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Editorial • Original Article • Review Article • Case Report

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Editorial

It is with immense pleasure, pride, and a profound sense of responsibility that I present the inaugural issue of the IIEI&H Journal of Ophthalmology, the official scientific journal of Ispahani Islamia Eye Institute & Hospital (IIEI&H), Bangladesh. The publication of this first issue marks a historic milestone in our institution's academic journey and reflects our enduring commitment to advancing ophthalmic science through research, innovation, education, and scholarly collaboration.

For more than six decades, IIEI&H has remained at the forefront of eye care in Bangladesh, providing high-quality tertiary clinical services, professional education and training, and community -based programmes aimed at preventing avoidable blindness and restoring vision. While patient care has always remained our foremost priority, academic excellence and research have become integral components of our institutional mission. The launch of this journal signifies an important transition—from being solely a center of clinical excellence to becoming a leading center for scientific discovery, knowledge generation, and evidence-based ophthalmic practice.

At this juncture, we respectfully recall the visionary leadership and philanthropic legacy of our founding father, Mr. M. A. Ispahani, whose foresight laid the foundation of this institution. We also pay tribute to our former Chairman, Mr. Ali Behrouze Ispahani, whose dedication and leadership elevated the hospital to new heights of excellence. In recognition of his remarkable contributions, our Research Center has been named in his honour, and we remain committed to carrying forward his enduring legacy. Under the visionary leadership of our current Chairman, Mr. Mirza Salman Ispahani; Advisor, Zahida Ispahani together with the members of the Management Committee, IIEI&H continues to progress with distinction, innovation, and an unwavering commitment to excellence.

The vision of establishing a peer-reviewed scientific journal has long been cherished by our institution. Today, that vision has become a reality through the collective dedication of our ophthalmologists, vision scientists, nurses, optometrists, counsellors, researchers, administrators, and support staff. Their commitment to excellence has made this publication possible, and I extend my sincere appreciation to every individual whose efforts have contributed to this remarkable achievement.

As one of the largest providers of eye care services in Bangladesh, IIEI&H generates a vast repository of high-quality clinical data every day. These invaluable data provide unique opportunities to conduct meaningful clinical research, evaluate healthcare practices, identify emerging challenges, and contribute to the global evidence base in ophthalmology. We envision this journal as a platform where clinical experience is transformed into scientific knowledge that ultimately improves patient care, informs policy, and advances evidence-based practice.

This inaugural issue would not have been possible without the unwavering support of our Editorial Board, reviewers, authors, and the Department of Research & Development. I express my deepest gratitude to each of them for their professionalism, dedication, and commitment to maintaining the highest academic standards. Their collective efforts have laid a strong foundation for the future growth and success of this journal.

Ophthalmology is evolving rapidly through advances in imaging technologies, microsurgery, artificial intelligence, precision medicine, regenerative therapies, and translational research. At the same time, many challenges unique to low- and middle-income countries remain underrepresented in the global scientific literature. The IIEI&H Journal of Ophthalmology seeks to bridge this gap by encouraging scientifically rigorous, ethically conducted, and clinically relevant research that addresses both local priorities and global ophthalmic challenges.

While scientific novelty continues to drive progress, we equally recognize the value of well-designed observational studies, clinical audits, quality improvement initiatives, review articles, educational research, and carefully documented case reports. Research conducted within local healthcare settings often provides practical solutions with direct implications for patient care. Every thoughtfully designed study whether groundbreaking or incremental has the potential to enrich scientific understanding and improve clinical practice.

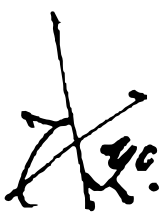
Our Editorial Board is firmly committed to upholding the highest standards of publication ethics, editorial independence, transparency, and scientific integrity. Through rigorous peer review and adherence to internationally accepted editorial guidelines, we aspire to establish the IIEI&H Journal of Ophthalmology as a trusted platform for ophthalmologists, vision scientists, public health professionals, and allied eye care practitioners in Bangladesh and beyond.

This journal belongs not only to our institution but also to the wider ophthalmic community. I warmly invite clinicians, researchers, educators, residents, and students to contribute their scholarly work, participate in constructive peer review, and engage with us in meaningful academic dialogue. Together, we can build a vibrant scientific community that promotes collaboration, encourages innovation, and advances excellence in ophthalmic care.

As we celebrate this inaugural issue, we recognize that this publication is not a destination but the beginning of a long and meaningful academic journey. Our aspiration is for the IIEI&H Journal of Ophthalmology to evolve into a respected national and international forum for high-quality scientific communication, contributing to improved eye health, strengthened research capacity, and ultimately, the prevention of avoidable blindness.

On behalf of the Editorial Board, I extend my sincere gratitude to all our readers, authors, reviewers, and supporters for placing their trust in this new academic initiative. I look forward to your continued collaboration as we work together to advance ophthalmic knowledge and improve the lives of patients through research, innovation, and clinical excellence.

We dedicate this inaugural issue to our patients, whose trust inspires our pursuit of excellence, and to the generations of eye care professionals whose commitment continues to advance the science and practice of ophthalmology.



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Surgical Capsulotomy for Dense Posterior Capsular Opacification Following Cataract Surgery: A Case Series from a Tertiary Eye Hospital in Bangladesh

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ORIGINAL ARTICLE

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Posterior capsular opacification
Surgical capsulotomy
Nd:YAG laser capsulotomy
Cataract surgery
Visual recovery
Case series

ABSTRACT

Purpose

To describe the clinical characteristics, surgical management, and visual outcomes of patients with posterior capsular opacification (PCO) following cataract surgery who were managed with surgical capsulotomy after failed or unsuitable neodymium-doped yttrium aluminium garnet (Nd:YAG) laser capsulotomy.

Methods

This retrospective case series included three patients with visually significant PCO managed at the Department of Cataract, Ispahani Islamia Eye Institute & Hospital (IIEI&H), Dhaka, Bangladesh. Clinical records were reviewed for demographic characteristics, ocular history, presenting symptoms, preoperative best-corrected visual acuity (BCVA), indications for surgical intervention, intraoperative findings, surgical technique, postoperative management, and visual outcomes. Surgical capsulotomy was performed using a ^{23}-gauge vitrector through a clear corneal approach to remove dense fibrotic posterior capsular tissue obstructing the visual axis. Patients were followed for one month after surgery.

Results

The three patients, aged 39–70 years, presented with marked visual impairment secondary to dense PCO following previous cataract surgery. One patient had capsular phimosis with posterior chamber intraocular lens (PCIOL) displacement, while another had persistent dense PCO despite an attempted Nd:YAG laser capsulotomy. Preoperative visual acuity ranged from finger counting at 0.5–1 metre to 3/60. Surgical capsulotomy was successfully completed in all cases without intraoperative complications. At one-month follow-up, visual acuity improved to 6/12, 6/18 (partial), and 6/24, respectively. No patient developed retinal detachment, cystoid macular oedema, endophthalmitis, or other sight-threatening postoperative complications.

Conclusion

Surgical capsulotomy is a safe and effective alternative for the management of dense PCO when Nd:YAG laser capsulotomy is unsuccessful, technically difficult, or contraindicated. Careful patient selection, meticulous surgical technique, and appropriate postoperative follow-up can result in favourable visual recovery with a low risk of complications.

1. Introduction

Posterior capsular opacification (PCO) remains the most frequent late complication following cataract surgery and is the leading cause of reduced visual acuity after an initially successful procedure. It develops as a consequence of proliferation, migration, and transdifferentiation of residual lens epithelial cells onto the posterior capsule, resulting in fibrotic changes, pearl formation, or a combination of both that obstruct the visual axis. Despite continuous advances in phacoemulsification techniques and intraocular lens (IOL) design, PCO continues to affect visual quality and remains an important cause of avoidable visual impairment after cataract surgery [1–4].

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The reported incidence of clinically significant PCO varies considerably depending on patient age, ocular comorbidities, surgical technique, duration of follow-up, and IOL characteristics. Contemporary studies have demonstrated lower rates of PCO with modern hydrophobic acrylic IOLs; however, visually significant opacification requiring intervention continues to occur in a proportion of patients, particularly in younger individuals and those with predisposing ocular conditions [1–3]. In addition to reduced visual acuity, patients may experience glare, decreased contrast sensitivity, monocular diplopia, and impaired fundus visualization, all of which may substantially affect quality of life.

Nd:YAG laser posterior capsulotomy is widely accepted as the first-line treatment for visually significant PCO because it is rapid, non-invasive, and generally associated with excellent visual outcomes [5,6]. Nevertheless, laser capsulotomy may not be feasible in every patient. Dense fibrotic opacification, marked capsular contraction, posterior capsule fibrosis associated with PCIOL displacement, poor visualization of the visual axis, or unsuccessful previous laser treatment may limit the effectiveness or safety of the procedure. In such situations, vitrector-assisted surgical posterior capsulotomy provides an alternative approach by allowing controlled mechanical removal of dense fibrotic tissue under direct visualization [7,8].

Although surgical posterior capsulotomy is performed less frequently in the era of Nd:YAG laser treatment, published evidence regarding its indications, surgical technique, and clinical outcomes remains limited. Most available reports consist of isolated case reports or small case series, and information from low- and middle-income countries is particularly scarce. Sharing clinical experience from tertiary referral centres may therefore contribute to improved decision-making in complex cases where laser treatment is unsuccessful or contraindicated.

This case series describes three patients with dense PCO following cataract surgery who underwent vitrector-assisted surgical posterior capsulotomy at a tertiary eye hospital in Bangladesh. We describe their clinical presentation, indications for surgery, surgical management, and postoperative visual outcomes while highlighting the role of surgical intervention as an effective treatment option in selected patients with complex PCO.

2. Patients and Methods

This retrospective case series was conducted at the Department of Cataract, IIEI&H, Dhaka, Bangladesh. Three consecutive patients with visually significant PCO following cataract surgery who underwent vitrector-assisted surgical posterior capsulotomy between January 2023 and December 2024 were included.

The indication for surgery was the presence of dense fibrotic PCO causing significant visual impairment in situations where Nd:YAG laser posterior capsulotomy was considered technically difficult, had previously failed, or was unlikely to achieve satisfactory visual rehabilitation. Preoperative evaluation included measurement of BCVA, slit-lamp biomicroscopy, intraocular pressure (IOP) measurement, and dilated fundus examination whenever visualization of the posterior segment was possible. B-scan ultrasonography was performed when dense media opacity precluded adequate retinal assessment.

All procedures were performed under local anaesthesia by experienced anterior segment surgeons using a standardized surgical technique. A clear corneal incision was created, and a 23-gauge vitrector was introduced into the anterior chamber to perform controlled removal of the dense fibrotic posterior capsule under direct microscopic visualization. Particular attention was paid to preserving PCIOL centration and stability while creating an adequate central capsulotomy to restore the visual axis. At the conclusion of surgery, the anterior chamber was reformed, wound integrity was confirmed, and standard postoperative topical antibiotic and corticosteroid therapy was prescribed.

Patients were reviewed on postoperative day 1, at 1 week, and at 1 month. Follow-up evaluation included BCVA, IOP measurement, slit-lamp examination, assessment of PCIOL position, and documentation of postoperative complications.

As this report describes a retrospective review of three clinical cases managed as part of routine clinical care without experimental intervention, formal ethical approval was not required according to the Research Policy of IIEI&H. The study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all patients for surgery and for publication of anonymized clinical information and clinical photographs.

3. Results

Three patients with visually significant PCO following cataract surgery underwent vitrector-assisted surgical posterior capsulotomy during the study period. The patients were aged 39–70 years and presented with progressive visual deterioration caused by dense fibrotic PCO. One patient had capsular phimosis associated with PCIOL decentration, while another had persistent dense PCO despite a previous Nd:YAG laser capsulotomy. All patients underwent successful surgical capsulotomy without intraoperative complications. Clinically meaningful improvement in BCVA was achieved in every case. The demographic characteristics, clinical presentation, surgical indications, and postoperative outcomes are summarized in Table 1.

Case 1

A 58-year-old man presented with progressive visual deterioration in his right eye three months after uncomplicated cataract surgery performed elsewhere. He reported gradual blurring of vision that interfered with his daily activities despite an otherwise uneventful postoperative recovery.

On examination, unaided visual acuity was limited to finger counting at 1 metre, improving to 1/60 with pinhole. Slit-lamp biomicroscopy demonstrated a well-centred PCIOL with dense fibrotic PCO completely obscuring the visual axis (Figure 1). The posterior segment could not be adequately visualized because of the dense opacity.

Considering the marked fibrosis and the limited likelihood of successful laser treatment, vitrector-assisted surgical posterior capsulotomy was performed through a clear corneal incision using a 23-gauge vitrector. The fibrotic capsule was removed without intraoperative complications, restoring a clear central visual axis while maintaining PCIOL centration and stability.

At the one-month follow-up, the eye remained quiet with a clear visual axis, and BCVA improved to 6/12 without postoperative complications.

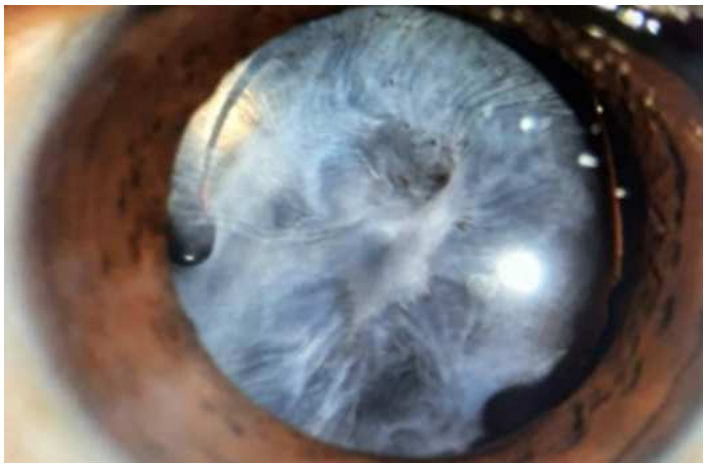

Figure 1. Dense fibrotic PCO following cataract surgery in Case 1 before vitrector-assisted surgical posterior capsulotomy.

Case 2

A 70-year-old woman presented with progressive deterioration of vision in her left eye one year after uncomplicated cataract surgery. Progressive capsular contraction had developed approximately three months after surgery and gradually worsened despite routine postoperative follow-up.

