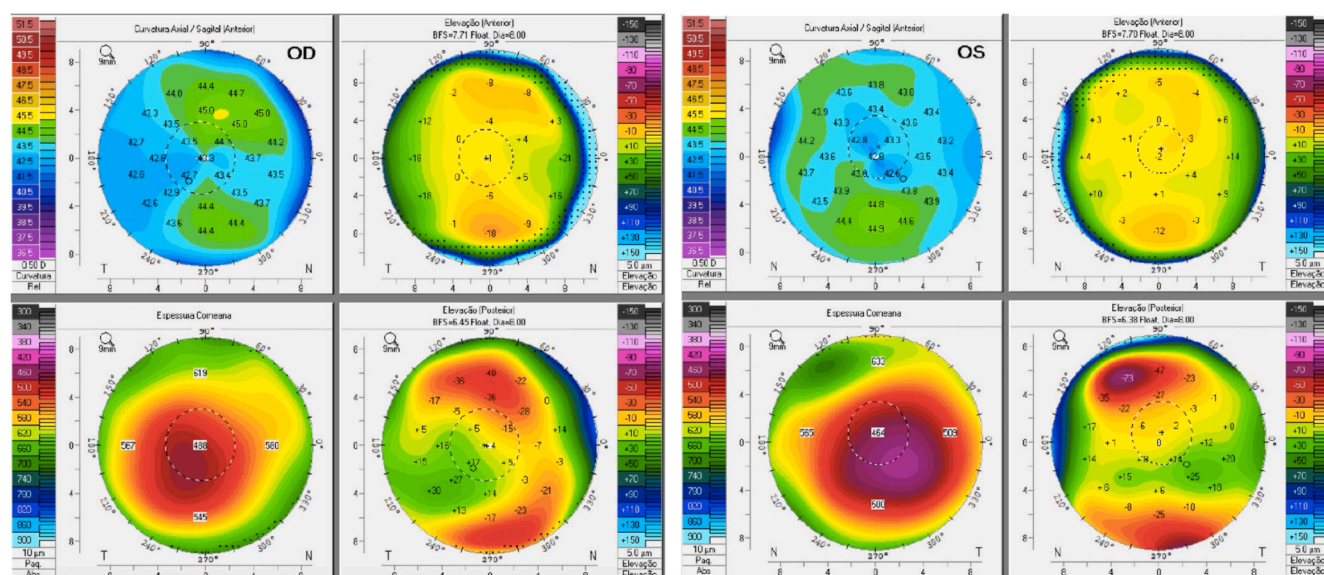


Fig. 5. Title: Post-operative Corneal tomography Legend: Corneal tomography after PHACO-DMEK, showing improvement of the topographic pattern, without edema.

presented with corneal edema 1+/4+. The irregular corneal surface observed in the corneal topography could potentially pose a challenge for the surgeon.

Following the first phacoemulsification and DMEK, there was a notable improvement in corneal topography. The edema had resolved, leaving behind only regular astigmatism - indicating that altered corneal topography was a result of corneal decompensation and edema.

Recently, polypseudophakia has become more popular. The placement of more than one IOL was first described in 1993; two IOLs were implanted in a capsular bag.³ Such “piggybacking” was associated with interlenticular opacification, capsular contraction, and hyperopic shift.¹⁷ Thus, only one IOL should be implanted in a capsular bag. The second IOL should be implanted in the ciliary sulcus.

In 2010, Kahraman and Amon described the first supplementary IOL specifically designed for sulcus implantation. The IOL was fabricated from a hydrophilic acrylic and featured a haptic angulation and an optic curvature facilitating implantation into the ciliary sulcus without interacting with the primary IOL in the capsule. The sulcus IOL did not contact the iris; the clinical results were excellent.^{8,18} Since then, the implantation of a supplementary IOL has become widely accepted as

safe, effective,^{19–21} predictable, well-tolerated, and - very importantly - reversible.⁹

Moreover, a recent in vitro study²² demonstrated that having two IOLs instead of one did not impact the visual quality for a pseudophakic patient. The study also showed that the performance results were comparable to those of a single trifocal IOL fixed in the capsular bag.

