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Case Report

Femtosecond LASER-Assisted Double Intraocular Lens Exchange in Nanophthalmic Eyes

Nadav Levinger[a, b] Nir Erdinest[a] Naomi London[c] Eliya Levinger[a, d] Shalhevet Goldfeather Ben Zaken[a, e] Dana Barequet[a, d] Irit Barequet[a, f] Asaf Achiron[a, d] Shmuel Levinger[a]

[a]Enaim Medical Center Jerusalem and Tel Aviv, Tel Aviv, Israel; [b]Hadassah Medical Center, Jerusalem, Israel; [c]Private Practice, Jerusalem, Israel; [d]Tel Aviv Sourasky Medical Center, Tel Aviv, Israel; [e]Department of Ophthalmology, Kaplan Medical Center, Rehovot, Israel; [f]Goldschleger Eye Institute, Sheba Medical Center, Sackler Faculty of Medicine, Tel Aviv University, Tel Hashomer, Israel

Keywords
Case report · Nanophthalmos · Refractive lens exchange · Double implant procedure

Abstract
Introduction: Though patients with nanophthalmos frequently endure decreased quality of vision with contact lenses or spectacles, refractive surgery is generally an inadequate alternative due to the associated high refractive error. A refractive lens exchange (RLE) is an alternative option but is technically challenging, requiring accuracy in biometry measurements and procedures. ***Case Presentation:*** This case discusses a 27-year-old female with nanophthalmos (axial lengths 17.6 mm and 17.4 mm, right and left eyes, respectively) who underwent a femtosecond laser-assisted (FLA) RLE with simultaneous implantation of a monofocal and a Sulcoflex trifocal (Rayner, Britain) lens in each eye. Preoperative cycloplegic refraction was +11.50/−0.75 × 145 and +12.00/−1.00 × 35 in the RE and LE, respectively. Best-corrected visual acuity (BCVA) at distance and near in the RE and LE was 6/7.5 and J1, 6/8.5 and J2, respectively. Uncorrected visual acuity (UCVA) was >6/120 and >J14 for each eye. FLA RLE was performed in the RE, then in the LE 2 weeks later. In each eye, a monofocal (44.0 D, RE, and LE) and a Sulcoflex trifocal lens (both implants, Rayner, Britain) were implanted in one procedure. Distance and near UCVA measured 6 weeks post-op RE and 1-month post-op LE at 6/8.5 and J1 in the RE, 6/10 and J1 in the LE. The RE and LE refraction and BCVA were +0.50/−1.00 × 115, 6/7.5, and plano/−1.00 × 55, 6/8.5, respectively. The post-op outcomes were uneventful. ***Conclusion:*** A single procedure concurrently implanting a monofocal and

Correspondence to:
Nadav Levinger, nadav.levinger@gmail.com

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Sulcoflex trifocal intraocular lens in nanophthalmic eyes resulted in an excellent UCVA. This procedure can be considered esthetic and reconstructive as it significantly improves patient appearance and function.

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Introduction

Small eyes are defined as eyes with an axial length (AL) of less than 21 mm in adults and 17.5 mm in children [1]. The spectrum is further subdivided into simple microphthalmos (small AL and no other ocular malformations), complex microphthalmos (small AL with additional ocular abnormalities), relative anterior microphthalmos (normal AL but anterior chamber depth (ACD) of less than 2.2 mm and corneal diameter of less than 11 mm), posterior microphthalmos (small AL and normal anterior segment), and nanophthalmos (AL of less than 21 mm, a high lens-to-eye ratio, a high degree of hyperopia, and scleral thickening) [1, 2].

Cataract surgery on small eyes is complex, resulting in higher complication rates and less predictable refractive outcomes [2]. Nonetheless, refractive lens exchange (RLE) has been proposed as a possible solution for patients with extreme refractive errors where other types of refractive surgery are inappropriate [3]. Presented here is a case of a 27-year-old female who underwent a unique bilateral RLE to treat extreme hyperopia with monofocal and Sulcoflex trifocal intraocular lenses (IOLs), which resulted in excellent visual acuity [4].

Case Presentation

A 27-year-old female presented for a refractive surgery consultation. The patient's medical history was uneventful, and she reported no ongoing medical treatment. The patient's ocular history was complicated by extreme hyperopia. The patient underwent strabismus surgery in childhood, and both eyes were mildly amblyopic [5].