Unaided visual acuity was finger counting at 0.5 metre without improvement on pinhole testing. Slit-lamp examination demonstrated marked capsular phimosis associated with dense fibrotic PCO and mild PCIOL decentration (Figure 2). Because visualization of the posterior segment was limited, B-scan ultrasonography confirmed the absence of retinal pathology.

Owing to the severe capsular contraction and the limited likelihood of achieving an adequate opening with Nd:YAG laser treatment, vitrector-assisted surgical posterior capsulotomy was performed using a 23-gauge vitrector. Dense fibrotic tissue was excised under direct microscopic visualization while preserving PCIOL stability and restoring the visual axis.

At the one-month follow-up, the eye remained quiet with a well-centred PCIOL and a clear visual axis. BCVA improved to 6/18 (partial), and no postoperative inflammation, elevation of IOP, or other complications were observed.

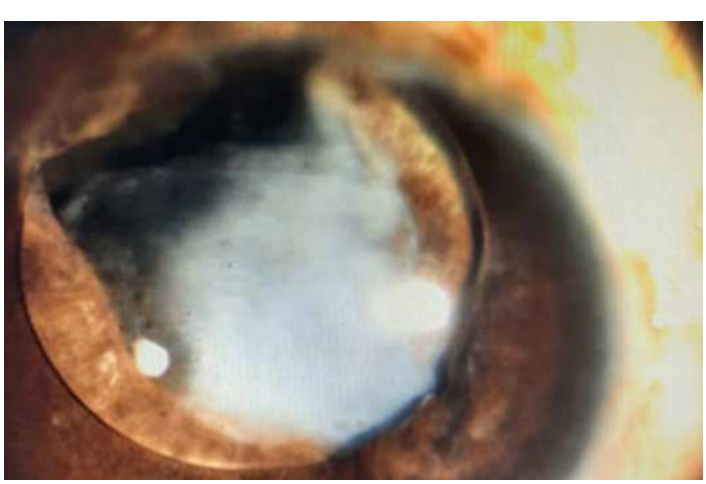

Figure 2. Capsular phimosis with dense PCO and PCIOL decentration in Case 2 before surgery.

Case 3

A 39-year-old man presented with persistent visual impairment in his right eye following traumatic cataract surgery performed five years earlier. He subsequently developed dense PCO and underwent Nd:YAG laser capsulotomy at another institution; however, the procedure failed to restore satisfactory vision because of persistent fibrotic opacity.

At presentation, unaided visual acuity was 3/60, improving to 1/60 with pinhole, while IOP was 10 mmHg. Slit-lamp examination demonstrated a well-positioned PCIOL with dense fibrotic PCO obscuring the visual axis (Figure 3). The previous laser capsulotomy opening remained inadequate because of persistent fibrosis.

Vitrector-assisted surgical posterior capsulotomy was therefore performed through a clear corneal incision using a 23-gauge vitrector. The fibrotic posterior capsule was removed under direct visualization, restoring a clear central visual axis without disturbing PCIOL position. The procedure was completed uneventfully.

At one-month follow-up, the anterior segment remained quiet, the visual axis was clear, and BCVA improved to 6/24. No postoperative complications, including retinal detachment, cystoid macular oedema, persistent elevation of IOP, or endophthalmitis, were observed.

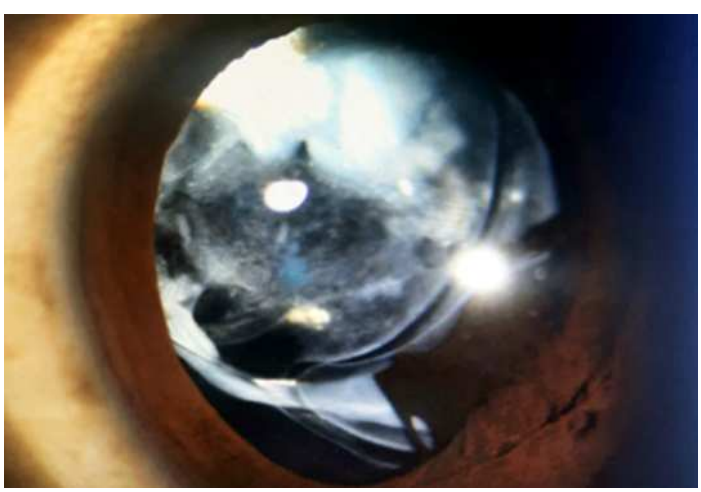

Figure 3. Dense fibrotic PCO following unsuccessful Nd:YAG laser posterior capsulotomy in Case 3 before surgical intervention.

Table 1. Clinical characteristics and postoperative outcomes of patients undergoing vitrector-assisted surgical posterior capsulotomy.

Characteristic	Case 1	Case 2	Case 3
Age (years)	58	70	39
Sex	Male	Female	Male
Interval from cataract surgery	3 months	1 year	5 years
Underlying condition	Dense fibrotic PCO	Capsular phimosis with dense PCO	Dense fibrotic PCO after traumatic cataract
Previous Nd:YAG laser	No	No	Yes (unsuccessful)
Preoperative visual acuity	FC at 1 m (PH 1/60)	FC at 0.5 m (no PH improvement)	3/60 (PH 1/60)
IOP (mmHg)	Normal	Normal	10
Surgical procedure	Vitrector-assisted surgical posterior capsulotomy	Vitrector-assisted surgical posterior capsulotomy	Vitrector-assisted surgical posterior capsulotomy

Characteristic	Case 1	Case 2	Case 3
Postoperative BCVA (1 month)	6/12	6/18 (partial)	6/24
Intraoperative complications	None	None	None
Postoperative complications	None	None	None

Abbreviations: BCVA, best-corrected visual acuity; FC, finger counting; IOP, intraocular pressure; Nd:YAG, neodymium-doped yttrium aluminium garnet; PCO, posterior capsular opacification; PH, pinhole.

4. Discussion

PCO remains the most common late complication of cataract surgery despite substantial advances in surgical techniques and IOL design. Although Nd:YAG laser posterior capsulotomy is regarded as the standard treatment for visually significant PCO, certain clinical situations including dense fibrotic opacification, severe capsular contraction, inadequate visualisation of the posterior capsule, or unsuccessful previous laser treatment may limit its effectiveness and necessitate surgical intervention [1,5,6].

This case series demonstrates that vitrector-assisted surgical posterior capsulotomy is an effective alternative in selected patients with complex PCO. All three patients had dense fibrotic PCO causing significant visual impairment, and conventional laser treatment was either unsuitable or unsuccessful. Surgical removal of the fibrotic posterior capsule restored a clear visual axis and resulted in clinically meaningful improvement in BCVA without major intraoperative or postoperative complications.

The indications for surgery differed among the three patients but reflected challenges frequently encountered in clinical practice. One patient had severe capsular phimosis associated with PCIOL decentration, making laser capsulotomy technically difficult and potentially hazardous. Another patient had persistent dense fibrotic PCO despite a previous Nd:YAG laser capsulotomy, while the remaining patient had extensive fibrosis that precluded safe laser treatment. These findings highlight that surgical capsulotomy continues to have an important role in managing selected cases where laser treatment alone is unlikely to provide satisfactory outcomes [7–9].

Vitrector-assisted posterior capsulotomy offers several advantages over manual surgical techniques. The procedure allows controlled excision of dense fibrotic capsular tissue under direct microscopic visualisation while maintaining anterior chamber stability and minimizing traction on the vitreous face and PCIOL. The use of a small-gauge vitrector also facilitates the creation of a smooth, centrally positioned capsulotomy with minimal manipulation of adjacent intraocular structures. Previous studies have similarly reported favourable anatomical and visual outcomes with vitrector-assisted techniques in eyes unsuitable for laser treatment [8–10].

Visual outcomes in the present series were encouraging. All patients experienced improvement in BCVA following surgery, reflecting successful restoration of the visual axis. The degree of visual recovery varied according to pre-existing ocular conditions, duration of visual impairment, and baseline retinal status. Similar variability has been reported in previous studies, where postoperative vision depends not only on successful capsulotomy but also on the presence of coexisting ocular pathology [5,8].

Importantly, no major intraoperative or postoperative complications were observed during follow-up. None of the patients developed retinal detachment, cystoid macular oedema, endophthalmitis, persistent elevation of IOP, or clinically significant PCIOL instability. Although the number of cases was limited, these findings suggest that vitrector-assisted surgical capsulotomy can be performed safely in carefully selected patients when undertaken by experienced surgeons. Nevertheless, meticulous surgical technique and close postoperative follow-up remain essential because complications associated with intraocular surgery cannot be completely eliminated [9,10].

This case series also highlights the importance of careful patient selection. While Nd:YAG laser posterior capsulotomy remains the preferred first-line treatment for most patients with PCO, surgical capsulotomy should be considered when laser treatment is technically difficult, contraindicated, or has failed to restore a satisfactory visual axis. Individualised assessment of capsular morphology, PCIOL position, and associated ocular pathology is therefore crucial in selecting the most appropriate management strategy.

The principal strengths of this study include detailed clinical documentation, a standardized surgical technique, and consistent postoperative follow-up in a tertiary referral eye hospital. However, several limitations should be acknowledged. The retrospective design, small sample size, and short follow-up period limit the generalisability of the findings. In addition, long-term visual outcomes and late postoperative complications could not be evaluated. Future prospective studies involving larger patient cohorts are required to compare surgical capsulotomy directly with alternative treatment approaches in complex PCO.

Overall, this case series demonstrates that vitrector-assisted surgical posterior capsulotomy is a safe and effective treatment option for selected patients with dense fibrotic PCO in whom Nd:YAG laser capsulotomy is unsuitable or unsuccessful. Appropriate patient selection, meticulous surgical technique, and careful postoperative monitoring are fundamental to achieving favourable visual outcomes.

5. Conclusion

Dense PCO remains an important cause of visual impairment following cataract surgery and may not always be amenable to Nd:YAG laser posterior capsulotomy, particularly in the presence of dense fibrosis, capsular phimosis, or previous unsuccessful laser treatment. This case series demonstrates that vitrector-assisted surgical posterior capsulotomy is a safe and effective alternative for restoring the visual axis in carefully selected patients with complex PCO.

All three patients experienced clinically meaningful improvement in BCVA without significant intraoperative or postoperative complications. Careful preoperative assessment, appropriate patient selection, meticulous surgical technique, and close postoperative follow-up were key factors contributing to favourable outcomes. Although larger prospective studies are needed to establish definitive treatment recommendations, surgical posterior capsulotomy should be considered a valuable therapeutic option when conventional Nd:YAG laser capsulotomy is unsuitable or unsuccessful.

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Author contributions

Md. Abdul Muyeed conceived the study, performed the surgical procedures, supervised data collection, interpreted the clinical findings, and prepared the initial manuscript. Md. Lutfuzzahan, Abdus Salam, Ahmed Zahir Bin Zia, and Md. Shakhawat Hossain contributed to patient management, data acquisition, interpretation of the clinical findings, and critical revision of the manuscript. All authors reviewed and approved the final manuscript and agree to be accountable for all aspects of the work.

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Conflict of Interest

The authors declare that they have no competing interests.

Data Availability Statement

All data supporting the findings of this case series are included within the manuscript. Additional anonymized clinical information may be made available by the corresponding author upon reasonable request, provided that patient confidentiality is maintained.

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Clinical Characteristics, Surgical Management, and Outcomes of Steroid-Induced Glaucoma in Young Patients: A Case Series from Bangladesh

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ORIGINAL ARTICLE

Keywords:
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Corticosteroids
Secondary open-angle glaucoma
Trabeculectomy
Mitomycin C
Intraocular pressure

ABSTRACT

Purpose

To describe the clinical characteristics, corticosteroid exposure, surgical management, and early postoperative outcomes of young patients with steroid-induced glaucoma Steroid-induced glaucoma (SIG) treated at a tertiary eye care centre in Bangladesh.

Methods

This retrospective case series included five consecutive young patients with SIG managed at the Department of Glaucoma, Ispahani Islamia Eye Institute & Hospital (IIEI&H), Dhaka, Bangladesh, between October 2024 and March 2026. All patients underwent comprehensive ophthalmic assessment, including best-corrected visual acuity (BCVA), slit-lamp biomicroscopy, Goldmann applanation tonometry, gonioscopy, optic nerve head evaluation, optical coherence tomography (OCT), and Humphrey visual field (HVF) testing where feasible. Patients with persistently elevated intraocular pressure (IOP) despite maximal tolerated medical therapy underwent glaucoma filtration surgery.

Results

Five patients (four males and one female) aged 12–32 years were included. Four had prolonged topical corticosteroid exposure, whereas one had received long-term systemic corticosteroid therapy. Presenting IOP ranged from 30 to 65 mmHg, and all patients had advanced glaucomatous optic neuropathy with open anterior chamber angles. Two patients had visually significant posterior subcapsular cataract (PSC). Three patients underwent trabeculectomy augmented with mitomycin C (MMC), whereas two underwent combined phacoemulsification, posterior chamber intraocular lens (PCIOL) implantation, and trabeculectomy with MMC. All patients achieved satisfactory postoperative IOP control with functioning filtering blebs. Visual acuity improved in patients undergoing combined surgery, and no major intraoperative or postoperative complications were observed during follow-up.

Conclusion

SIG is an important but preventable cause of irreversible visual impairment among young individuals receiving prolonged corticosteroid therapy. Regular IOP monitoring, early recognition of steroid responders, appropriate modification of corticosteroid therapy, and timely surgical intervention are essential for preserving visual function and preventing irreversible glaucomatous damage.

1. Introduction

Corticosteroids are among the most effective anti-inflammatory and immunosuppressive agents used in ophthalmic practice. They play a pivotal role in the management of numerous ocular disorders, including allergic conjunctivitis, vernal keratoconjunctivitis, uveitis, keratitis, postoperative inflammation, and immune-mediated ocular diseases. Despite their well-established therapeutic benefits, prolonged or inappropriate corticosteroid use may lead to sight-threatening complications, particularly posterior subcapsular cataract (PSC) and steroid-induced glaucoma (SIG), both of which can result in irreversible visual impairment if not recognised and managed promptly [1–4].

