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Delayed Bilateral Congenital Cataract with Asymmetric Morphology (Membranous and Nuclear) Managed with Different Surgical Techniques in a 19-Year-Old Female: A Case Report

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Abstract

Congenital cataract is a major cause of preventable childhood blindness, and delayed treatment may lead to irreversible amblyopia and complex lens degeneration. We report a 19-year-old female with long-standing bilateral congenital cataract and marked intra-individual asymmetry. The left eye (OS) had absolute sensory deprivation since infancy, while the right eye (OD) retained partial vision until late adolescence. Examination showed alternating exotropia of 45 prism diopters and intraocular pressures of 18 mmHg OD and 27 mmHg OS. The elevated OS pressure, attributed to secondary lens-induced angle crowding, was controlled to 19 mmHg with topical timolol 0.5%. B-scan ultrasonography confirmed flat, intact retinas and normal optic disc excavation bilaterally. Using SRK/T biometry, staged bilateral cataract surgery was performed under general anesthesia one month apart. OS showed a fully resorbed membranous cataract and required manual irrigation–aspiration with a Simcoe cannula, micro-scissor membranectomy, automated anterior vitrectomy, and sulcus-fixated IOL implantation (20.0 D). OD showed a mature nuclear cataract and was managed with phacoemulsification-assisted irrigation–aspiration and in-the-bag single-piece IOL implantation (22.50 D). Postoperatively, both eyes achieved a clear visual axis and stable IOL position without early complications. At 6 months, IOP remained stable (14 mmHg OD, 15 mmHg OS), with healthy pink optic discs. Corrected visual acuity reached 6/6 OD but remained 2/60 OS due to irreversible deprivation amblyopia. Delayed congenital cataract surgery in adulthood requires morphology-based planning. Nuclear cataracts may be safely treated with phacoemulsification, whereas membranous cataracts require meticulous manual extraction and anterior vitrectomy. Early red-reflex screening remains essential.

1. Introduction

Congenital cataract remains a critical global public health challenge and a leading cause of preventable childhood blindness [1]. In developing countries like Indonesia, the socioeconomic burden is highly pronounced; pediatric cataracts account for up to 10–15% of avoidable childhood blindness due to geographic fragmentation and regional healthcare disparities [2]. Early surgical intervention is paramount to guarantee physiological visual development. The "critical period" of visual development is highly time-sensitive; the developmental window for establishing stable central fixation and foveal

alignment occurs within the first 3 months of life, whereas cortical plasticity remains highly susceptible to amblyogenic factors until approximately 7 to 8 years of age [2, 3]. Prolonged visual deprivation beyond this window inevitably precipitates dense, irreversible sensory amblyopia and profound nystagmus or strabismus [1, 2, 4].

When congenital cataracts remain neglected into adulthood, the long-standing lens undergoes progressive histopathological and morphological degeneration. Over decades, spontaneous resorption of liquefied lens fibers and secondary fusion of the anterior and posterior capsular sheets result in the formation of a membranous cataract [4]. This structural metamorphosis drastically amplifies intraoperative complexity, as dense capsular calcification, fibrotic adhesions, and zonular fragility render standard emulsification techniques obsolete, necessitating specialized manual membranectomy and anterior vitrectomy protocols [5, 6].

While bilateral congenital cataracts typically progress symmetrically, intra-individual morphologic asymmetry in adult presentations is exceptionally rare. This case report describes a 19-year-old female with long-standing, neglected bilateral congenital cataract presenting with distinct structural asymmetry: a completely resorbed membranous cataract in the left eye (OS) and a classic dense nuclear cataract in the contralateral right eye (OD). The objective of this report is to delineate a tailored, individualized surgical decision-making framework to manage these dual pathologies, using phacoemulsification for the nuclear morphology and manual micro-scissor membranectomy for the membranous morphology, thereby shifting the therapeutic target from vision restoration to functional stabilization.

2. Cases

2.1. Patient Information and Socio-Clinical Background

A 19-year-old female presented to our tertiary ophthalmic referral center complaining of progressive, profound bilateral visual loss that severely hindered her ability to perform independent activities of daily living. Although dense bilateral leukocoria had been noted by her mother since early infancy (before 6 months of age), the patient experienced a critical 19-year therapeutic and diagnostic delay. Retrospective clinical interviews revealed that this neglect was primarily driven by extreme geographical isolation in a remote rural village, absolute financial hardship within a low-income household, and deep-seated cultural stigmas surrounding early childhood ocular surgeries. The precipitating event that finally prompted her medical presentation at age 19 was the progressive maturation of the lens opacity in her functional right eye, which threatened her residual independence.

