International Clinical and Medical Case Reports Journal
Case Report (ISSN: 2832-5788)

Nanophthalmos and Cataract Surgical Management: A Case Report

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Citation: Brittany Hodges, Nikki Neequaye, Abdullah Virk, Eugene Wang, Ugur Celik and Karen Allison. Nanophthalmos and Cataract Surgical Management: A Case Report. Int Clinc Med Case Rep Jour. 2025;4(9):1-10.

Received Date: 04 September 2025; **Accepted Date:** 08 September 2025; **Published Date:** 10 September 2025

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ABSTRACT

Background: This case report is relevant to the field of ophthalmology because it enhances understanding of diagnosis and surgical management for complicated cataract procedures in patients with narrow angle glaucoma, high hyperopia, and nanophthalmos. These coexisting morbidities are of primary concern due to increased risk for serious complications including angle-closure glaucoma, uveal effusions, refractive surprise, aqueous misdirection, and retinal abnormalities. This case report will help to close knowledge gaps by offering a patient example.

Case Presentation: A 54-year-old Caucasian male ship engineer with no significant past medical history but an ocular history of anatomical narrow angle, high intraocular pressures, high hyperopia, and previous bilateral Laser Peripheral Iridotomy (LPI) performed in 2011. He has no family history of ocular disease and no relevant social history.

The patient presented to a Flaum Eye Institute satellite clinic for a routine comprehensive eye exam with an optometrist in early December 2022. Anterior segment exam was unremarkable except for bilateral LPI and narrow angle. Distance visual acuity with correction was 20/30 in both eyes (OU) with improvement to 20/20 in the right eye (OD) and 20/25 +3 in the left (OS) following refraction. Refraction was OD: +10.75 -1.00 x 075 and OS: +9.75 -1.00 x 105. Intraocular Pressure (IOP) documented during the encounter was initially 19 OD and 21 OS. Dilation precipitated an IOP spike to 38 OD and 40 OS after 40 minutes. He was then treated with two drops each of Dorzolamide-Timolol and Brimonidine OU, which reduced IOP to 18 OD and 18 OS over the next 2 hours. He was prescribed Dorzolamide-Timolol QAM and Latanoprost QHS OU drops to use at home. He was referred and seen by the glaucoma service 13 days later for further evaluation. Following a comprehensive examination that included gonioscopy, it was determined that he had Shaffer grade 1 narrow angle with pigmentation in both eyes and signs of optic nerve damage in the right eye (early superior defects, cup-to-disc ratio of 0.5). Consequently, he was scheduled for laser iridoplasty in the right eye eight days later. Laser iridoplasty in the right eye was well tolerated, resulting in an intraocular pressure of 14 mmHg in the right eye. The patient was prescribed Prednisolone drops to be administered four times daily for a duration of one week. During the follow-up assessment in January 2023, it was observed that the patient had improved to Shaffer grade 2 in the right eye. Additionally, he was informed about the

eventual necessity for cataract surgery.

The patient was lost to follow-up and was not seen again until late August 2024 when he returned for possible cataract evaluation. He was made aware of the heightened risk of cataract surgery due to his ocular history. During his next visit in late October 2024, the patient reported experiencing itchiness and burning in the left eye, as well as glare in both eyes. Upon examination, his visual acuity with correction was measured at 20/25 in the right eye and 20/30 in the left eye. Manifest refraction was OD: +9.75+1.00 x 165 and OS: +8.75 +1.00 x 015. He was determined to have visually significant cataracts OU limiting activities of daily living. Axial length was 18.97 mm OD and 19.12 mm OS, with an anterior chamber depth of 2.52 mm OD and 2.49 mm OS. Given these findings, the patient was initially scheduled for cataract extraction with Posterior Chamber Intraocular Lens (PCIOL) implantation and goniotomy OS December 2024. One week after surgery, the patient reported visual symptoms of aniseikonia and anisometropia and was found to have a tilted Intraocular Lens (IOL) with posterior synechiae OS on Slit Lamp Examination (SLE) which was further confirmed by Ultrasound Biomicroscopy (UBM). The patient subsequently had intraocular lens repositioning and anterior vitrectomy OS with resolution of visual symptoms. Four months later in April 2025, the patient underwent cataract extraction and PCIOL implantation, anterior vitrectomy, and goniotomy OD. The procedure was uncomplicated and he reported no visual complaints on subsequent follow-up.

Conclusions: This case report underlines the importance of early diagnosis, appropriate surgical management, and potential complications of patients with nanophthalmos and cataracts.