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SIG is a secondary open-angle glaucoma caused by corticosteroid-induced impairment of aqueous humour outflow through the trabecular meshwork, resulting in elevated intraocular pressure (IOP). Experimental studies have demonstrated that corticosteroids induce structural and biochemical changes within the trabecular meshwork, including extracellular matrix accumulation, reduced phagocytic activity, cytoskeletal remodelling, and altered cellular metabolism. These changes increase aqueous outflow resistance, leading to sustained IOP elevation, progressive retinal ganglion cell loss, glaucomatous optic neuropathy, and irreversible visual field defects if appropriate intervention is delayed [5–7].

The risk of developing SIG is influenced by several factors, including corticosteroid potency, route of administration, treatment duration, cumulative dose, frequency of administration, and individual susceptibility. Topical ophthalmic corticosteroids are associated with the highest risk because of direct exposure of the trabecular meshwork. However, ocular hypertension has also been reported following systemic, periocular, intravitreal, inhaled, intranasal, and dermatological corticosteroid therapy [4,5,7,8]. Children and young adults appear particularly susceptible to corticosteroid-induced IOP elevation and may develop advanced glaucomatous damage before symptoms become evident, especially when corticosteroids are used for prolonged periods without regular ophthalmic surveillance [4,7,9].

The initial management of SIG involves withdrawal, tapering, or substitution of corticosteroid therapy whenever clinically feasible, followed by topical and, when required, systemic IOP-lowering medications. Nevertheless, patients with persistently uncontrolled IOP, progressive optic nerve damage, or advanced visual field loss despite maximal tolerated medical therapy frequently require glaucoma filtration surgery to preserve visual function [10–12].

Although corticosteroids are widely prescribed in Bangladesh, published evidence describing the clinical profile and surgical management of SIG remains limited. This retrospective case series describes five young patients with medically uncontrolled SIG who underwent glaucoma filtration surgery at a tertiary eye care centre. The study highlights their corticosteroid exposure, clinical presentation, surgical management, and short-term postoperative outcomes, with the aim of increasing awareness of this preventable cause of glaucoma and emphasising the importance of regular IOP monitoring, early diagnosis, and timely referral for specialist care.

2. Materials and Methods

Study Design and Setting

This retrospective case series was conducted at the Department of Glaucoma, Ispahani Islamia Eye Institute & Hospital (IIEI&H), Dhaka, Bangladesh. Medical records of consecutive young patients diagnosed with SIG between October 2024 and March 2026 were reviewed. Five patients who required glaucoma filtration surgery because of persistently elevated IOP despite maximal tolerated medical therapy were included in the study.

Eligibility Criteria

Eligible patients had a documented history of corticosteroid exposure, elevated IOP with open anterior chamber angles on gonioscopy, characteristic glaucomatous optic nerve head changes, and clinical findings consistent with SIG. Patients with primary glaucoma, angle-closure glaucoma, other secondary glaucomas, previous glaucoma surgery, or incomplete clinical records were excluded.

Clinical Assessment

All patients underwent a comprehensive ophthalmic examination performed by glaucoma specialists. Clinical evaluation included best-corrected visual acuity (BCVA) measurement using a Snellen chart, slit-lamp biomicroscopy, Goldmann applanation tonometry, gonioscopy, dilated fundus examination, and optic nerve head assessment.

Optical coherence tomography (OCT) of the retinal nerve fibre layer (RNFL) and Humphrey visual field (HVF) testing were performed whenever clinically feasible to assess the severity of glaucomatous damage. The presence of posterior subcapsular cataract (PSC) and other corticosteroid-related ocular complications was also documented.

Information regarding corticosteroid therapy, including the indication, route of administration, formulation, dosage, duration of treatment, and previous ocular management, was obtained from hospital records and patient interviews.

Surgical Management

Whenever clinically appropriate, corticosteroid therapy was discontinued, tapered, or substituted in consultation with the treating physician. All patients initially received maximal tolerated topical anti-glaucoma medication. Patients with persistently uncontrolled IOP, progressive glaucomatous optic neuropathy, or advanced visual field loss underwent surgical intervention.

Three patients underwent trabeculectomy augmented with mitomycin C (MMC), whereas two patients with visually significant PSC underwent combined phacoemulsification, posterior chamber intraocular lens (PCIOL) implantation, and trabeculectomy with MMC. All procedures were performed by experienced glaucoma surgeons using standardized institutional surgical techniques.

Postoperative Follow-up and Outcome Measures

Patients were reviewed on postoperative day 1, 1 week, 1 month, and 3 months after surgery. At each follow-up visit, BCVA, IOP, slit-lamp findings, filtering bleb morphology, optic nerve head status, and postoperative complications were assessed.

The primary outcome measures were successful postoperative IOP control, preservation or improvement of visual function, and stabilization of glaucomatous optic neuropathy. Secondary outcome measures included filtering bleb morphology, postoperative complications, and overall anatomical success following surgical intervention.

Statistical Analysis

Because of the small sample size, only descriptive statistical analyses were performed. Continuous variables are presented as ranges, whereas categorical variables are expressed as frequencies and percentages. Inferential statistical analyses were not undertaken because the primary objective of this study was to describe the clinical characteristics, surgical management, and postoperative outcomes of this case series.

Ethical Considerations

The study adhered to the principles of the Declaration of Helsinki. According to the Research Policy of Ispahani Islamia Eye Institute & Hospital (IIEI&H), retrospective case reports and case series describing routine clinical practice are exempt from formal review by an Institutional Review Board or Ethics Committee. Therefore, formal ethical approval was not required.

Written informed consent was obtained from all patients or, in the case of minors, from their parents or legal guardians for publication of anonymized clinical information and clinical photographs.

3. Results

Five young patients with SIG were included in this retrospective case series. The patients ranged in age from 12 to 32 years and comprised four males and one female. All had bilateral disease with a documented history of prolonged corticosteroid exposure before presentation. Four patients had received long-term topical corticosteroid therapy for chronic ocular disorders, whereas one had received prolonged systemic corticosteroid treatment.

At presentation, all patients had markedly elevated IOP, ranging from 30 to 65 mmHg, despite maximal tolerated medical therapy. Gonioscopy demonstrated open anterior chamber angles in all eyes, while optic nerve head examination revealed advanced glaucomatous cupping consistent with severe glaucomatous optic neuropathy. Two patients had visually significant PSC. Following withdrawal or tapering of corticosteroid therapy, none of the patients achieved satisfactory IOP control with medical treatment alone, necessitating glaucoma filtration surgery.

The demographic characteristics, corticosteroid exposure, surgical procedures, and postoperative outcomes are summarised in Table 1.

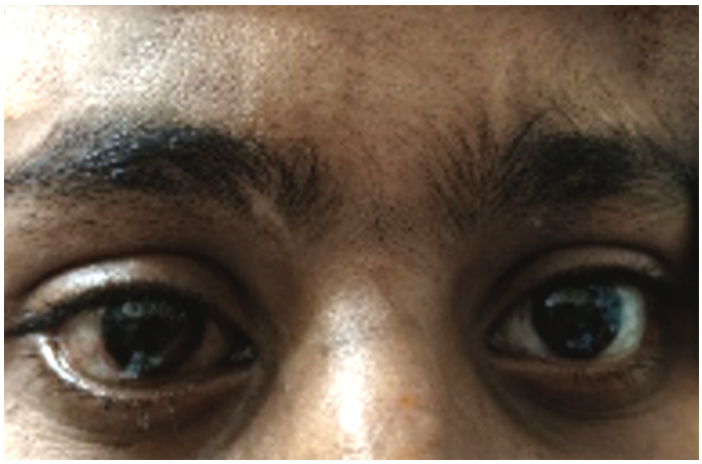
Table 1. Demographic characteristics, corticosteroid exposure, surgical management, and postoperative outcomes of the study patients.

Variable	Findings (n = 5)
Age (years)	12–32*
Sex	4 males, 1 female
Eyes affected	Bilateral (100%)
Corticosteroid exposure	Topical (4), Systemic (1)
Primary indication	Vernal keratoconjunctivitis, chronic ocular inflammation, systemic disease
Duration of therapy	Several months to several years
Presenting IOP	30–65 mmHg*
Open anterior chamber angles	5 (100%)
Advanced glaucomatous optic neuropathy	5 (100%)
PSC	2 (40%)
Trabeculectomy with MMC	3 (60%)
Combined phacoemulsification + PCIOL + trabeculectomy with MMC	2 (40%)
Successful postoperative IOP control	5 (100%)
Major intraoperative complications	None
Major postoperative complications	None

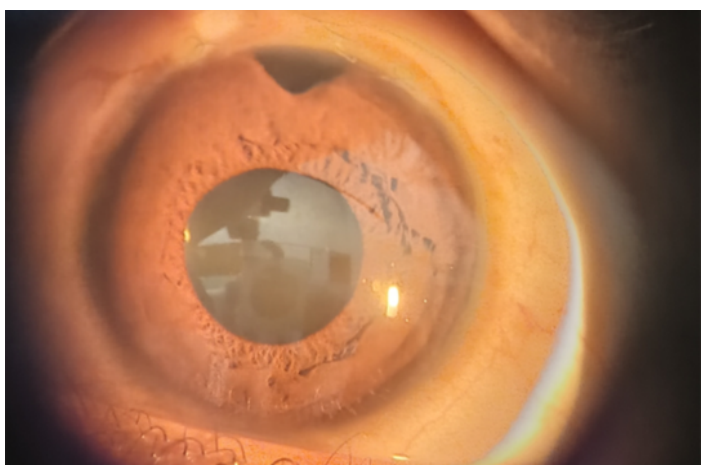
*Values are presented as ranges.

Case 1

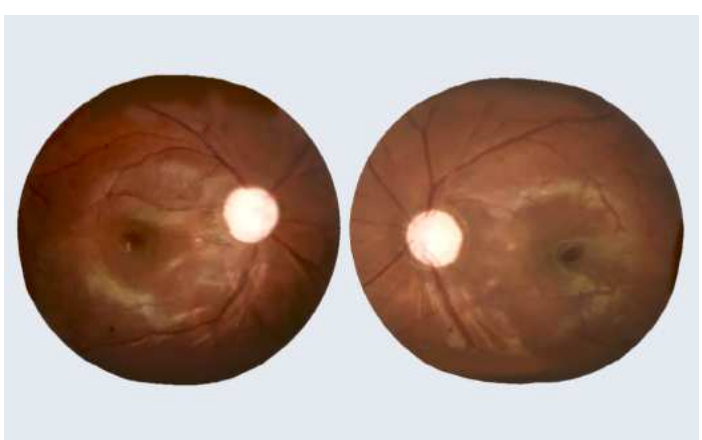
A 12-year-old boy with a history of prolonged topical corticosteroid therapy for vernal keratoconjunctivitis presented with progressive bilateral visual impairment. Clinical examination demonstrated markedly elevated IOP, advanced glaucomatous optic neuropathy, and severe bilateral visual field defects (Figures 1 and Supplementary Figures 1). Following unsuccessful medical management and withdrawal of corticosteroid therapy, the patient underwent trabeculectomy with MMC. The postoperative course was uneventful, resulting in satisfactory IOP control and the development of a well-functioning filtering bleb.



(A) External appearance before surgery.



(B) Postoperative slit-lamp photograph demonstrating a functioning filtering bleb following trabeculectomy with MMC.



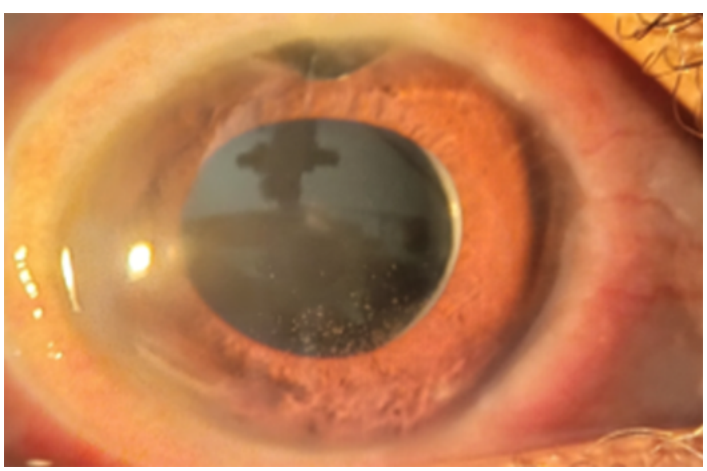
(C) Postoperative slit-lamp photographs demonstrating a functioning filtering bleb following trabeculectomy with MMC.

Figures 1 (A–C). Clinical findings in Case 1.

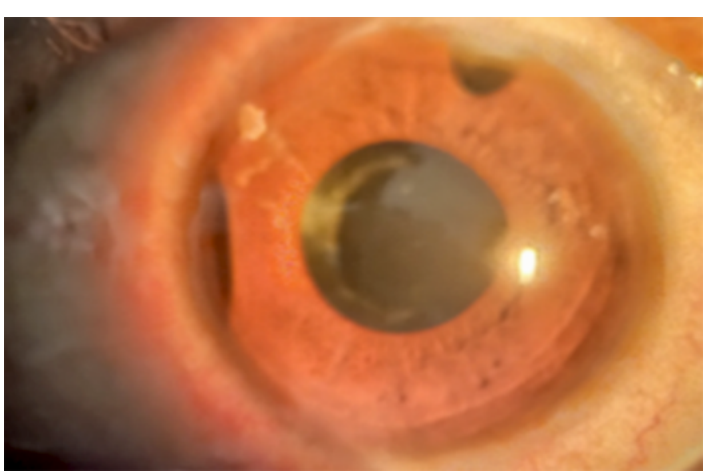
Case 2

A young male with prolonged unsupervised topical corticosteroid use presented with advanced bilateral SIG associated with visually significant PSC. Despite maximal tolerated medical therapy, the patient's IOP remained uncontrolled (Figures 2 and Supplementary Figures 2). He underwent combined phacoemulsification, PCIOL implantation, and trabeculectomy with MMC. Postoperatively, satisfactory IOP control was achieved, visual acuity improved following cataract extraction, and a healthy functioning filtering bleb was maintained throughout follow-up.