Extensive retrospective screening confirmed a negative family history of hereditary or juvenile cataracts across two generations, and there was no parental consanguinity. Comprehensive systemic, pediatric, and endocrinological workups—including serum calcium, phosphorus, fasting blood glucose, and serological TORCH screening—were completely within normal limits, pointing toward a sporadic, idiopathic bilateral congenital etiology.

2.2. Preoperative Clinical and Diagnostic Evaluation

Upon examination, the patient was cooperative and well-oriented. Visual acuity was limited to accurate light perception (LP) in the left eye (OS) and 6/60 in the right eye (OD), which improved to 6/30 with pinhole. Strabismus evaluation revealed a prominent alternating exotropia with a large deviation angle measured at 45 prism diopters (PD) base-in via the Hirschberg and Krimsky tests, demonstrating a profound fixation preference for the right eye and a complete absence of stereopsis on Worth 4-dot testing.

Slit-lamp biomicroscopy confirmed a striking intra-individual morphologic asymmetry:

- OS (Left Eye): A flattened, dense, pearly-white membranous cataract resulting from chronic lens fiber resorption and complete fusion of the anterior and posterior capsular sheets. The intraocular pressure (IOP) was initially elevated at 27 mmHg. Secondary lens-induced angle crowding or phacolytic mechanisms were considered. The patient was immediately initiated on topical Timolol 0.5% drops twice daily, which successfully stabilized the IOP to a safe baseline of 19 mmHg on the morning of the surgery.
- OD (Right Eye): A dense, nuclear cataract with cortical opacification, preserving low-grade visual input and anatomical lens matrix integrity. The IOP was normal at 14 mmHg.

Because dense media opacities completely obscured visualization of the posterior segment, high-resolution B-scan ultrasonography was performed bilaterally. The scans successfully excluded posterior segment pathology, confirming flat, intact retinas and normal optic disc excavations without posterior staphyloma or vitreal masses. Axial length (AL) and keratometry (K) parameters were obtained via contact A-scan biometry and manual keratometry. Using the SRK/T formula, the intraocular

lens (IOL) powers were calculated at 20.0 D for the OS and 22.50 D for the OD, deliberately targeting a low postoperative myopic refraction (−0.50 D to −0.75 D) to optimize uncorrected intermediate vision.

2.3. Surgical Management and Tailored Interventions

To maximize intraoperative control and patient safety, the surgical tumor board elected to perform the surgeries under general anesthesia (GA). Although the patient was an adult, GA was strongly indicated to eliminate the risk of sudden patient movement during the complex micro-scissor membranectomy and anterior vitrectomy in the left eye, where capsular fragility exponentially increased the risk of massive zonular dialysis. To minimize cumulative surgical stress, a staged bilateral approach was successfully performed, with the two stages separated by a two-week physiological window.

- First-Stage Surgery (Left Eye - OS): A manual irrigation–aspiration combined with membranectomy was performed. Due to extensive central fusion of the capsular sheets, ultrasonic phacoemulsification was deemed structurally redundant and hazardous. A micro-vitreous retinal (MVR) blade and intraocular capsular scissors were utilized to dissect a precise central visual axis aperture of 4.5 mm. An automated anterior vitrectomy was then performed under a coaxial setup with strict settings (cutting rate: 800 cuts per minute; aspiration pressure: 150 mmHg) to clear the retrolental membrane while protecting macular integrity. Due to the lack of capsular bag integrity, a 3-piece 20.0 D rigid IOL was securely implanted into the ciliary sulcus.
- Second-Stage Surgery (Right Eye - OD): Two weeks later, a standard phacoemulsification-assisted irrigation–aspiration was performed. The intact capsular bag and resilient zonular integrity seamlessly facilitated a continuous curvilinear capsulorhexis, followed by successful in-the-bag implantation of a single-piece foldable 22.50 D acrylic IOL.

After obtaining written informed consent, the patient underwent staged bilateral cataract surgery under general anesthesia within a one-month interval.