Keywords: Aniseikonia; Anisometropia; Anterior vitrectomy; Cataract; Cataract extraction; Goniotomy; Nanophthalmos; Posterior chamber intraocular lens; Iridoplasty; Iridotomy

Abbreviations: IOP: Intraocular Pressure; OU: Both Eyes; OD: Right Eye; OS: Left Eye; PCIOL: Posterior Chamber Intra Ocular Lens; IOL: Intraocular Lens; SLE: Slit Lamp Examination; OCT: Optical Coherence Tomography; VF: Visual Field; UBM: Ultrasound Biomicroscopy; ACD: Anterior Chamber Depth; RNFL: Retinal Nerve Fiber Layer

INTRODUCTION

Nanophthalmos is a rare developmental disorder characterized by small but structurally normal eyes [1]. It consists of smaller anterior and posterior segments due to impaired development of the eye after the embryonic fissure is closed [2,3]. Nanophthalmos can be both unilateral and bilateral, with prevalences of less than 1% in most populations [3,4]. The disorder may be sporadic or inherited, with genes such as MFRP, TMEM98, PRSS56, BEST1, and CRB1 being linked to the familial form of the disease [1].

Nanophthalmic eyes tend to have anatomical characteristics such as shorter axial lengths (<20.5mm), small corneal diameters (<11.0mm), shallow anterior chambers (<2.71mm), narrow angles, larger lens thickness to eyeball volume ratio (11-32%), and thickened chorioretinal scleral thickness (>1.7mm) [2,3,5]. These anatomical features increase risk of additional secondary disease etiology and surgical complications. Nanophthalmos increases risk of strabismus and high hyperopia, which can result in irreversible amblyopia if not corrected in early childhood [1,4]. Moreover, additional conditions that can be secondary to nanophthalmic eyes include angle closure glaucoma,

exudative retinal detachment, cystoid macular edema, or uveal effusion syndrome, each of which necessitates additional medical or surgical therapy [4].

Although nanophthalmos presents with an increased risk of surgical complications, surgeries such as cataract surgery, glaucoma filtering surgery, or sclerotomies amongst others may provide clinical benefit to the patient depending on the presence of various clinical features and diseases present [2]. Due to the larger lens-to-eyeball volume ratio and shallow anterior chamber in small eyes, middle-aged nanophthalmic patients are at risk of angle closure due to the natural increase in size of the lens pushing the iris forward, resulting in further crowding of the iridocorneal angle [2,6]. Angle closure results in an increase of IOP and subsequent irreversible damage to the optic nerve. Hence, cataract surgery may benefit nanopthalmic patients with co-morbid aging cataracts and narrow angles by reducing both IOP and the risk for further angle closure. Consequently, early cataract surgery may also decrease the need for further procedures such as laser iridotomy, iridoplasty, or sclerotomies [6].

CASE PRESENTATION

In December 2022, a 54-year-old Caucasian male ship engineer on no medication with ocular history of high hyperopia, anatomical narrow angles, and previous bilateral LPI initially presented to a Flaum Eye Institute satellite clinic for a comprehensive eye exam. He reported stable distance vision with blurry near vision. He denied eye pain, flashes, or floaters. There was no family history of ocular disease. Distance visual acuity with correction was 20/30 OU. Near vision with correction was J3 OD and J2 OS. Manifest refraction was OD: +10.75 -1.00 x 075 and OS: +9.75 -1.00 x 105, improving visual acuity to 20/20 OD and 20/25 +3 OS. Dilation precipitated an IOP spike to 38/40 (from 19/21). Cup-to-disc (C/D) ratio was 0.3 in the right eye and 0.35 in the left eye. Two instillations each of Dorzolamide-Timolol and Brimonidine drops were administered with IOP reduction to 18/18. He was then referred to the glaucoma service for evaluation. Latanoprost QHS and Dorzolamide-Timolol QAM were prescribed in the interim prior to his glaucoma referral appointment scheduled 13 days later.

Two weeks later, he was seen by the glaucoma service and a comprehensive eye exam was performed including gonioscopy which showed Shaffer grade 2 narrow angles with pigmentation OU. Furthermore, there was evidence of optic nerve asymmetry (C/D ratio 0.5 OD and 0.4 OS). Visual acuity with correction was 20/25 OD and 20/25 +3 OS. Manifest refraction was OD: +10.75 -1.00 x 075 and OS: +9.75 -1.00 x 105. IOP measured by Goldmann applanation tonometry was 19 mmHg OU. Corneal thickness was 528 microns OD and 526 microns OS via Pachymetry. Humphrey Visual Field (VF) testing showed early superior VF defects OD and few temporal VF defects OS (Figure 1). Optical Coherence Tomography (OCT) of the Retinal Nerve Fiber Layer (RNFL) demonstrated thickness of 133 microns OD and 112 microns OS, both within normal limits (Figure 2). One week later, he received laser iridoplasty in the right eye and was subsequently treated with prednisolone drops four times a day for one week in the right eye. He continued to use Latanoprost once daily at bedtime and Dorzolamide-Timolol twice daily in both eyes.