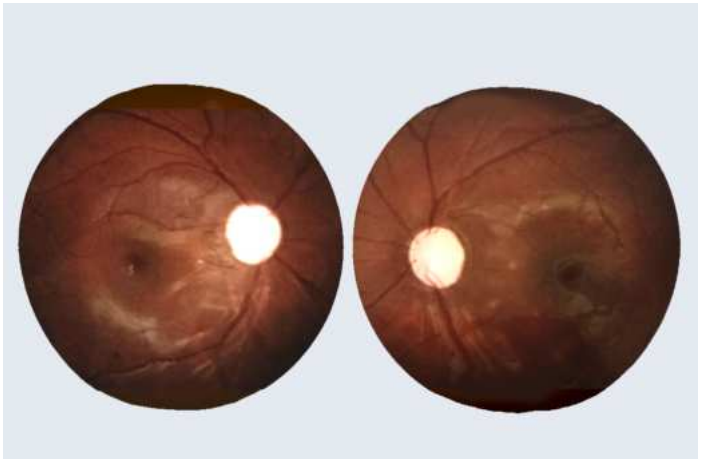
(A) External appearance at presentation.



(B) Postoperative slit-lamp photographs.



(C) Postoperative slit-lamp photographs.

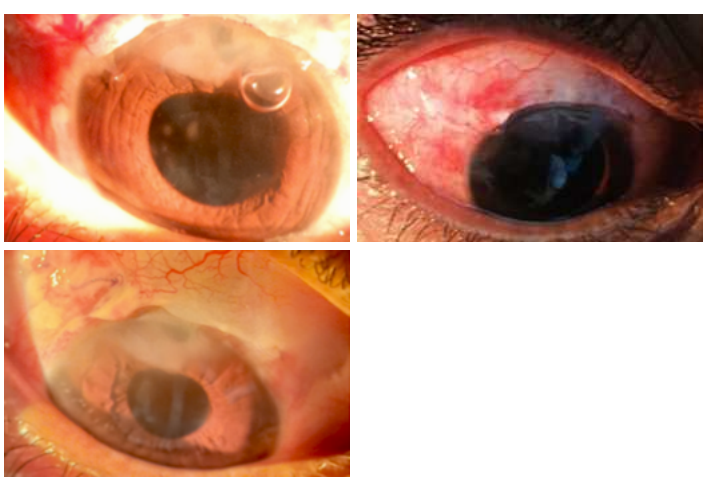


(D) Colour fundus photographs demonstrating glaucomatous optic neuropathy.

Figures 2 (A–D). Clinical findings in Cases 2.

Case 3

A young adult male developed bilateral SIG following prolonged topical corticosteroid therapy for chronic ocular inflammation. Persistently elevated IOP and advanced glaucomatous optic neuropathy were observed despite maximal tolerated medical treatment. The patient underwent trabeculectomy with MMC, resulting in satisfactory postoperative IOP control, stable optic nerve status, and a healthy filtering bleb throughout the follow-up period (Figures 3 and Supplementary Figures 3).

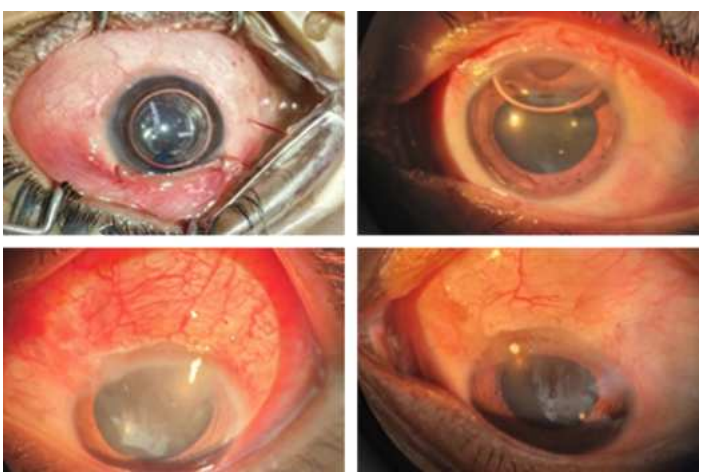


Figures 3. Sequential postoperative slit-lamp photographs showing a functioning filtering bleb.

Case 4

A young female presented with bilateral SIG associated with visually significant PSC following prolonged corticosteroid therapy. Because of uncontrolled IOP and coexisting cataract, the patient underwent combined phacoemulsification, PCIOL implantation, and trabeculectomy with MMC. The postoperative course was uncomplicated, with satisfactory IOP control, improved visual acuity, and maintenance of a healthy filtering bleb during follow-up (Figures 4 and Supplementary Figures 4).

(A) External appearance before surgery.

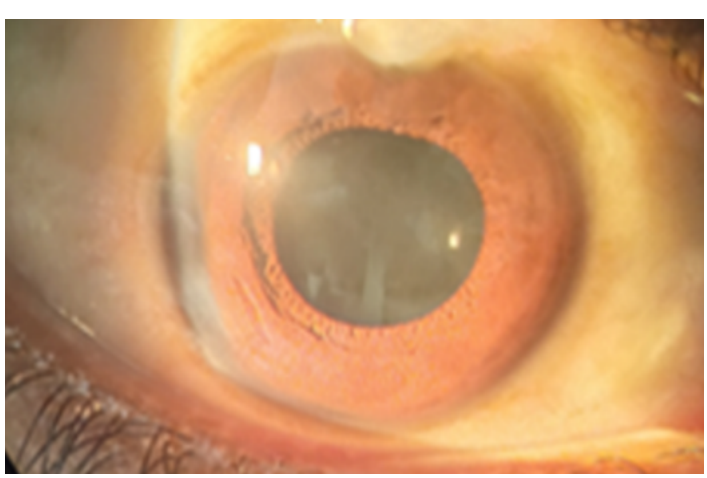


(B) Sequential postoperative slit-lamp photographs demonstrating a healthy filtering bleb.

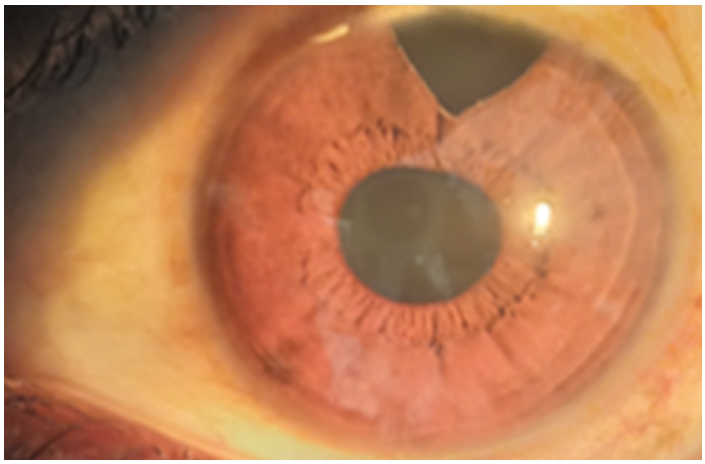
Figures 4 (A–B). Clinical findings in Case 4.

Case 5

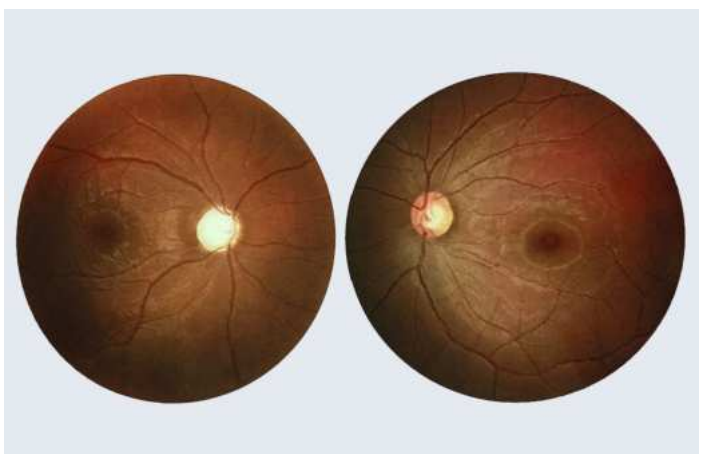
A 32-year-old man receiving prolonged systemic corticosteroid therapy developed bilateral SIG with persistently elevated IOP despite maximal tolerated medical treatment. The patient underwent trabeculectomy with MMC, achieving satisfactory postoperative IOP control and stabilization of glaucomatous optic neuropathy without significant postoperative complications (Figures 5 and Supplementary Figure 5).



(A) Postoperative slit-lamp appearance (1).



(A) Postoperative slit-lamp appearance (2).



(B) Colour fundus photographs demonstrating glaucomatous optic neuropathy.

Figures 5 (A–B). Clinical findings in Case 5.

Overall, three patients (60%) underwent trabeculectomy with MMC alone, whereas two patients (40%) underwent combined phacoemulsification, PCIOL implantation, and trabeculectomy with MMC because of coexisting visually significant PSC. At the 3-month follow-up, all patients achieved satisfactory IOP control with functioning filtering blebs. No major intraoperative or postoperative complications, including hypotony, bleb leak, endophthalmitis, or persistent postoperative IOP elevation, were observed. Patients who underwent combined surgery experienced improved visual acuity following cataract extraction, while optic nerve status remained clinically stable in all five cases.

4. Discussion

SIG is a potentially preventable form of secondary open-angle glaucoma resulting from corticosteroid-induced elevation of IOP. Although corticosteroids remain indispensable for the management of a wide range of ocular and systemic inflammatory disorders, prolonged or unsupervised use may result in irreversible glaucomatous optic neuropathy if regular ophthalmic monitoring is not undertaken [1,4,7]. This case series describes the clinical characteristics, corticosteroid exposure, surgical management, and short-term outcomes of five young patients with advanced SIG who required glaucoma filtration surgery after medical therapy failed to achieve satisfactory IOP control.

One of the most notable findings of this series was the relatively young age of the affected patients. Four of the five patients were younger than 30 years, and all presented with advanced glaucomatous optic neuropathy at their initial specialist consultation. Previous studies have demonstrated that children and young adults are particularly susceptible to corticosteroid-induced ocular hypertension, especially following prolonged use of potent topical corticosteroids for chronic allergic eye diseases such as vernal keratoconjunctivitis [4,7,10]. Delayed referral, prolonged corticosteroid exposure, and inadequate IOP monitoring probably contributed to the advanced disease observed in our patients.

Topical corticosteroid therapy was the principal risk factor in four patients, whereas one patient developed SIG following prolonged systemic corticosteroid treatment. This observation is consistent with previous reports indicating that topical ophthalmic corticosteroids pose the greatest risk because of their direct effect on the trabecular meshwork. Nevertheless, ocular hypertension has also been associated with systemic, periocular, intravitreal, inhaled, intranasal, and dermatological corticosteroid therapy [5,7,8]. These findings reinforce the importance of prescribing the lowest effective corticosteroid dose for the shortest possible duration while ensuring regular ophthalmic surveillance regardless of the route of administration.

When withdrawal or modification of corticosteroid therapy and maximal tolerated medical treatment fail to achieve adequate IOP control, surgical intervention becomes essential to prevent further glaucomatous damage. In the present series, three patients underwent trabeculectomy with MMC, whereas two patients with visually significant PSC underwent combined phacoemulsification, PCIOL implantation, and trabeculectomy with MMC. All patients achieved satisfactory postoperative IOP control without major intraoperative or postoperative complications. These findings are consistent with previous studies demonstrating favourable outcomes following filtration surgery for medically uncontrolled SIG [11,12,14].

Two patients had visually significant PSC, another recognised complication of prolonged corticosteroid therapy. Combined cataract extraction and glaucoma filtration surgery allowed simultaneous visual rehabilitation and long-term IOP control while avoiding a second operative procedure. Consequently, individualized surgical planning should consider both the severity of glaucomatous damage and the presence of coexisting cataract to optimise functional and anatomical outcomes.

The findings of this study also have important public health implications. In many low- and middle-income countries, topical corticosteroids remain readily accessible, and unsupervised or prolonged use is common. Consequently, patients frequently present only after substantial optic nerve damage has occurred. Greater awareness among ophthalmologists, paediatricians, physicians, dermatologists, pharmacists, and primary healthcare providers regarding corticosteroid-associated ocular complications is therefore essential. Patients receiving prolonged corticosteroid therapy should undergo baseline and periodic ophthalmic examinations, including IOP measurement and optic nerve head assessment, while education regarding the hazards of self-medication should be reinforced.

This study provides real-world evidence from a tertiary glaucoma service in Bangladesh and contributes locally relevant data regarding the surgical management of advanced SIG in young patients. Although the retrospective design, small sample size, descriptive nature of the study, and relatively short follow-up limit the generalisability of the findings, the standardized clinical assessment, uniform surgical approach, and consistent postoperative evaluation strengthen the clinical relevance of this case series. Larger multicentre studies with longer follow-up are warranted to evaluate long-term surgical outcomes and identify prognostic factors associated with successful treatment.

5. Conclusion

Steroid-induced glucoma (SIG) is an important but largely preventable cause of irreversible visual impairment, particularly among young patients receiving prolonged corticosteroid therapy without appropriate ophthalmic monitoring. Delayed diagnosis and sustained elevation of intraocular pressure frequently result in advanced glaucomatous optic neuropathy, often necessitating surgical intervention to preserve visual function.

This case series demonstrates that timely withdrawal or modification of corticosteroid therapy, combined with glaucoma filtration surgery in medically uncontrolled cases, can achieve satisfactory intraocular pressure control and stabilise glaucomatous disease progression. Patients with coexisting posterior subcapsular cataract may benefit from combined phacoemulsification, posterior chamber intraocular lens implantation, and trabeculectomy, enabling simultaneous visual rehabilitation and long-term glaucoma management.

Regular ophthalmic surveillance, including periodic intraocular pressure measurement and optic nerve head assessment, should be incorporated into the routine care of all patients receiving prolonged corticosteroid therapy, irrespective of the route of administration. Increased awareness among ophthalmologists and other healthcare professionals regarding corticosteroid-associated ocular complications may facilitate earlier diagnosis, timely referral, and prevention of avoidable glaucoma-related visual loss. Further multicentre studies with larger sample sizes and longer follow-up are warranted to validate these findings and evaluate long-term surgical outcomes.