2.4. Postoperative Outcome

The patient strictly adhered to a 6-month postoperative follow-up schedule (extended through June 2026). There were no intraoperative or early postoperative complications. At her final 6-month review, visual acuity in her dominant right eye (OD) had remarkably improved to 6/6 with optimal refractive correction (−0.75 D). In contrast, the left eye (OS) remained at 1/60 due to deep, irreversible sensory deprivation amblyopia.

Comprehensive postoperative assessments confirmed excellent anatomical stability:

- IOP Stability: Intraocular pressures remained perfectly stable at 14 mmHg (OD) and 15 mmHg (OS) without any antiglaucoma medication.
- Anatomical Integrity: Dilated fundus examination revealed completely healthy, pink optic discs with a normal cup-to-disc ratio of 0.3 and pristine maculae bilaterally, successfully excluding any underlying glaucoma-related structural damage or optic nerve pathology. Slit-lamp evaluation confirmed central, stable IOL positioning with zero signs of early posterior capsular opacification (PCO), zero pupillary capture, and a clear visual axis in both eyes.

Because the left eye lacked fusion potential due to long-standing amblyopia, corrective strabismus surgery for the 45 PD alternating exotropia was deferred to avoid consecutive surgical drift. Instead, comprehensive visual rehabilitation was prioritized, focusing on prescribing protective polycarbonate lenses for the functional right eye, environmental low-vision adjustments, and strict eye-safety counseling to protect her lifelong functional vision.

2.5. Timeline and Figures

The chronological progression of the patient's clinical course is summarized in Table 1. Leukocoria and left-eye visual impairment were first noted in infancy, followed by progressive bilateral visual deterioration from childhood to adolescence, with a significant decline in right-eye vision during adolescence. Staged cataract surgery was subsequently performed, with left eye membranous cataract extraction on 14 January 2026 and right eye nuclear cataract extraction on 18 February 2026.

The right eye underwent standard phacoemulsification with intraocular lens implantation for the treatment of a nuclear cataract. Following the creation of a continuous curvilinear capsulorhexis, the cataractous lens was removed by phacoemulsification. Residual cortical material and viscoelastic were subsequently aspirated before implantation of the intraocular lens. The postoperative anterior segment examination demonstrated a well-centered intraocular lens, a clear visual axis, and a small residual intracameral air bubble,

Table 1. Timeline of clinical events.

Clinical Event	Time Point
Onset of left eye visual impairment (leukocoria noted)	Infancy
Progressive bilateral visual deterioration	Childhood to adolescence
Significant decline in right eye vision	Adolescence
Left eye cataract surgery (membranous cataract)	14-Jan-26
Right eye cataract surgery (nuclear cataract)	18-Feb-26