Over the past decade, given the importance attached by pseudophakic patients to spectacle-independence at all distances, sulcus-fixated lenses have been greatly refined.²³ Until recently, only monofocal or bifocal supplementary IOLs were available. However, diffractive bifocal lenses lack the intermediate focus required by users of smartphones, tablets, and PCs.²⁴ To provide the outstanding near and intermediate vision needed for everyday activities, multifocal IOLs have been developed, which have achieved excellent results without significant postoperative complications.²⁵ Recently, the new Sulcoflex trifocal IOL supplementary lens was introduced by Rayner Intraocular Lenses Ltd. - Worthing, UK¹²; and reversible trifocality became possible for the first time.

The Sulcoflex supplementary IOL from Rayner Intraocular Lenses

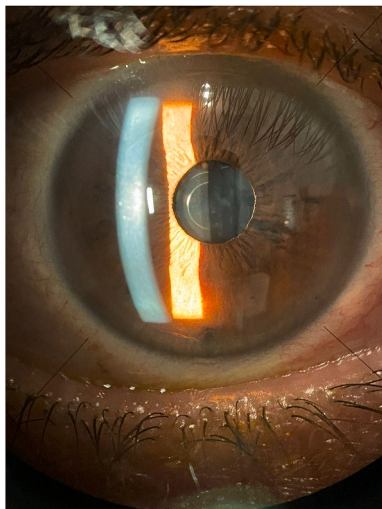


Fig. 6. Title: Post-operative biomicroscopy

Legend: Biomicroscopy of the right eye after the described procedures (PHACO-DMEK and secondary sulcus IOL implantation for presbyopia correction). Clear cornea and centered IOLs.

Ltd. is a single-piece hydrophilic acrylic IOL known for its excellent uveal biocompatibility. It features 14.0 mm haptics angled at 10° with undulated edges, designed to prevent IOL rotation and create a gap between the IOL and the iris.¹² It is already known to be more appropriate to use IOLs with smooth rounded optic edges, reducing the risk of pigment dispersion syndrome²⁶ or optic capture, especially when implanted in the sulcus in a piggyback configuration, hence our choice of implanting the Sulcoflex Trifocal supplementary IOL.

The implantation of an IOL into the ciliary sulcus may be associated with a different set of problems, such as the pigmentary dispersion syndrome and secondary damage to the endothelium from having a lens in the posterior chamber. Concerned about that, the patient continues to undergo periodic monitoring. Even though using a hydrophilic intraocular lens in the sulcus after a DMEK may be a concern because of potential IOL calcification in case of another endothelial transplantation, this is a reversible procedure and the IOL could be exchanged.

These lenses are now available in monofocal, bifocal and toric versions, and can correct postoperative refractive errors or create multifocality in pseudophakic eyes with monofocal IOLs implanted in capsular bags. Such IOL blending has become commonplace and it is safe, predictable, and reversible.

4. Conclusions

After conducting a literature review we did not find any prior reports of a similar case describing the implantation of a supplementary trifocal IOL in a pseudophakic patient with a history of DMEK. Spectacle-independence was attained at all distances and the patient was satisfied. Secondary implantation of a supplementary lens did not significantly affect the postoperative endothelial cell count.

5. Claims of priority

After conducting a literature review on April 18th 2024 utilizing PubMed, Google Scholar, and Cochrane Library using the key words sulcus IOL, Fuchs' endothelial corneal dystrophy, supplementary IOL and Descemet membrane endothelial keratoplasty we did not find any prior reports of a similar case describing the implantation of a supplementary trifocal IOL after a combined triple procedure in a patient with FECD.

5.1. Patient consent

All research procedures adhered to the ethical guidelines of the Declaration of Helsinki with written informed consent for publication of this case report.

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Authorship

All authors attest that they meet the current ICMJE criteria.

CRediT authorship contribution statement

Luiza Moschetta Zimmermann: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Guilherme Vieira Peixoto:** Writing – review & editing, Writing – original draft. **Júlia Margoni Biluca:** Writing – review & editing, Visualization, Conceptualization. **José Maurílio Tavares de Lucena:** Writing – review & editing, Writing – original draft, Validation. **Ricardo Menon Nosé:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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