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Author Contributions

Samia Mazumder Koli conceived the study, managed the patients, collected and interpreted the clinical data, and drafted the manuscript. Mohammad Zafrul Hassan, Mohammad Syed Jahangir Kabir, Salma Manjur, and Tania Rahman Chhara contributed to patient management, surgical care, interpretation of findings, and critical revision of the manuscript. All authors reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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The authors received no external funding for this study.

Conflict of Interest

The authors declare that they have no competing interests.

Data Availability Statement

All data supporting the findings of this case series are presented within the manuscript. Additional anonymized clinical information may be made available by the corresponding author upon reasonable request, provided patient confidentiality is maintained.

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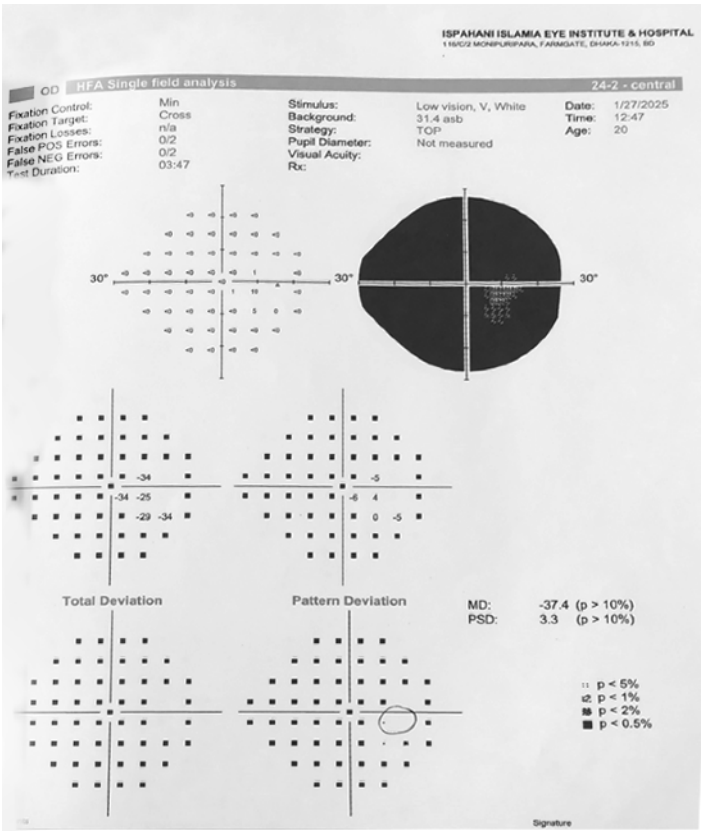
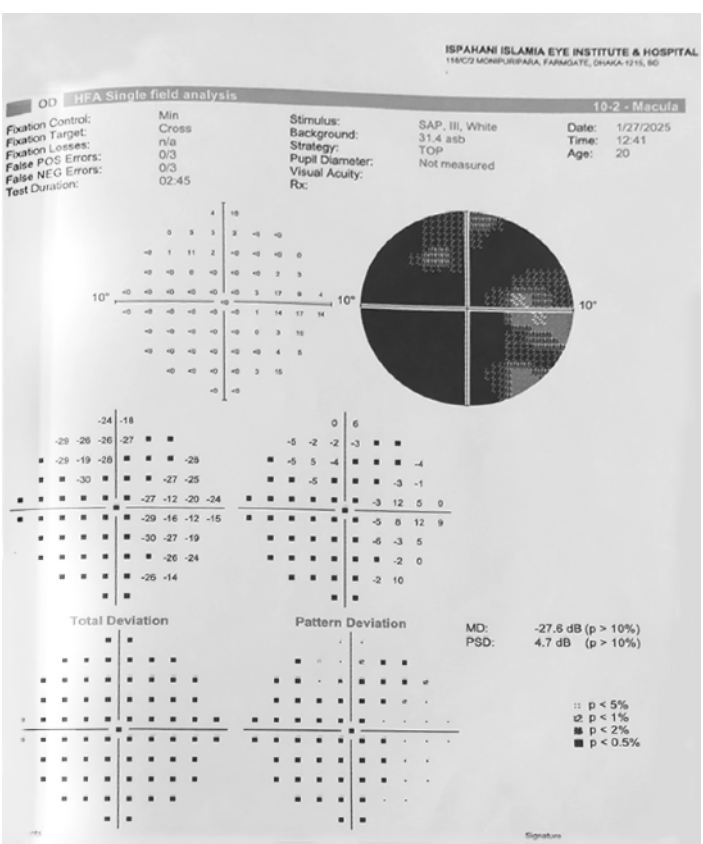
Visit next page to see Supplimentary Data

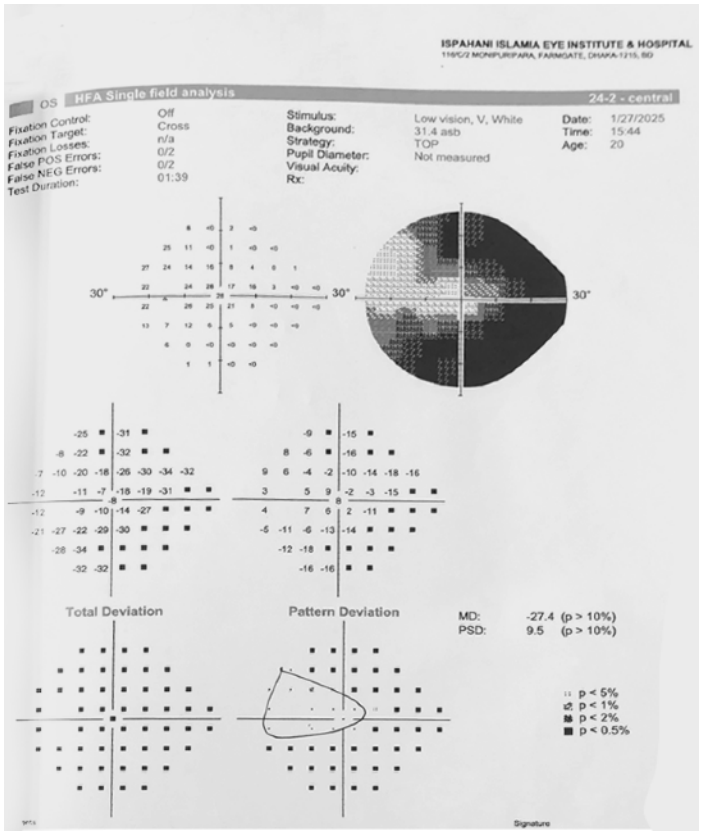
Supplementary Data



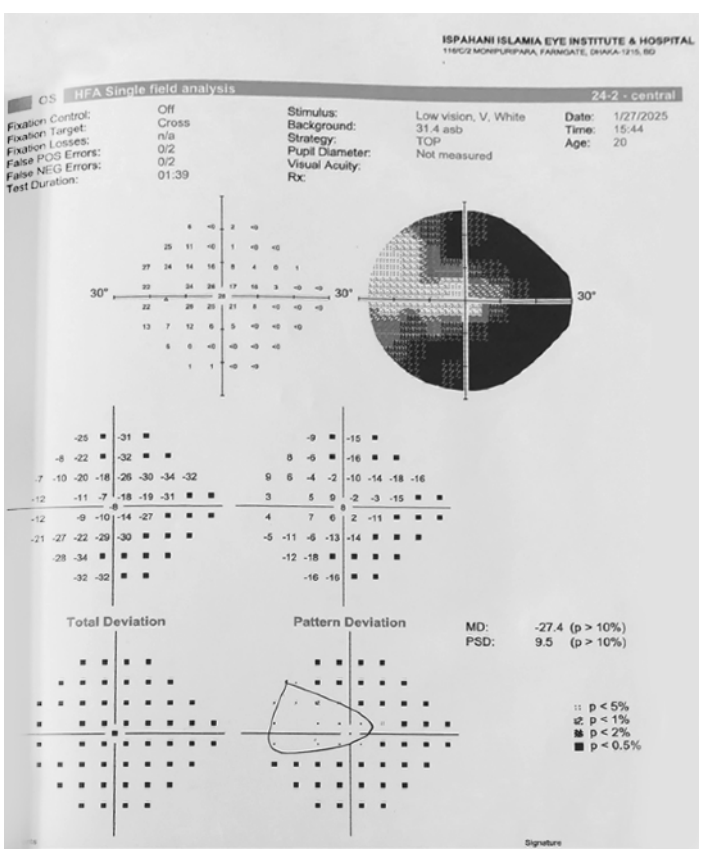
(A) HVF 24-2 at Right Eye.



(B) HVF 10-2 at Right Eye.

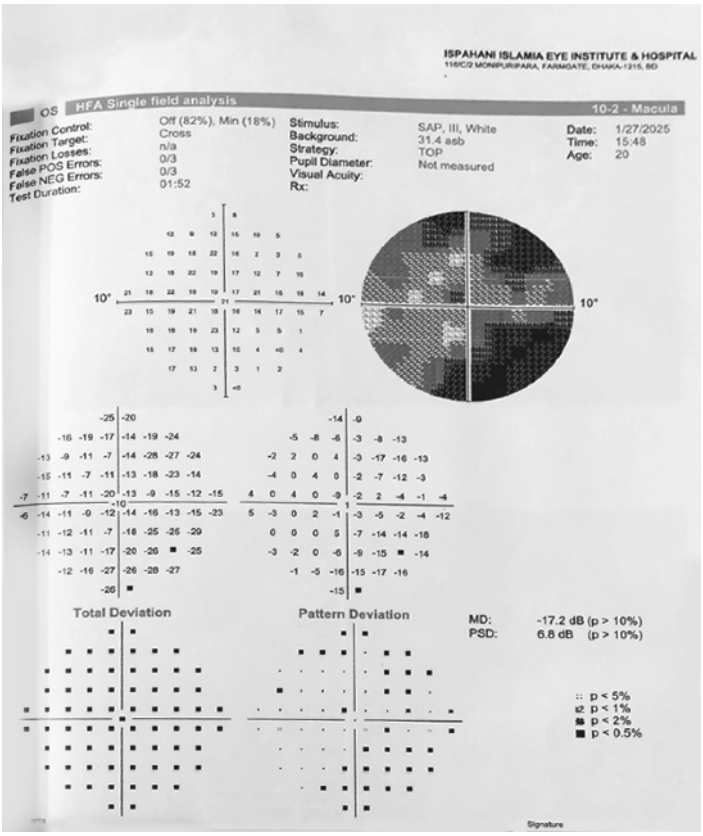


(C) HVF 24-2 at Left Eye.

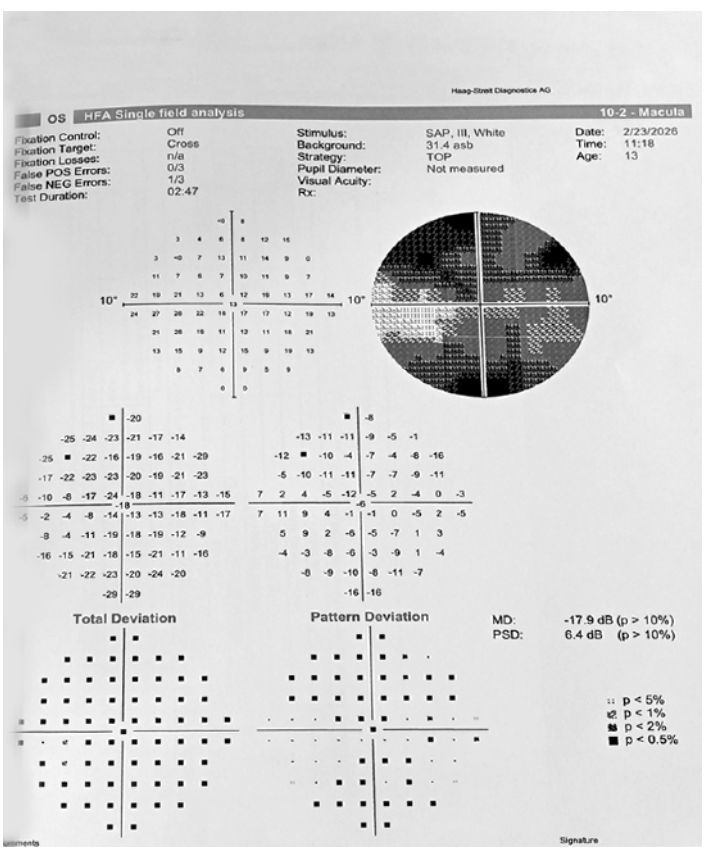


(D) HVF 10-2 at Left Eye.

Supplementary Figures 1 (A–D). HVF findings in Case 1 demonstrating advanced bilateral glaucomatous visual field defects before surgery.