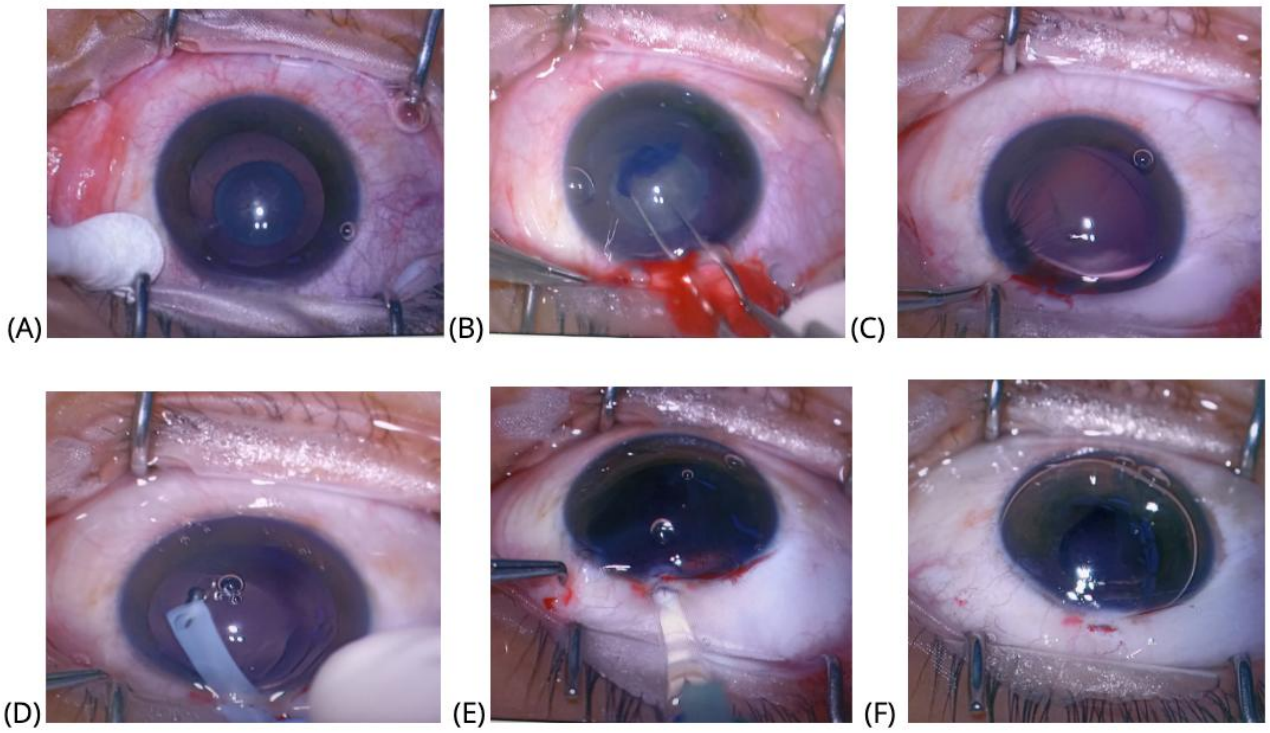

Figure 1. Stepwise surgical management of the right eye with a nuclear cataract. (A) Preoperative appearance of the nuclear cataract. (B) Creation of a continuous curvilinear capsulorhexis (CCC). (C) Phacoemulsification of the cataractous lens. (D) Cortical cleanup and removal of viscoelastic material. (E) Intraocular lens implantation. (F) Postoperative anterior segment photograph demonstrating a clear visual axis with a residual intracameral air bubble.

consistent with an uncomplicated surgical outcome (Figure 1).

The left eye underwent membranous cataract extraction with intraocular lens implantation. Following the creationof a continuous curvilinear capsulorhexis, the lens material was removed by manual irrigation–aspiration using a Simcoe cannula. After complete lens aspiration, the residual posterior capsular membrane was identified and managed appropriately before implantation of a 20.0 D intraocular lens. Residual cortical material and viscoelastic were subsequently removed, resulting in a well-centered intraocular lens and a stable postoperative anterior segment appearance (Figure 2).

3. Discussions

Delayed clinical management of bilateral congenital cataract in low- and middle-income countries (LMICs) presents profound public health, socio-economic, and therapeutic challenges [2, 3]. When dense lens opacities remain untreated beyond the time-sensitive physiological "critical period"—defined as the first 3 months of life for foveal alignment and up to 7–8 years of age for central cortical plasticity—prolonged visual deprivation causes profound cortical structural modifications, leading to deep sensory amblyopia and alternating strabismus, as observed in this 19-year-old patient [2–4]. While previous large cohorts published by Superstein et al. and Zhang et al. primarily evaluated long-standing childhood cataracts, this case details a rare adult presentation of intra-individual bilateral lens-morphology asymmetry managed via two markedly distinct ophthalmic surgical methodologies [5, 6].

The underlying pathogenetic mechanism driving this intra-individual structural asymmetry—where the left eye (OS) progressed to a fully resorbed membranous configuration while the contralateral fellow eye (OD) maintained a nuclear configuration—remains unique. In