The patient was lost to follow up for 2 years. He returned to the clinic in August 2024. After a comprehensive eye exam and Humphrey Visual Field testing, the VF was noted within normal limits OD and low reliability and borderline central VF defects OS. (Figure 3). On a subsequent visit in October 2024, he presented with new

symptoms of increased glare, cloudy vision, difficulty reading, mild burning, and itchiness OU which was most concerning for visually significant cataracts. Visual acuity testing was 20/25 OD and 20/30 OS. Brightness acuity testing was notable for visual acuity of 20/70 OD and 20/60 OS with high glare. Slit lamp examination showed trace nuclear sclerotic cataract and narrow angles OU. Manifest refraction was OD: +9.75 +1.00 x 165 and OS: +8.75 +1.00 x 015. He was deemed a candidate for cataract surgery based on presenting symptoms and brightness acuity testing. IOL Master Biometry determined axial length to be 18.97 mm OD and 19.12 mm OS, indicating a short eye (Figure 4). Anterior Chamber Depth (ACD) was 2.52 mm OD and 2.49 mm OS. On December 16, 2024, the patient underwent uncomplicated cataract extraction and goniotomy of his left eye after informed consent. A +38D AcrySof (model SA60AT) Single-piece IOL was implanted OS based on lens calculations (Figure 5).

One day post-op, the patient reported clearer vision OD compared to OS. Visual acuity was 20/20 OD with correction *versus* 20/200 without correction and 20/70 with pinhole OS. IOP was 18 OS. One-week post-op, the patient reported having to patch his left eye because his vision was asymmetrical and he was constantly running into things. Autorefraction was OD: +11.00 -1.00 x 071 and OS: -3.75 -1.75 x 104. On SLE, he was found to have a tilted IOL with posterior synechiae OS, possible aqueous misdirection and myopia all of which were likely factors contributing to his aniseikonia and anisometropia. UBM was performed and confirmed a tilted lens and posterior synechiae (Figure 6). The decision was made, based on findings obtained, to reposition or exchange the IOL as well as to do an anterior vitrectomy to decompress the vitreous.

In December 2024, he underwent IOL repositioning and anterior vitrectomy OS for persistent narrow angles and possible aqueous misdirection. During his January 2025 follow-up appointment, the patient reported improvement of his visual symptoms. His vision was 20/50 OD with correction and 20/150 OS without correction. IOP was 15 OD and 19 OS. Manifest refraction was OS: -3.00 -1.25 x 100, add +2.50. Distance visual acuity was 20/25 OS (Table 1).

In April 2025 the patient was scheduled for cataract extraction, anterior vitrectomy, and goniotomy OD. A +38D AcrySof (model SA60AT) single-piece IOL was placed. He underwent the procedure with no complication. One day post-op the patient reported mild pain, blurry vision, and a floater in the center of his right VF. At a 2-week follow-up appointment, the patient reported improved visual acuity with mild discomfort with best corrected visual acuity of 20/30 without correction OD as well as 20/50 without correction and 20/40 pinhole OS. IOP was 12 OU. Manifest refraction was OD: Plano -1.50 x 045 with distance visual acuity 20/25. OCT of the RNFL demonstrated thickness of 145 microns OD and 108 microns OS, both within normal limits (Figure 7). He was continued on Latanoprost QHS OU. The patient later endorsed satisfaction with achieved visual acuity. His current best corrected visual acuity is 20/25 OD and 20/30 OS. The patient was satisfied with his vision and did not choose to have lens exchange in the left eye.