The examination revealed cycloplegic refraction of +11.50/−0.75 × 145 in the right eye (RE) and +12.00/−1.00 × 35 in the left eye (LE). The best-corrected visual acuity at distance and near in the RE and LE was 6/7.5 and J1, 6/8.5 and J2, respectively. Uncorrected visual acuity was >6/120 and >J14 for each eye.

Biometry measurements were conducted using the optical biometer Tomey OA-2000 (Tomey Corporation, Nagoya, Japan). They showed average corneal curvatures of 48.28D and 48.42D, eye lengths of 17.66 mm and 17.44 mm, and anterior chamber depths of 3.14 mm and 3.19 mm in the right and left eyes, respectively (shown in Fig. 1).

The central corneal thickness pachymetry was 543 in the RE and 549 in the LE, respectively. All measurements were obtained using the Sirius system (Costruzione Strumenti Oftalmici, Florence, Italy). These measurements were complemented by anterior segment optical coherence tomography (AS-OCT) using the MS-39 device (CSO, Florence, Italy, shown in Fig. 2).

The patient underwent a complete ophthalmological evaluation that noted a transparent cornea and lens with normal posterior segments. Perioperative examinations noted normal macular OCT, normal corneal tomography, a horizontal white-to-white distance of 10.8 mm in the RE and 10.7 mm in the LE, and a cup/disc ratio of 0.3 with no RNFL damage in either eye. Intraocular pressure (IOP) measured with Goldman tonometry was 12 mm Hg in both eyes.

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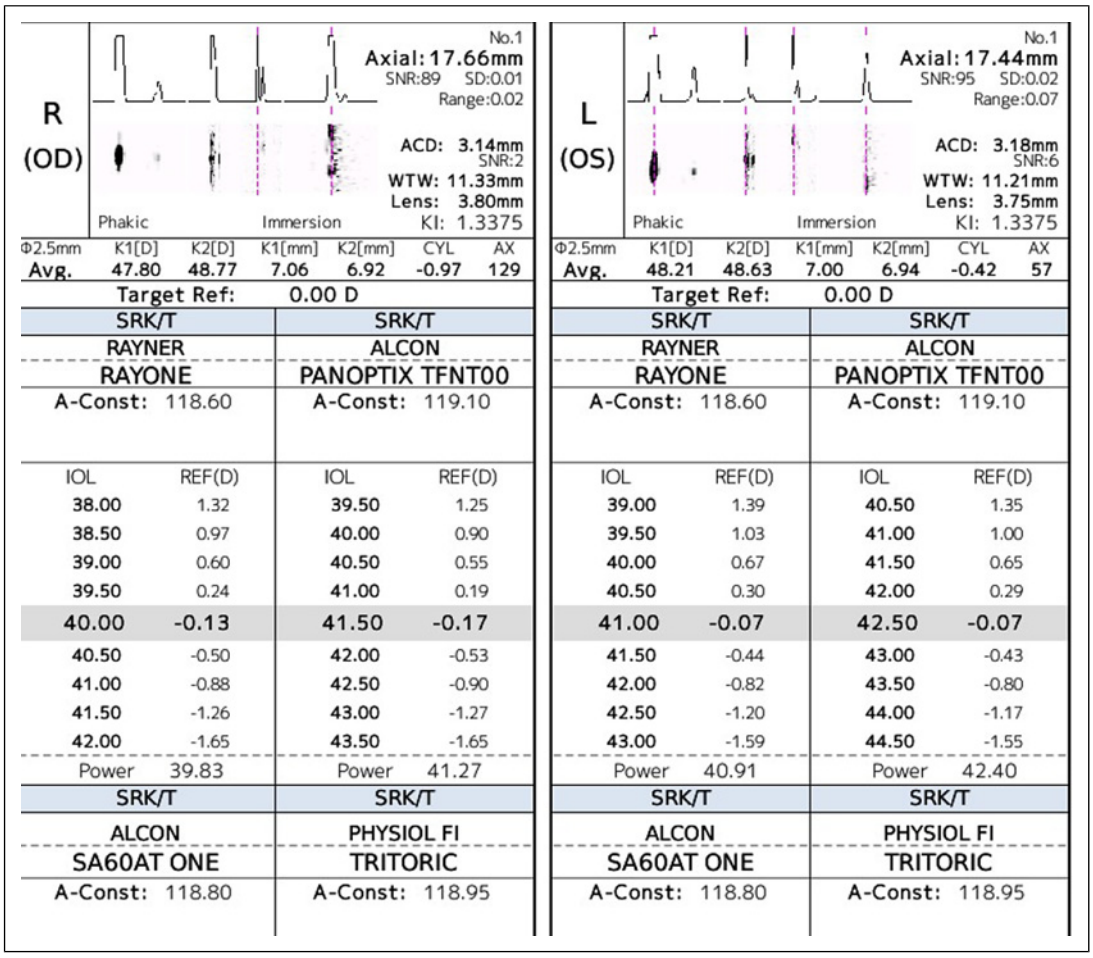

Fig. 1. Biometry data output. The biometric exam shows a steep anterior cornea.