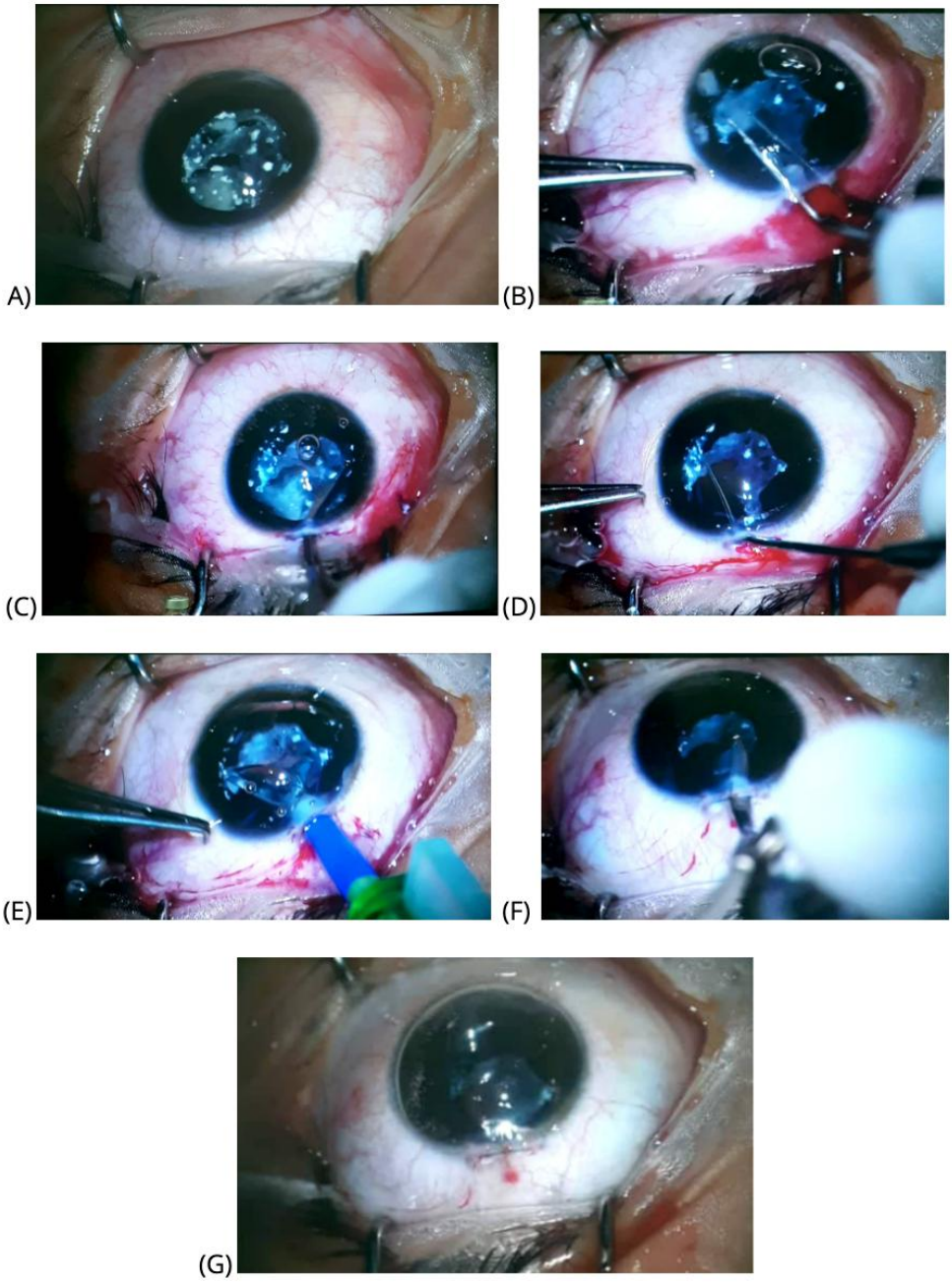

Figure 2. Stepwise surgical management of the left eye with a membranous cataract. (A) Preoperative appearance of the membranous cataract. (B) Creation of a continuous curvilinear capsulorhexis (CCC). (C) Manual irrigation–aspiration of lens material using a Simcoe cannula. (D) Residual posterior capsular membrane following lens aspiration. (E) Implantation of a 20.0 D intraocular lens. (F) Cortical cleanup and removal of viscoelastic material. (G) Postoperative anterior segment photograph demonstrating a well-centered intraocular lens with a stable postoperative appearance.

congenital cataracts, membranous metamorphosis represents an advanced, multi-decadal degenerative pathway in which liquefied lens fibers spontaneously resorb through a compromised or fragile capsule, resulting in the complete fusion and intense fibrosis of the anterior and posterior capsular sheets [5, 6]. This asymmetry most likely reflects complete sensory deprivation and a microenvironmental barrier in the left eye since birth. In contrast, the right eye likely had a partial, less-dense nuclear opacity during early childhood, preserving low-grade visual feedback and maintaining baseline anatomical stability of the lens matrix into late adolescence before progressing to a mature nuclear cataract [4–6].