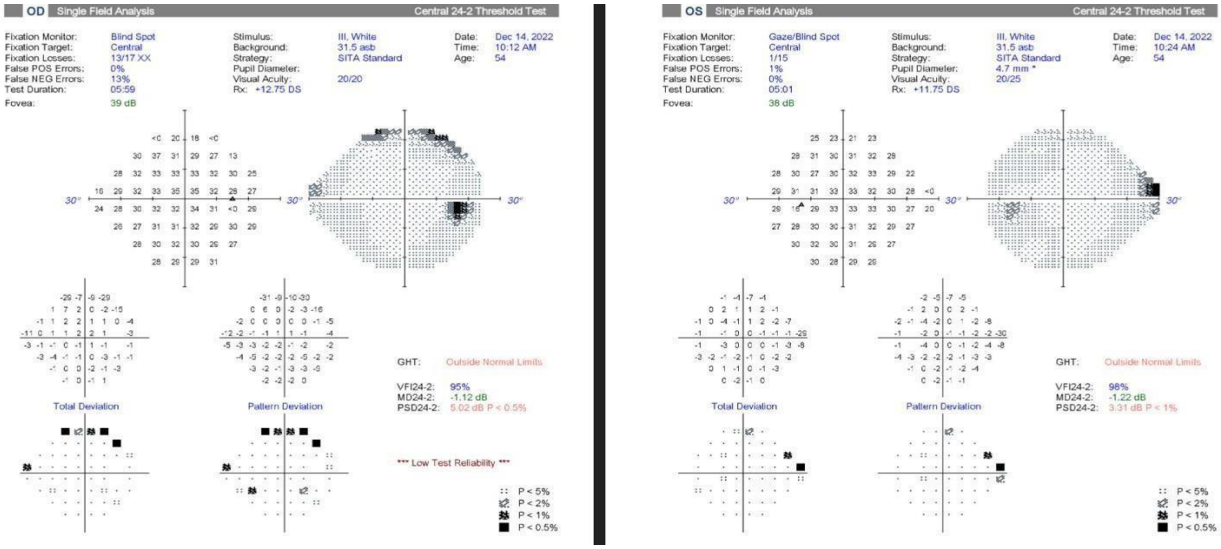

Figure 1: Humphrey VF of both eyes demonstrating early superior VF defects OD and few temporal VF defects OS (December 2022).

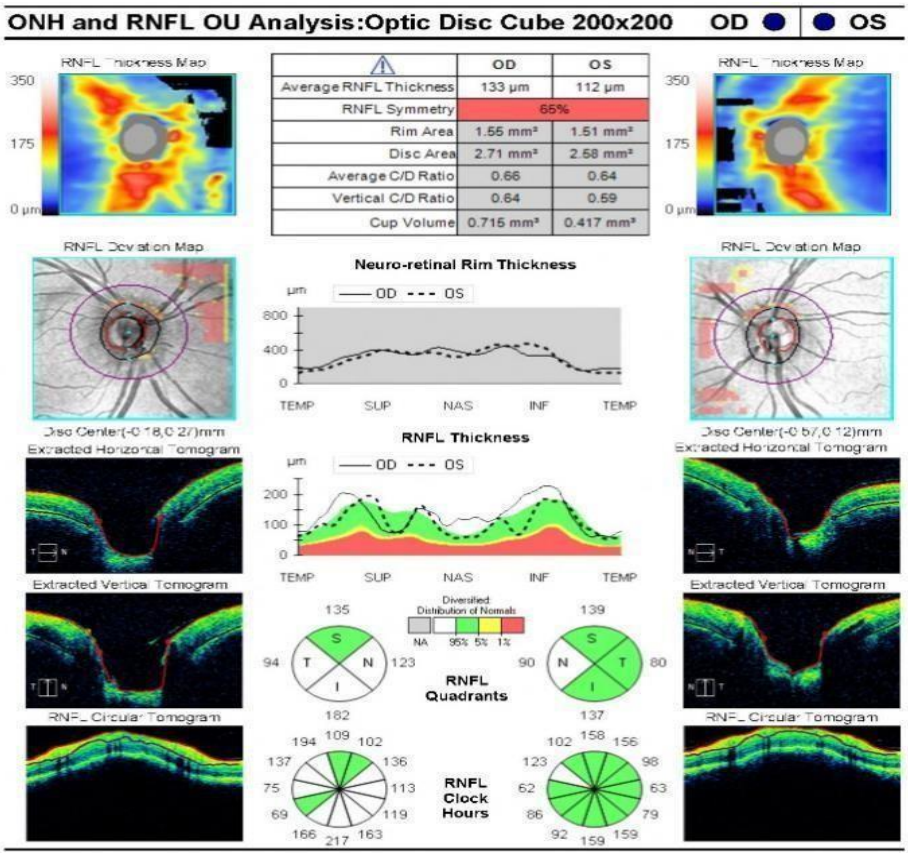

Figure 2: OCT of both eyes demonstrating RNFL thickness of 133 µm OD and 112 µm OS (December 2022).