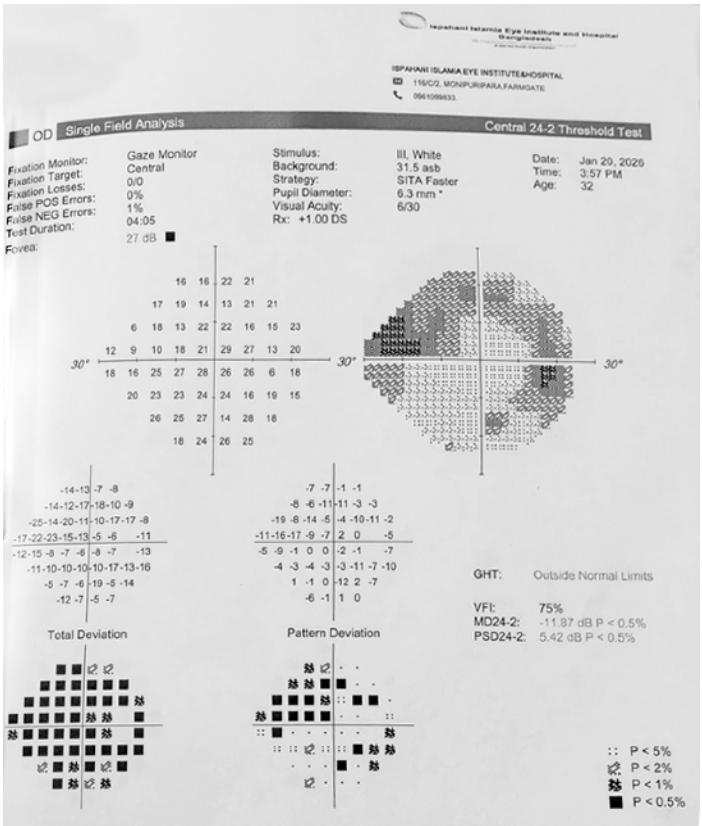


(A) HVF 24-2 at Left Eye

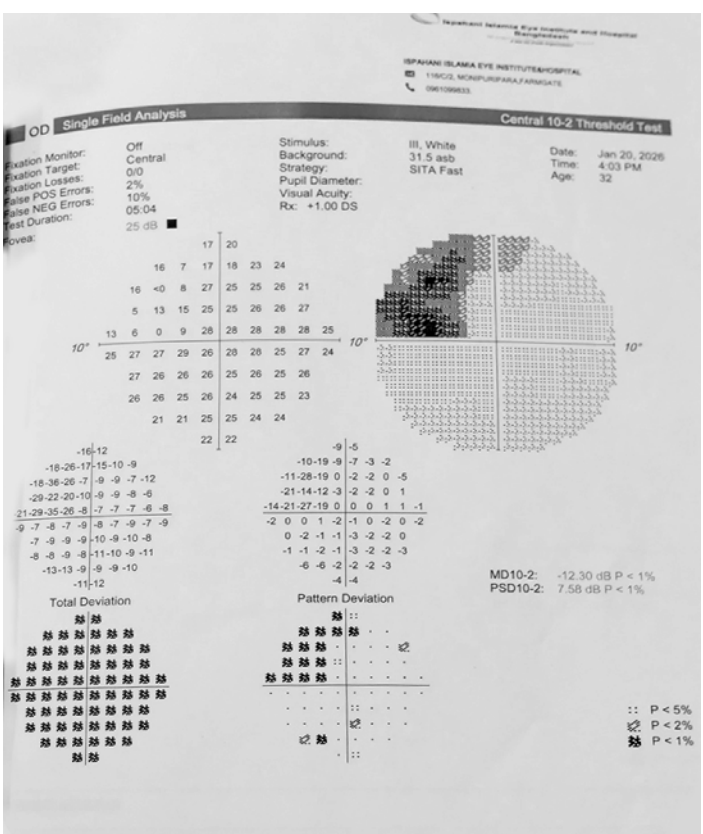


(B) HVF 10-2 at Left Eye

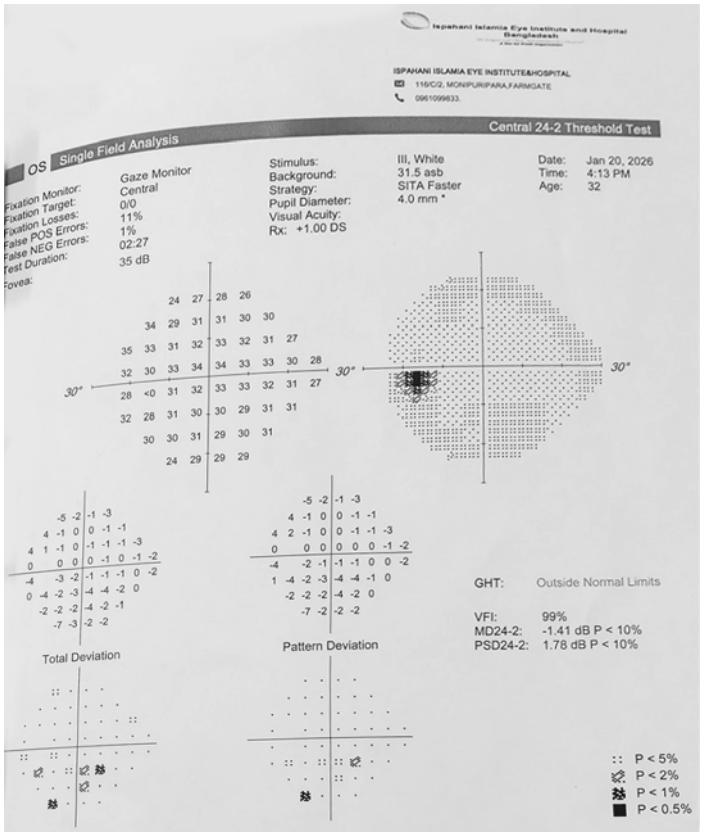
Supplementary Figures 2 (A–B). HVF findings showing advanced bilateral visual field loss.



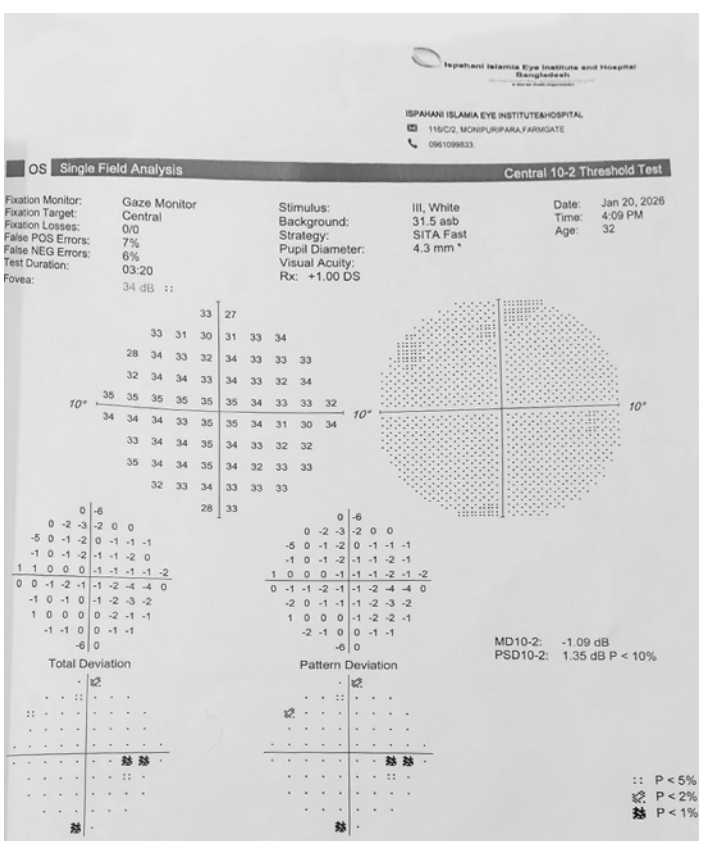
(A) HVF 24-2 at Right Eye.



(B) HVF 10-2 at Right Eye.

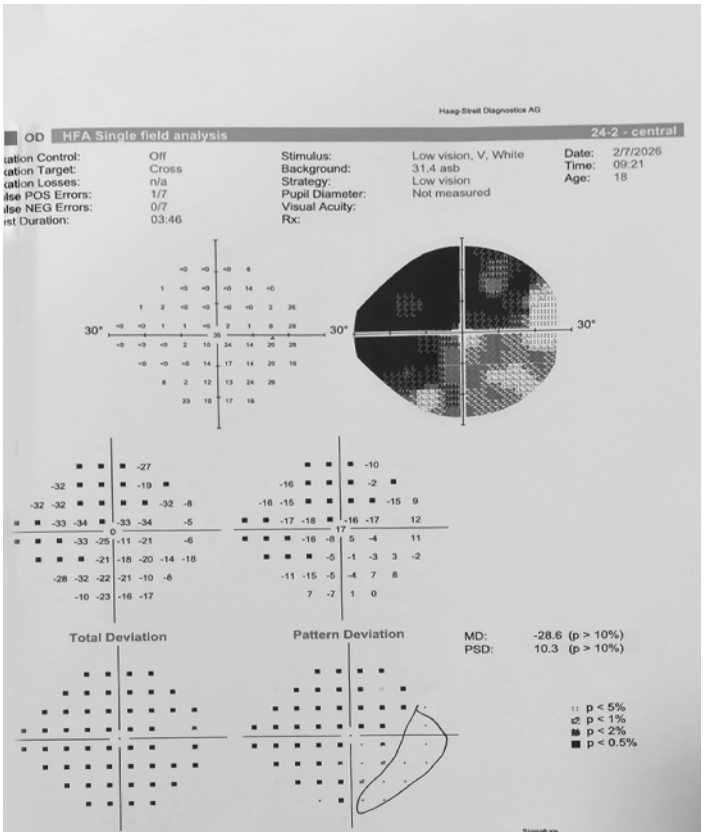


(C) HVF 24-2 at Left Eye.

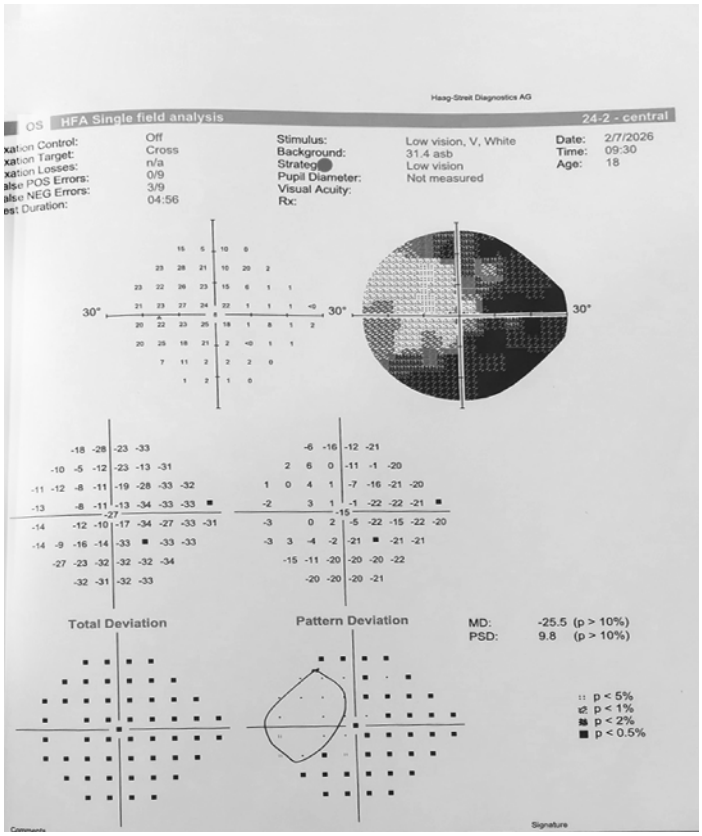


(D) HVF 10-2 at Left Eye.

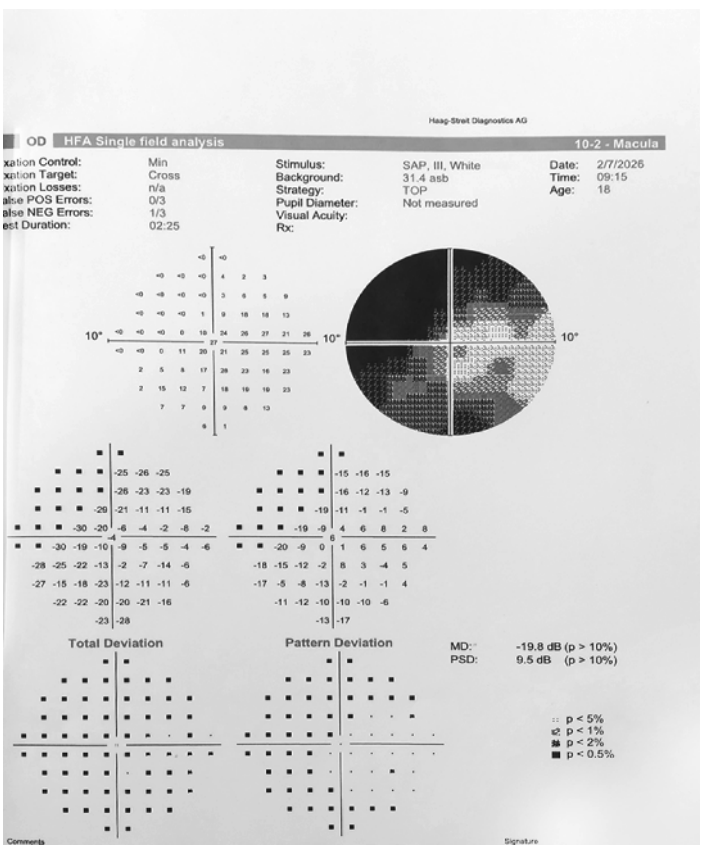
Supplementary Figures 3 (A–D). HVF findings (C-E) demonstrating advanced glaucomatous visual field defects.



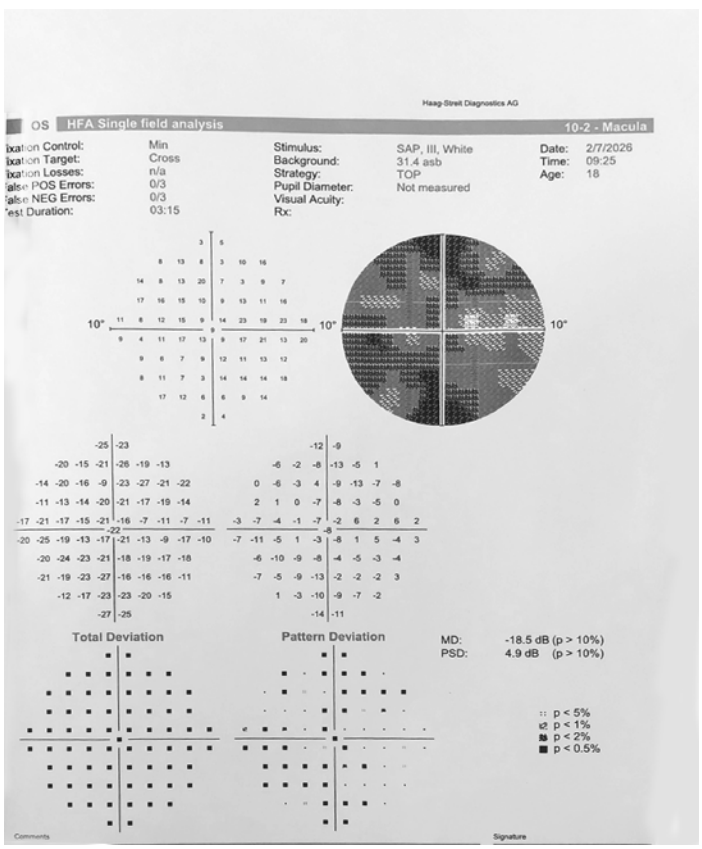
(A) HVF 24-2 at Right Eye.