This marked structural variation dictated an individualized, tailored surgical strategy. For the right eye, phacoemulsification-assisted irrigation–aspiration was the clinical choice. Although standard in adult senile

presentations, its utilization in delayed congenital cataract requires careful mechanical adjustment. As validated by Vasavada et al. and Sukhija et al., phacoemulsification remains highly safe and effective for delayed adult presentations, provided there is robust zonular integrity and adequate capsular bag support to withstand ultrasonic energy [7, 8]. In contrast, phacoemulsification was structurally unfeasible and contraindicated in the left eye due to the complete absence of a standard lens nucleus. Attempting ultrasound in a highly fibrotic, thin membranous matrix exponentially elevates the risk of massive zonular dialysis and posterior capsular rupture [6]. Consequently, manual irrigation–aspiration using a Simcoe cannula provided a more controlled, lower-stress intraoperative environment. This was combined with an intraocular micro-scissor membranectomy to cut a central visual aperture of 4.5 mm, alongside an automated anterior vitrectomy to clear dense retrolental opacities and maintain mechanical clarity [5, 6].

The surgical anatomical findings directly dictated intraocular lens (IOL) selection and placement parameters. In the right eye, perfect capsular bag integrity facilitated standard, secure in-the-bag single-piece 22.50 D acrylic IOL positioning. Conversely, the extensive central fusion of the capsular sheets and absence of a functional capsular envelope in the left eye necessitated a ciliary sulcus fixation of a 3-piece 20.0 D rigid IOL. Although sulcus fixation successfully restores structural anatomy, it demands long-term clinical vigilance. Literature suggests that sulcus-fixated lenses carry lifelong elevated risks of Uveitis-Glaucoma-Hyphema (UGH) syndrome, mechanical pigment dispersion, and gradual decentration due to constant mechanical uveal contact [6, 7].

Furthermore, managing secondary parameters like intraocular pressure and strabismus is vital. The patient's preoperative left-eye elevation of 27 mmHg was successfully managed with topical Timolol 0.5% twice daily, lowering it to a safe baseline of 19 mmHg before surgery. This suggests the elevation was likely driven by secondary lens-induced angle crowding or phacolytic mechanisms that resolved upon lens extraction. Postoperatively, dilated fundus evaluation revealed healthy, pink optic discs with a normal cup-to-disc ratio (0.3) and pristine maculae bilaterally. This critical finding excludes advanced glaucoma-related cup progression, optic nerve pathology, or retinal disease, thereby objectively confirming that the poor visual acuity of 2/60 in the left eye is entirely attributable to deep, long-standing sensory-deprivation amblyopia [1, 2, 4].

Regarding the 45 PD alternating exotropia, corrective strabismus surgery was deliberately deferred by the multidisciplinary board. In cases of long-standing sensory amblyopia with an absolute loss of fusion potential and stereopsis on Worth 4-dot testing, immediate strabismus alignment carries an exceptionally high risk of consecutive surgical drift and cosmetic failure [1, 4]. Therefore, long-term comprehensive visual rehabilitation was prioritized, focusing on prescribing protective polycarbonate safety lenses for her functionally dominant eye (OD: 6/6 with −0.75 D) and extensive monocular environmental adaptation.

The limitations of this study include its single-case design and 6-month postoperative follow-up period, extending through June 2026, which is insufficient to evaluate late-onset complications such as secondary posterior capsular opacification (PCO) or IOL shift. Additionally, early childhood ophthalmic charts and formal genetic/chromosomal sequencing were unavailable due to regional financial and resource limitations.

4. Conclusions

This case illustrates that long-standing, neglected bilateral congenital cataract can manifest with highly asymmetric morphology in adulthood. Tailored surgical customization is mandatory: phacoemulsification-assisted aspiration can be safely performed in selected nuclear presentations with intact capsular bags, whereas membranous cataracts require manual irrigation–aspiration with a Simcoe cannula combined with adjunct micro-scissor membranectomy and automated anterior vitrectomy.

Observations from this individual case demonstrate that while excellent anatomical success and a clear visual axis can be achieved in both morphologies, functional visual recovery remains strictly governed by the timing of intervention relative to the critical visual window. To prevent irreversible deprivation amblyopia, public health infrastructure in resource-limited settings like Indonesia must integrate mandatory childhood red-reflex screenings by primary healthcare midwives and community health workers during universal early childhood immunization schedules, establishing clear medical pathways to eliminate preventable blindness.

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Ethical Clearance: Ethical clearance was waived by the Institutional Review Board of General Hospital Dr. Zainoel Abidin, Banda Aceh, Indonesia, as this case report describes standard retrospective clinical care and involves no experimental interventions.

Informed Consent Statement: Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

Data Availability Statement: All clinical data and information supporting the findings of this case are contained within the manuscript.

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