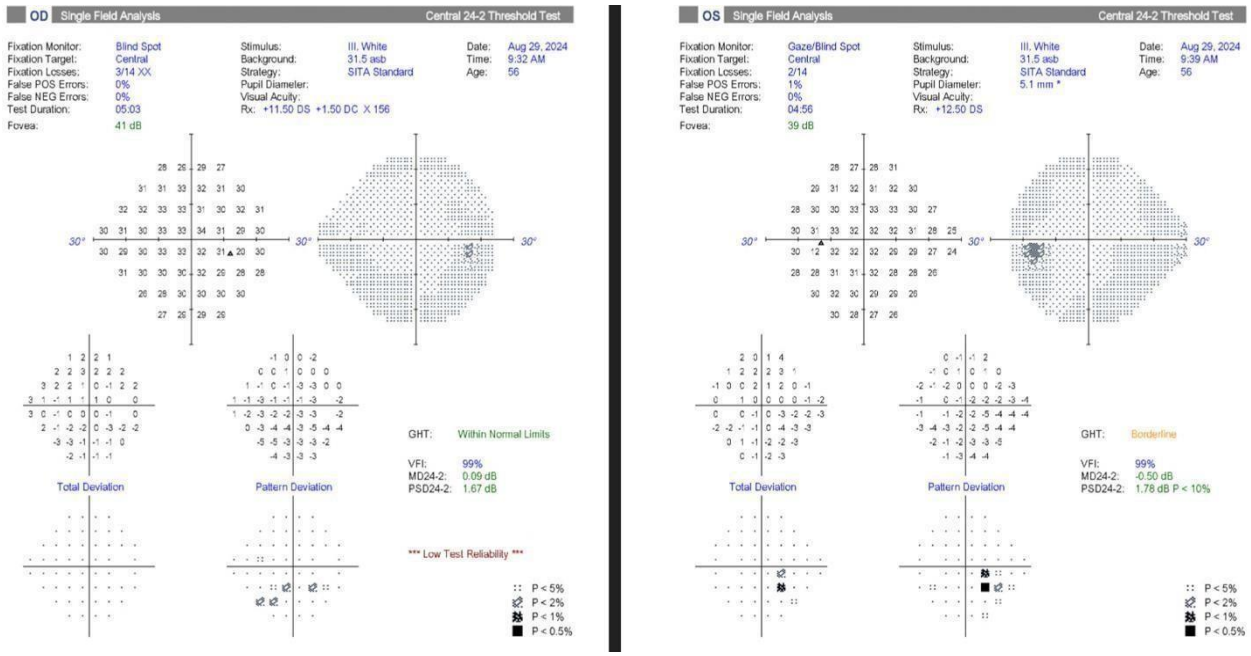

Figure 3: Humphrey VF of both eyes demonstrating VF within normal limits OD under low test reliability and borderline central VF deficits OS (August 2024).