Endothelial cell count was 3,412 mm^2 and 3,528 mm^2 in the RE and LE, respectively. The AL was 17.6 mm and 17.4 mm in the RE and LE, respectively.

The patient underwent FLA RLE implanted with a monofocal +44.0 D IOL in front of the posterior capsule to correct the spherical component and a Sulcoflex trifocal plano/+1.50D/+3.50D (Rayner, Britain) placed in the ciliary sulcus in both eyes. The lens powers were calculated using manufacturers' guidelines, corneal shape, refractive error and subjective refraction, with a 2-week procedure interim between eyes.

Although the biometer was calculated for a +41D, after adjusting for the type of IOL, the use of Sulcoflex, and consulting the company, an aspheric Rayner C-flex (model 970c) power of +44D and Sulcoflex trifocal (modal 703f) were chosen for both eyes. The eye was patched till the day after surgery, then treated with Sterodex (Fischer Pharmaceuticals LTD), Nevanac, and Vigamox (Novartis AG). Follow-up examinations took place a day, week, and month after surgery.

At 6 weeks post-op RE and 1 month post-op LE, the uncorrected visual acuity was 6/8.5 and J1 in the RE, 6/10 and J1 in the LE. The RE and LE residual refraction and best-corrected visual acuity were +0.50/−1.00 × 115, 6/7.5, and plano/−1.00 × 55, 6/8.5, respectively. IOP was 14 mm Hg in each eye. There were no additional post-op sequelae to report. This case demonstrates the benefit of sequential implantation of a capsular bag IOL and a supplementary sulcus-fixated trifocal IOL RLE in a nanopthalmic eye.

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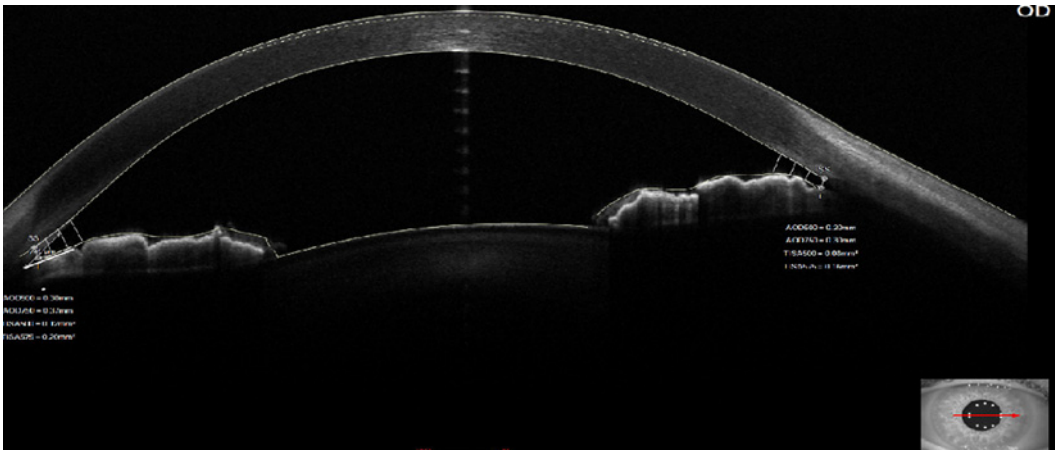

Fig. 2. Anterior segment (AS) OCT image of OD's corneal and anterior segment. The AS-OCT showed notable depths for the anterior chambers in both eyes.

Discussion

The patient had worn contact lenses for many years but developed an intolerance. As her spectacle visual acuity was insufficient for her needs, she explored the option of refractive surgery. In smaller eyes, there are increased potential risks to consider, considering there is often a small axial length or shallow anterior chamber.

A corneal procedure was not advisable due to her extreme hyperopia. Extremely steep K values would be required to correct the cycloplegic refraction fully. Most studies that demonstrate positive corneal hyperopic procedure outcomes discuss low to medium hyperopia [6, 7], and there is a lack of clinical evidence regarding effective results from corneal procedures in cases with very high hyperopia. Treatment of extreme hyperopia has been shown to potentially cause optical aberrations, dry eyes, and high regression rates [8].