(C) HVF 24-2 at Left Eye.

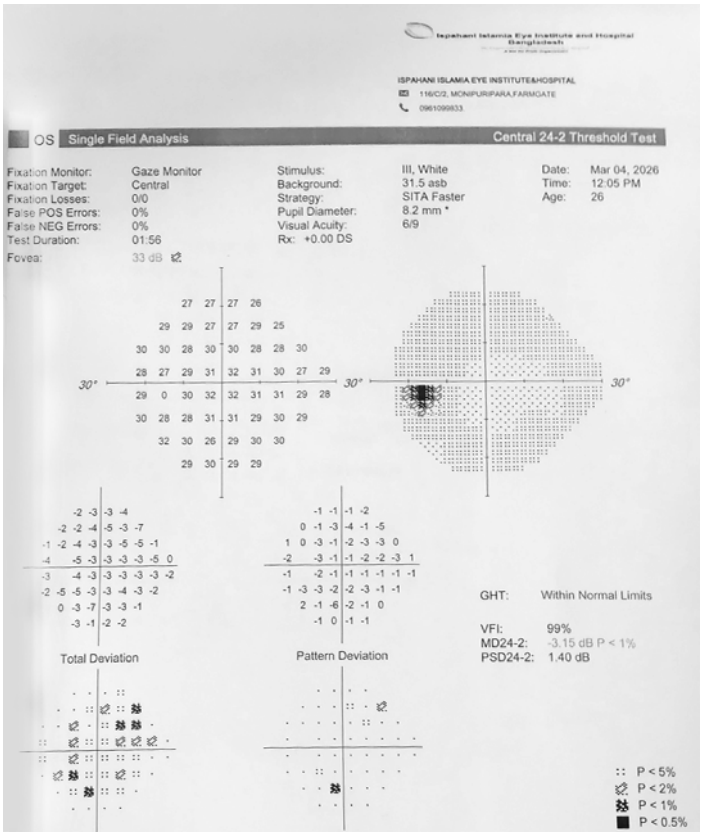


(B) HVF 10-2 at Right Eye.



(D) HVF 10-2 at Left Eye.

Supplementary Figures 4 (A–D). HVF findings in Case 4 showing advanced bilateral glaucomatous visual field defects.



Supplementary Figure 5. HVF findings following surgical intervention.

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Neuro-ophthalmic Manifestations Following Trauma: A Prospective Hospital-based Study

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ORIGINAL ARTICLE

Keywords:
Neuro-ophthalmic manifestations
Ocular trauma
Head trauma
Traumatic optic neuropathy
Road traffic accidents
Visual impairment

ABSTRACT

Background

Neuro-ophthalmic manifestations are common sequelae of ocular and head trauma and may result in substantial visual morbidity if not recognised and managed promptly. Patients frequently present with vision loss, diplopia, ocular motility disorders, ptosis, and pupillary abnormalities. This study aimed to determine the spectrum of neuro-ophthalmic manifestations among patients presenting after trauma at a tertiary eye care hospital in Bangladesh.

Methods

This prospective hospital-based observational study was conducted in the Department of Neuro-Ophthalmology, Ispahani Islamia Eye Institute & Hospital (IIEI&H), Dhaka, Bangladesh, between January and December 2022. A total of 132 consecutive patients fulfilling the eligibility criteria were enrolled using purposive sampling. Demographic and clinical information was collected using a structured questionnaire followed by comprehensive neuro-ophthalmic evaluation. Data were analysed using IBM SPSS Statistics for Windows, Version 25.0.

Results

Among the 132 participants, 117 (88.6%) were male and 15 (11.4%) were female. More than half (53.0%) were aged 10–29 years. Traumatic optic neuropathy (TON) was the most common diagnosis, accounting for 70.5% of cases, followed by traumatic ocular motor nerve palsies. Vision loss was the predominant presenting complaint (75.0%), followed by diplopia (12.9%) and ptosis with ophthalmoplegia (5.3%). Moderate visual impairment (visual acuity worse than 6/18–6/60) was observed in 25.0% of patients, while 43.2% had severe visual impairment or blindness (visual acuity worse than 3/60). Road traffic accidents accounted for 57.6% of injuries, followed by blunt trauma (26.5%) and falls from height (9.1%). Among motorcycle accident victims, only 14.0% reported wearing helmets and 12.3% possessed a valid driving licence.

Conclusion

Traumatic optic neuropathy (TON) was the most frequent neuro-ophthalmic manifestation following trauma, predominantly affecting young males involved in road traffic accidents. Early diagnosis, prompt referral, multidisciplinary management, and improved road safety measures particularly increased helmet use among motorcyclists are essential for reducing trauma-related visual disability.

1. Introduction

Neuro-ophthalmology is a subspecialty integrating ophthalmology and neurology that focuses on disorders affecting the visual pathways, ocular motility, pupillary function, and their neurological control. Traumatic injuries involving the head and orbit frequently affect these structures, resulting in a wide spectrum of neuro-ophthalmic manifestations that may cause temporary or permanent visual impairment if not recognised and managed promptly [1,2].

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Trauma remains a major cause of ocular morbidity and preventable visual disability worldwide, particularly among children and young adults. Injury to the afferent and efferent visual pathways may result in conditions such as traumatic optic neuropathy (TON), cranial nerve III, IV, VI, and VII palsies, traumatic mydriasis, ptosis, diplopia, and visual field defects. These disorders often produce substantial functional impairment and adversely affect quality of life [3–5].

Among these conditions, TON is the most common vision-threatening neuro-ophthalmic complication following trauma. It typically presents with sudden visual loss, a relative afferent pupillary defect, impaired colour vision, and visual field abnormalities. Cranial nerve palsies may result in diplopia and ocular motility disorders, while associated eyelid and pupillary abnormalities further contribute to visual dysfunction. Early diagnosis and multidisciplinary management involving ophthalmologists, neurologists, neurosurgeons, and radiologists are essential for improving visual outcomes [6–8].

Previous studies have consistently shown that young males are disproportionately affected by traumatic neuro-ophthalmic disorders, with road traffic accidents, falls, and interpersonal violence representing the leading mechanisms of injury. However, the epidemiology and clinical spectrum vary across regions because of differences in road safety practices, occupational exposure, healthcare accessibility, and referral systems [9–11]. Despite the growing burden of trauma-related visual impairment, published data describing neuro-ophthalmic manifestations in Bangladesh remain limited.

Understanding the clinical characteristics of these patients is important for facilitating early diagnosis, strengthening referral pathways, improving multidisciplinary management, and informing preventive public health strategies. Therefore, this study aimed to determine the spectrum of neuro-ophthalmic manifestations following trauma among patients presenting to a tertiary eye care hospital in Bangladesh [12].

2. Materials and Methods

Study Design and Setting

This prospective hospital-based observational study was conducted in the Department of Neuro-Ophthalmology, Ispahani Islamia Eye Institute & Hospital (IIEI&H), Dhaka, Bangladesh, between January and December 2022.

Study Population

A total of 132 consecutive patients presenting with neuro-ophthalmic manifestations following ocular or head trauma were enrolled using a purposive sampling technique. Eligible patients who fulfilled the inclusion criteria and provided written informed consent were included in the study.

Inclusion Criteria

Patients presenting within 6 weeks of ocular or head trauma with clinical features suggestive of neuro-ophthalmic involvement secondary to trauma were eligible for inclusion.

Exclusion Criteria

Patients with isolated ocular injuries without neuro-ophthalmic involvement were excluded. These included traumatic lens subluxation or dislocation, traumatic cataract, macular hole, retinal detachment, vitreous haemorrhage, secondary glaucoma, commotio retinae, endophthalmitis, and sympathetic ophthalmia.

Clinical Assessment

Baseline demographic characteristics, occupation, socioeconomic status, mechanism of injury, presenting complaints, and relevant medical history were recorded using a standardized data collection form.

All participants underwent a comprehensive neuro-ophthalmic examination, including best-corrected visual acuity (BCVA) assessment using the Snellen chart, colour vision testing with Ishihara pseudoisochromatic plates, pupillary examination, slit-lamp biomicroscopy, and dilated fundus examination using a +90-dioptre lens. Additional laboratory investigations and neuroimaging were performed whenever clinically indicated to establish the diagnosis or identify associated injuries.

Neuro-ophthalmic diagnoses were established based on clinical history, ophthalmic examination, and relevant ancillary investigations.

Outcome Measures

The primary outcome was the spectrum of neuro-ophthalmic manifestations following trauma. Secondary outcome measures included demographic characteristics, mechanism of injury, presenting symptoms, laterality, BCVA at presentation, and the final neuro-ophthalmic diagnosis.

Statistical Analysis

Data were entered into and analysed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the study findings. Continuous variables are presented as means with standard deviations, whereas categorical variables are presented as frequencies and percentages.

Ethical Considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Ethical Review Committee (ERC) of IIEI&H, Dhaka, Bangladesh (Approval No. IIEI&H/ERC/3075-2022). Written informed consent was obtained from all participants prior to enrolment. For participants younger than 18 years, written informed consent was obtained from a parent or legal guardian. Participant confidentiality and anonymity were maintained throughout the study.

3. Results

A total of 132 patients with neuro-ophthalmic manifestations following trauma were enrolled during the study period. The mean age was 28.0 ± 15.9 years (range, 5–75 years). Male patients predominated, accounting for 117 (88.6%) cases, while 15 (11.4%) were female, giving a male-to-female ratio of 7.8:1. More than half of the participants (53.0%) were aged between 10 and 29 years (Figures 1 and 2).

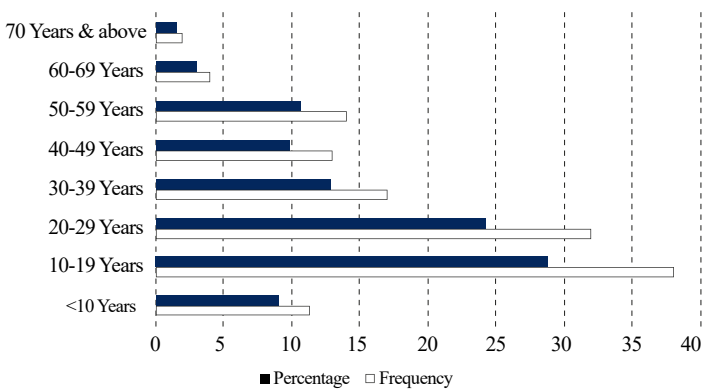

Figure 1. Age distribution of the study participants (n = 132).

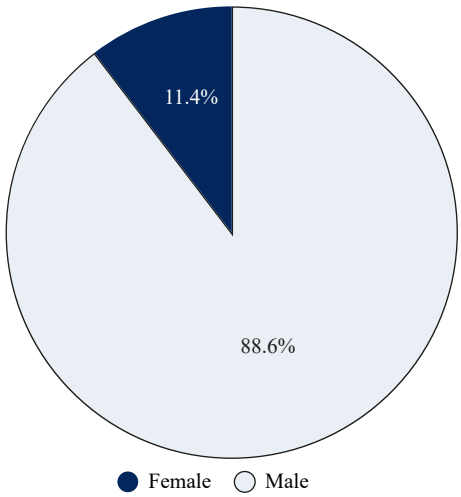

Figure 2. Sex distribution of the study participants (n = 132).

Road traffic accidents were the leading mechanism of injury, accounting for 76 (57.6%) cases. Motorcycle accidents constituted the largest subgroup (57 patients; 43.2%), followed by bus accidents (19 patients; 14.4%). Other mechanisms included blunt trauma (35 patients; 26.5%), falls from height (12 patients; 9.1%), falls on the ground (7 patients; 5.3%), and physical assault (2 patients; 1.5%) (Table 1).

Among the 57 patients involved in motorcycle accidents, only 8 (14.0%) reported wearing a helmet at the time of injury, while 7 (12.3%) possessed a valid driving licence.

Table 1. Mechanism of injury among the study participants (n = 132).

Mechanism of injury	n (%)
Motorcycle accident	57 (43.2)
Bus accident	19 (14.4)
Blunt trauma	35 (26.5)
Fall from height	12 (9.1)
Fall on the ground	7 (5.3)
Physical assault	2 (1.5)
Total	**132 (100.0)**

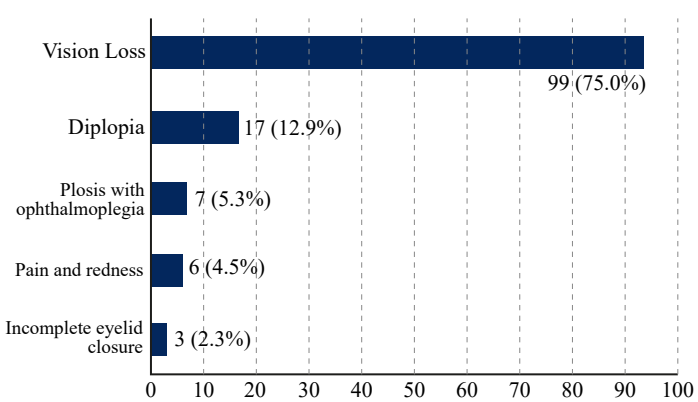

Figure 3. Presenting complaints among the study participants (n = 132).

A total of 75% of participants reported vision loss (Figure 3). The right eye was affected in 71 (53.8%) patients, the left eye in 58 (43.9%), and bilateral involvement was observed in only 3 (2.3%) patients (Table 2).

Table 2. Laterality of neuro-ophthalmic involvement (n = 132).

Eye involved	n (%)
Right	71 (53.8)
Left	58 (43.9)
Bilateral	3 (2.3)
Total	**132 (100.0)**

At presentation, 42 (31.8%) patients had BCVA between 6/6 and 6/18. Moderate visual impairment (worse than 6/18–6/60) was observed in 33 (25.0%) patients, while 4 (3.0%) had severe visual impairment (worse than 6/60–3/60). Blindness (BCVA <3/60) was present in 53 (40.2%) patients according to the World Health Organization (WHO) classification (Table 3).

Table 3. Presenting BCVA of the study participants (n = 132).