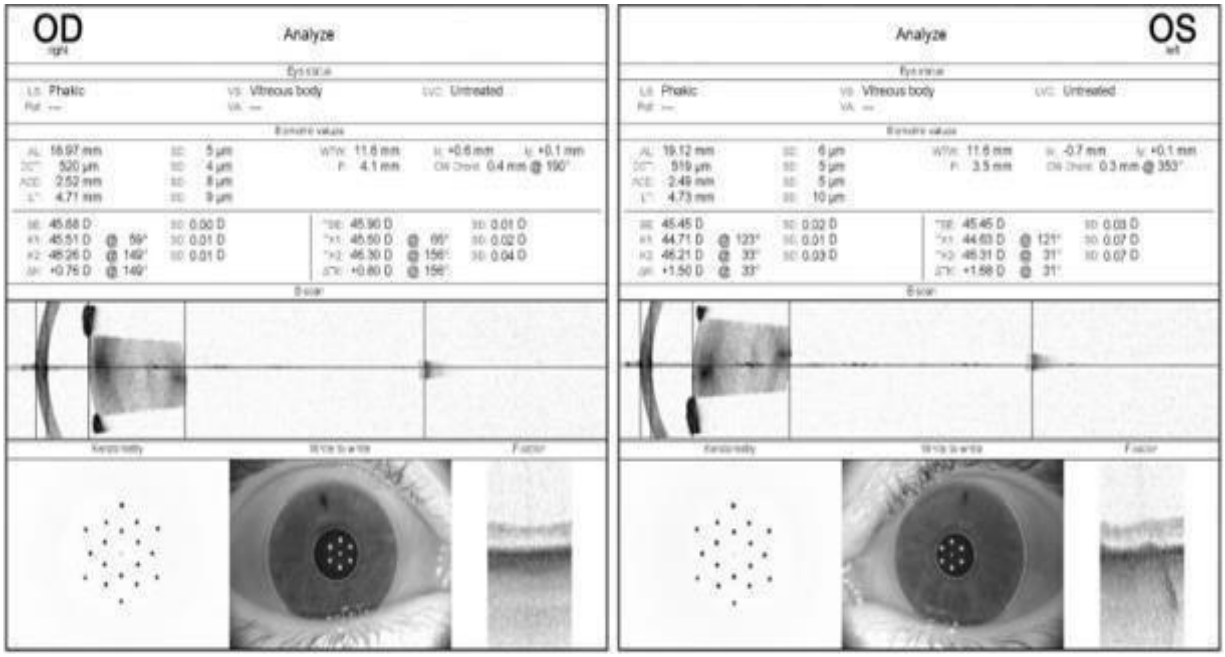

Figure 4: IOL Master biometry of both eyes demonstrating axial length (OD: 18.97 mm, OS: 19.12 mm) and anterior chamber depth (OD: 2.52 mm; OS: 2.49 mm) (December 2024).

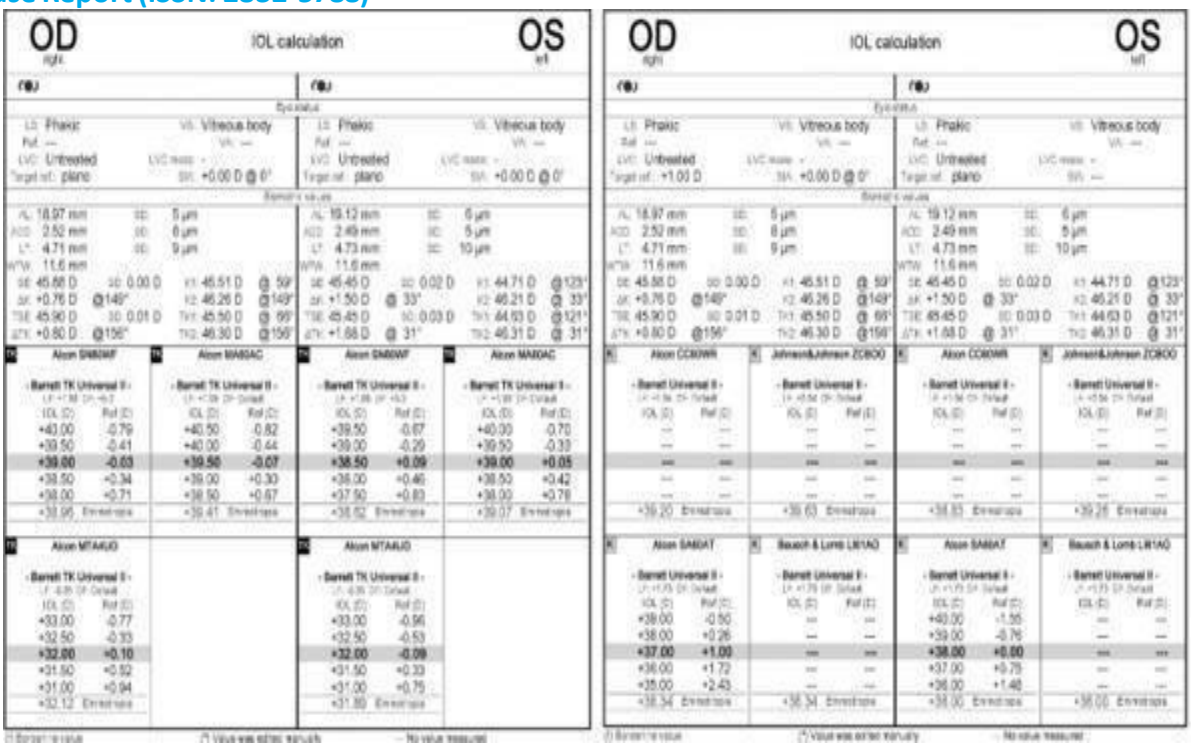

Figure 5: IOL Master lens calculations demonstrating target refractions and recommended IOL powers for both eyes (April 2025).