An alternative option for patients with high hyperopia is phakic IOL (PIOL) implantation. This procedure can provide excellent visual acuity and a low complication rate [9]. However, this patient was not an ideal candidate for PIOL due to her small eye and the risk that the anterior chamber may become even smaller over time, as often occurs in shorter eyes. Thus, the surgeons' choice prioritized long-term patient safety. As the use of sequential implantation of a capsular bag IOL and a supplementary sulcus-fixated trifocal IOL was demonstrated to be safe and effective in a past study by Kahraman et al. [10], RLE became the most appropriate alternative. As this patient's goal was spectacle independence, both near and far visual acuity needed addressing. With a history of strabismus but currently no binocular issues, she was not a good candidate for monovision [11].

Calculating the correct IOL for these extremely short eyes was a challenge. A study by Yosar et al. [2] demonstrated some advantages of the SRK/T formula for IOL calculation. Therefore, it was chosen along with measurements from the Tomey IOL calculator, Sirius and Orbscan tomography, and subjective refraction.

The patient needed IOLs with power above 40D; no multifocal IOL was available in these parameters. Therefore, it was suggested to implant a monofocal IOL to correct the spherical component and, simultaneously, a Sulcoflex trifocal IOL. Although bioptic surgery that involves the performing of RLE and, after that, excimer LASER for the residual refractive error is a possible alternative [12], it was decided against due to the high incisal K values that would result and some corneal irregularities present in the corneal

tomography. It was also decided not to implant a Sulcoflex trifocal as a second separate procedure to minimize procedures to these highly complex eyes in the operating room. Though the use of two IOLs can potentially increase the risk of iris chafing, raise the IOP due to the small eye size and placement of the implants, and, rarely, cause uveitis glaucoma hyphema syndrome, this case did not present with any of these complications probably because of the angle, and ACD were of sufficient size.

The use of femtosecond LASER was critical to the success of this surgery as it enabled the safe removal of the physiological IOL in a small eye. Moreover, the precise anterior capsulorhexis enhanced the safety and predictability of the Sulcoflex implantation [13].

Although an effective procedure, the higher risks of complication, especially severe intraocular complications, should be considered before performing refractive lens exchange. Multiple articles have demonstrated that the age and axial length of the patient are important. Younger patients and those who are more myopic have a higher rate of rhegmatogenous retinal detachment compared to older and emmetropic [14, 15].

Additional intraocular complications may occur, such as earlier posterior capsule opacification and secondary YAG capsulotomy [16–20]. A higher rate of posterior vitreous detachment, epiretinal membrane, and retinal detachment may present following a YAG capsulotomy [18, 21–23].

In our patient, with nonophthalmic eyes, the risk of retinal detachment is less severe, but the risk of other complications, particularly uveitis glaucoma hyphema syndrome with Sulcoflex IOL and uveal effusion, increases [24]. Before implementing an RLE in a highly emmetropic eye, the surgeon must weigh the benefits and potential complications and balance the procedure's effectiveness and the possible complications.

In conclusion, this case demonstrates the need to explore innovative solutions for patients with extreme refractive errors. In this case, the use of sophisticated evaluating equipment, a double lens implantation, the femtosecond LASER, and an experienced surgeon all assisted in creating the successful outcome of a complicated surgery. This procedure can be considered cosmetic and reconstructive, as it provided, in this case, excellent unaided vision, eliminating the need for significant hyperopic spectacles. The authors have completed the CARE checklist for this case report, which is attached as online supplementary material (for all online suppl. material, see https://doi.org/10.1159/000536190).

Statement of Ethics

Ethical approval is not required for this study in accordance with local guidelines. Written informed consent was obtained from the patient to publish this case report and any accompanying images.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

Nadav Levinger and Nir Erdinest: writing the first version of the manuscript; Naomi London, Eliya Levinger, Shalhevet Goldfeather Ben Zaken, Asaf Achiron, and Shmuel Levinger: substantial contributions to the conception or design of the work; Nir Erdinest: acquisition, analysis, interpretation of data for the work; Nir Erdinest and Naomi London: drafting the work; Dana Barequet and Irit Barequet: reviewing it critically for important intellectual content; and Nadav Levinger, Nir Erdinest, Naomi London, Eliya Levinger, Shalhevet Goldfeather Ben Zaken, Dana Barequet, Irit Barequet, Asaf Achiron, and Shmuel Levinger: final approval of the version to be published.

Data Availability Statement

All data generated and pertinent to this study are included in this article. Further inquiries can be directed to the corresponding author.

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