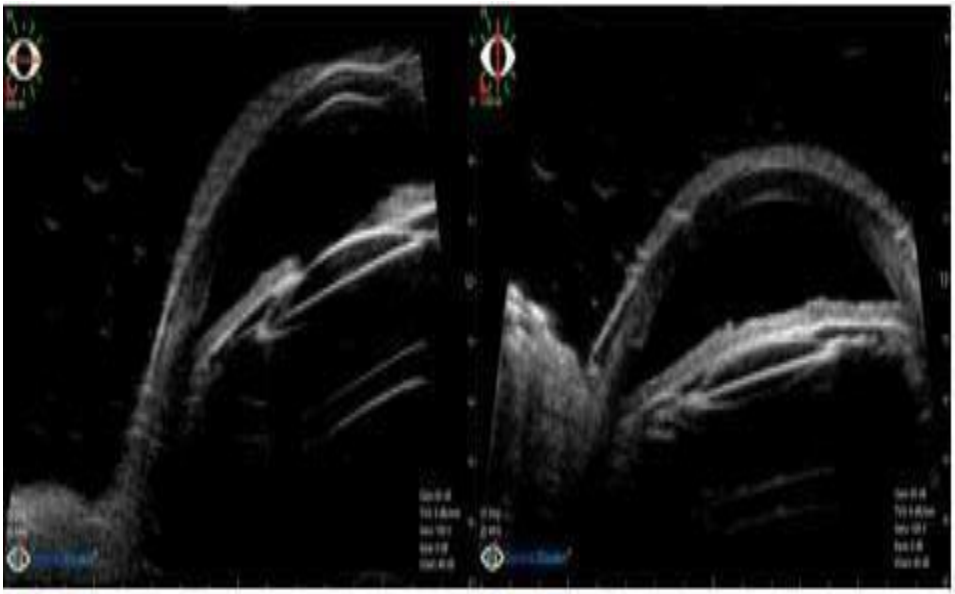

Figure 6: Ultrasound Biomicroscopy (UBM) of the left eye demonstrating tilted IOL (IOL) and posterior synechiae (December 2024).

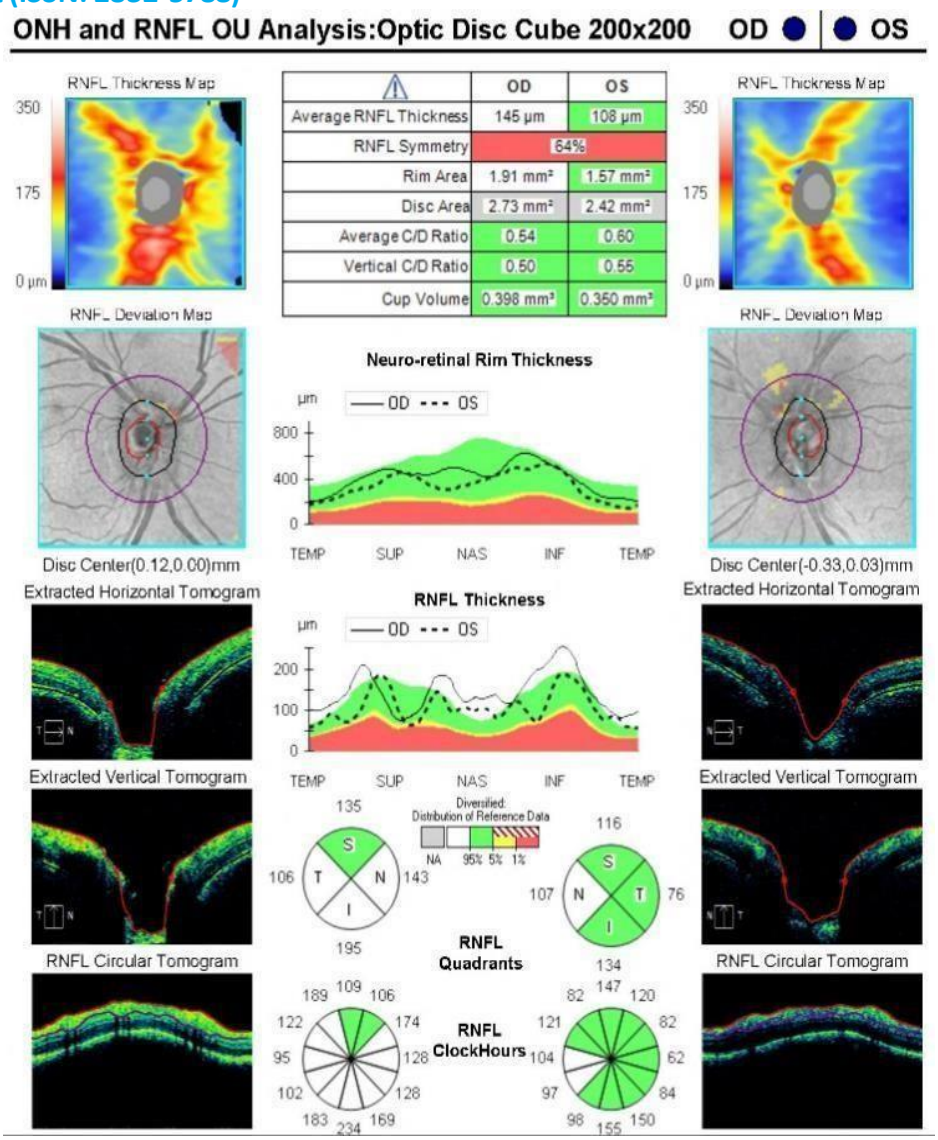

Figure 7: OCT of both eyes demonstrating RNFL thickness of 145 µm OD and 108 µm OS (July 2025).

Table 1: Changes in visual metrics OS from IOL repositioning and anterior vitrectomy.

Metric	Visual Acuity	ACD	Axial Length
Before	20/25 -1	3.13 mm	19.07 mm
After	20/25	3.90 mm	19.00 mm

The table currently includes the ACD and AL from the pseudophakic IOL measurements prior to repositioning and vitrectomy on 12/30/2025.

Phakic measurements OS

- ACD 2.49 mm
- AL 19.12 mm

DISCUSSION

It remains essential that ophthalmologists carefully examine and manage patients with nanophthalmos and cataracts pre- and postoperatively to ensure the best outcomes. Pre-operative assessment and testing should include visual acuity, IOP, keratometry, grade of angle through and refraction gonioscopy, axial length measurements, ACD, IOL master as well as possible UBM, OCT, Optos to assess the fundus and identify comorbidities and/or prior ocular surgeries [6,7]. Smaller eyes tend to sit deeper in the orbit, resulting in difficulty accessing the eye for the surgeon; a more temporal approach may be advised to increase access to these eyes during surgery [7]. Nanopthalmic eyes are also more prone to the complication of refractive surprise, where post-operative vision with IOL differs from the intended target [8]. This is primarily due to the higher optical power required of IOLs in shorter eyes, which adds weight to errors in IOL position predictions. While there still remains no global consensus on the optimal method of IOL prediction in short eyes, according to a review, the most reliable traditional formulas (relying on biometric data and theoretical optics) are the Haigis, Hoffer Q, and Holladay 2 formulas [9]. Additionally, recent studies have supported potential for the AI-enhanced Kane formula to be superior to traditional formulas in predictive accuracy for IOL power in short eyes [10].

Although small incision cataract surgery techniques have reduced complications, conditions such as uveal effusions are still common in nanophthalmic eyes, with previous studies reporting 10.8% intraoperative or postoperative rates of uveal effusions [4]. The anatomically shallow anterior chamber of nanophthalmic eyes results in increased risk of iris prolapse during the surgery as well due to the incision site being closer to the iris; surgeons should be cautious when inserting and removing instruments in these eyes [7,11]. The use of pre-operative Mannitol is preferred by some ophthalmologists as it lowers IOP by dehydrating the vitreous body, lowering the risk of effusions through reducing intraocular volume. Mannitol also creates room in the anterior chamber to improve surgical access and reduce the possibility of iris prolapse [12]. However, mannitol use can lead to many systemic complications such as fluid and electrolyte imbalance (hypovolemia, hyponatremia), exacerbation of heart failure, renal complications such as acute kidney injury, and hypersensitivity reactions, including anaphylaxis [13].

Furthermore, instrument insertion and removal along with IOP fluctuations during surgery can also increase risk for uveal effusion, therefore making it necessary for the surgeon to stay vigilant of any IOP fluctuations during the surgery [3]. After the surgery, the physician should monitor for any possible complications such as residual refractive error, angle closure, malignant glaucoma, IOP spikes, uveal effusion, anterior uveitis, macular edema, choroidal hemorrhage, vitreous hemorrhage, retinal detachment, or corneal decompression [3,7].

CONCLUSION

This case presentation underscores the challenges associated with diagnosis, surgical management, and perioperative complications associated with nanophthalmos cataracts. Continued research is warranted to further assess the optimal surgical techniques that minimize intraoperative and postoperative complications of nanophthalmos cataract surgery.

ACKNOWLEDGMENT

Declarations: No conflict of Interest.

Ethics approval: No ethical approval is required. This case report is exempt from ethical approval.

Consent to participate: The patient has given consent to participate.

Consent for publication: The patient has given consent to publish.

Availability of date material: The data is in the patient's file.

Authors contribution: KA: Conceive, conceptualize, methodology, revision, supervision, funding acquisition; BH: Methodology, writing and revision; AV: Revision; NN: Revision; EW: Revision; UC: Revision.

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