Visual acuity	n (%)
6/6–6/18	42 (31.8)
Worse than 6/18–6/60	33 (25.0)
Worse than 6/60–3/60	4 (3.0)
Blindness (<3/60)	53 (40.2)
Total	**132 (100.0)**

TON was the most frequent neuro-ophthalmic diagnosis, accounting for 93 (70.5%) patients. Other diagnoses included traumatic sixth nerve palsy (9 patients; 6.8%), traumatic mydriasis (9 patients; 6.8%), traumatic fourth nerve palsy (8 patients; 6.1%), traumatic ptosis (4 patients; 3.0%), traumatic third nerve palsy (3 patients; 2.3%), traumatic seventh nerve palsy (3 patients; 2.3%), and traumatic carotid-cavernous fistula (3 patients; 2.3%) (Figure 4).

Overall, TON accounted for more than two-thirds of all neuro-ophthalmic manifestations observed in this study.

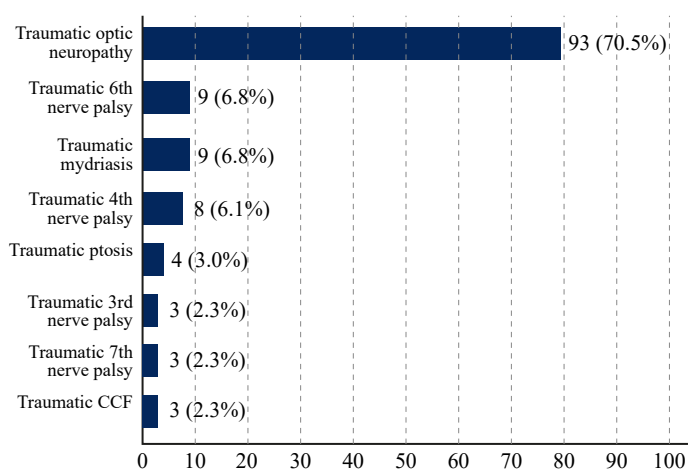

Figure 4. Distribution of neuro-ophthalmic diagnoses among the study participants (n = 132).

4. Discussion

The present prospective hospital-based study evaluated the spectrum of neuro-ophthalmic manifestations following ocular and head trauma in patients presenting to a tertiary eye care centre in Bangladesh. The findings demonstrate that trauma-related neuro-ophthalmic disorders predominantly affected young males, with road traffic accidents emerging as the principal mechanism of injury. TON was the most frequent

diagnosis, and a substantial proportion of patients presented with severe visual impairment or blindness, highlighting the considerable clinical and public health burden of trauma-related neuro-ophthalmic disease.

The marked predominance of young male patients observed in this study is consistent with previous reports from both developed and developing countries. Young adults are more frequently exposed to high-risk occupations, outdoor activities, and road traffic environments, increasing their susceptibility to ocular and craniofacial trauma. Similar demographic patterns have been reported by Lee et al., Van Stavern et al., and Pirouzmand, who likewise found a predominance of young males among patients with traumatic neuro-ophthalmic disorders [6,14,17]. These findings are more likely attributable to behavioural and occupational risk factors than to biological susceptibility.

Road traffic accidents accounted for nearly three-fifths of all injuries, with motorcycle accidents representing the largest subgroup. Of particular concern, only 14.0% of motorcycle riders reported wearing helmets, and only 12.3% possessed a valid driving licence. These findings indicate significant deficiencies in road safety practices and suggest that many of these injuries may be preventable. Similar observations have been reported from other low- and middle-income countries, where inadequate helmet use, poor compliance with traffic regulations, and unsafe driving behaviours remain major contributors to ocular and head injuries [9,13]. Strengthening enforcement of traffic legislation, promoting helmet use, and implementing public awareness programmes could substantially reduce the burden of preventable neuro-ophthalmic trauma.

TON accounted for more than two-thirds of all neuro-ophthalmic diagnoses, confirming its position as the most common vision-threatening consequence of head and orbital trauma. This finding is consistent with previous studies that identified TON as the leading cause of severe visual loss following blunt craniofacial injury [6,7,15–17]. The relatively high proportion of patients with TON in the present study may reflect the referral pattern of a tertiary neuro-ophthalmology service, where patients with profound visual loss are more likely to receive specialist assessment. Although the optimal management of TON remains controversial, early recognition through careful clinical examination and appropriate neuroimaging remains essential for excluding associated orbital or intracranial injuries and facilitating timely management [2,7,18].

Vision loss was the predominant presenting complaint, affecting three-quarters of the study population. Furthermore, more than 40% of patients presented with blindness according to the WHO classification, indicating that many patients reached specialist care only after sustaining severe optic nerve or ocular injury. Delayed presentation, limited access to specialised neuro-ophthalmic services, and the severity of the initial trauma may all contribute to poor visual status at presentation. These findings emphasise the importance of establishing efficient referral pathways from emergency departments and peripheral healthcare facilities to specialised ophthalmic centres.

Traumatic ocular motor nerve palsies represented the second most common group of neuro-ophthalmic disorders. Sixth nerve palsy occurred more frequently than third- or fourth-nerve palsies, a finding consistent with the anatomical vulnerability of the abducens nerve because of its long intracranial course. Stretching and compression during head trauma make this nerve particularly susceptible to injury. Although many traumatic cranial nerve palsies improve spontaneously, persistent cases may require prism correction or strabismus surgery to restore binocular single vision and improve quality of life [13,14].

The present study provides valuable epidemiological information regarding trauma-related neuro-ophthalmic disorders in Bangladesh, where published prospective data remain scarce. The findings offer useful baseline evidence for clinicians, researchers, and policymakers involved in trauma prevention, emergency care, and neuro-ophthalmic service planning.

This study has several strengths, including its prospective design, standardized clinical assessment, and inclusion of consecutive patients, which enhanced the completeness and reliability of the clinical data. Nevertheless, several limitations should be acknowledged. The study was conducted at a single tertiary referral centre, which may limit the generalisability of the findings to the wider population. Purposive sampling may also have introduced selection bias because patients with more severe neuro-ophthalmic disorders are more likely to be referred to specialised centres. In addition, the study focused primarily on the clinical spectrum at presentation and did not evaluate treatment outcomes, long-term visual recovery, or prognostic factors. Future multicentre prospective studies with larger sample sizes and longer follow-up are warranted to evaluate visual outcomes and identify predictors of prognosis.

Overall, this study demonstrates that trauma-related neuro-ophthalmic disorders remain an important cause of visual morbidity in Bangladesh. Early recognition of TON and traumatic cranial nerve injuries, prompt referral to specialised neuro-ophthalmic services, and effective road safety interventions—particularly improved helmet use and stricter enforcement of traffic regulations—have the potential to substantially reduce preventable visual disability.

5. Conclusion

Trauma-related neuro-ophthalmic disorders predominantly affect young males and represent an important cause of visual morbidity in Bangladesh. Traumatic optic neuropathy (TON) was the most common neuro-ophthalmic manifestation, with road traffic accidents, particularly motorcycle-related injuries, accounting for the majority of cases. A substantial proportion of patients presented with severe visual impairment or blindness, underscoring the importance of early recognition and timely referral.

Comprehensive neuro-ophthalmic assessment following ocular or head trauma is essential for accurate diagnosis and appropriate management. Strengthening road safety measures, promoting helmet use, improving compliance with traffic regulations, and increasing public awareness may substantially reduce the incidence of preventable trauma-related visual disability.

Acknowledgements

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Author Contributions

Sanjida Naharin conceived and designed the study, recruited participants, performed clinical assessments, interpreted the data, and drafted theinitial manuscript. Md. Sibgatullah contributed to the study design, supervised the clinical work, interpreted the findings, and critically revised the manuscript. Nazmun Nahar participated in study supervision, interpretation of the results, and critical manuscript review. Syeda Fatima Jinat contributed to patient evaluation, data collection, and

manuscript review. Salwa Khan and Tamanna Hossain participated in patient recruitment, clinical assessment, and data collection. All authors critically reviewed the manuscript, approved the final version, and agree to be accountable for all aspects of the work.

Funding

The authors received no external funding for this study.

Conflict of Interest

The authors declare that they have no competing interests.

Data Availability Statement

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

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Surgical Outcomes of Myo-conjunctival Enucleation Using a Polymethyl Methacrylate Implant: A Prospective Interventional Study

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ORIGINAL ARTICLE

Keywords:
Enucleation
Myo-conjunctival technique
Polymethyl methacrylate implant
Orbital implant
Prosthetic motility
Cosmetic outcome

ABSTRACT

Background

Enucleation involves surgical removal of the globe together with a segment of the optic nerve and is performed for various malignant and non-malignant ocular conditions. Restoration of orbital volume, satisfactory cosmetic appearance, and adequate prosthetic motility are the principal objectives of postoperative rehabilitation. The myo-conjunctival enucleation technique has been developed to improve implant stability, prosthetic motility, and cosmetic outcomes. This study evaluated the surgical outcomes of myo-conjunctival enucleation using a polymethyl methacrylate (PMMA) orbital implant at a tertiary eye hospital.

Methods

This prospective interventional study was conducted at the Department of Oculoplasty and Ocular Oncology, Ispahani Islamia Eye Institute & Hospital (IIEI&H), Dhaka, Bangladesh, between June 2023 and June 2024. Forty consecutive patients who underwent myo-conjunctival enucleation with a PMMA implant were enrolled. Data collected included demographic characteristics, indication for surgery, implant size, cosmetic outcome, prosthetic motility, and postoperative complications. Cosmetic outcome was assessed by upper eyelid sulcus symmetry and eyelid position, while prosthetic motility was evaluated in the horizontal and vertical meridians.

Results

Forty patients were included, comprising 27 (67.5%) males and 13 (32.5%) females, with a mean age of 9.63 ± 14.28 years. Retinoblastoma was the most common indication for enucleation (62.5%), followed by phthisis bulbi (25.0%), choroidal melanoma (7.5%), and other causes (5.0%). The mean implant diameter was 19.32 ± 0.61 mm. Mild superior sulcus deepening was observed in 21 patients (52.5%), while complete upper eyelid symmetry was achieved in 16 (40.0%). Normal eyelid position was maintained in 27 patients (67.5%). Horizontal prosthetic motility of up to 10° was observed in 31 patients (77.5%), whereas vertical motility of up to 10° was observed in 14 patients (35.0%). Postoperative complications occurred in only two patients (5.0%), including one case each of implant extrusion and implant migration.

Conclusion

Myo-conjunctival enucleation using a PMMA implant provides satisfactory cosmetic rehabilitation, favourable prosthetic motility, and a low incidence of postoperative complications. The technique appears to be a safe, effective, and cost-efficient option for primary orbital rehabilitation following enucleation.

1. Introduction

Enucleation is a surgical procedure involving complete removal of the globe together with a segment of the optic nerve and is indicated for a variety of malignant and non-malignant ocular conditions, including severe ocular trauma, intraocular tumours, painful blind eyes, phthisis bulbi, refractory endophthalmitis, severe microphthalmia, and selected congenital anomalies [1–3]. Worldwide, ocular trauma remains one of the leading indications for enucleation in adults, whereas retinoblastoma is the most common indication in children [2,3].

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Successful rehabilitation of the anophthalmic socket depends on restoration of orbital volume, preservation of eyelid symmetry, and achievement of satisfactory prosthetic motility. Advances in orbital implant design and surgical techniques have substantially improved cosmetic and functional outcomes following enucleation [4]. Among the available implant materials, polymethyl methacrylate (PMMA) remains widely used because of its excellent biocompatibility, affordability, ease of availability, and acceptable long-term safety profile [5].

Several surgical techniques have been described for implant placement following enucleation, including rectus muscle imbrication, integrated implant techniques, and the myo-conjunctival technique [6–8]. The myo-conjunctival technique involves suturing each rectus muscle to its corresponding conjunctival fornix through the anterior Tenon's–conjunctival complex without reattaching the oblique muscles. This approach improves force transmission from the extraocular muscles to the prosthesis, enhances implant stability and prosthetic motility, and eliminates the need for implant wrapping, thereby reducing surgical cost and simplifying the procedure [5,9].

Previous studies have demonstrated superior prosthetic motility and favourable cosmetic outcomes with the myo-conjunctival technique compared with conventional enucleation methods, without increasing postoperative complications [5,8,10]. However, published data from South Asia remain limited, particularly regarding outcomes with PMMA implants in routine clinical practice.

The present study aimed to evaluate the cosmetic outcomes, prosthetic motility, and postoperative complications following myo-conjunctival enucleation using a PMMA implant at a tertiary eye hospital in Bangladesh.

2. Materials and Methods

This prospective interventional study was conducted in the Department of Oculoplasty and Ocular Oncology, Ispahani Islamia Eye Institute & Hospital (IIEI&H), Dhaka, Bangladesh, over a 12-month period from June 2023 to June 2024. The study included patients requiring enucleation for both malignant and non-malignant ocular conditions who underwent primary myo-conjunctival enucleation with a PMMA orbital implant.

A purposive sampling technique was used, and 40 consecutive patients meeting the eligibility criteria were enrolled. Patients of all ages and both sexes were eligible for inclusion. Patients were excluded if enucleation was performed without an orbital implant, if they declined participation, or if they had significant adnexal deformities, shallow conjunctival fornices, or orbital extension of malignancy.

The primary outcome measures were cosmetic outcome, prosthetic motility, and postoperative complications. Cosmetic outcome was assessed by upper eyelid sulcus symmetry and eyelid position. Prosthetic motility was evaluated in the horizontal and vertical meridians using standardized clinical assessment during follow-up.

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) of IIEI&H, Dhaka, Bangladesh (Approval No. IIEI&H-ED/3806/23). Written informed consent was obtained from all adult participants before enrolment. For participants younger than 18 years, written informed consent was obtained from their parents or legal guardians.

Baseline demographic and clinical information was recorded using a structured data collection form. All patients underwent comprehensive ophthalmic and systemic evaluation. Computed tomography (CT) of the orbit and B-scan ultrasonography were performed whenever clinically indicated to assess orbital or posterior segment pathology and to assist preoperative planning.

All surgical procedures were performed under general anaesthesia by experienced oculoplastic surgeons using a standardized myo-conjunctival enucleation technique. Following a 360° perilimbal peritomy and tenotomy, each rectus muscle was isolated with a squint hook and secured using traction and tag sutures. After disinsertion of the rectus and oblique muscles, the globe was delivered, and an adequate segment of the optic nerve was excised. Haemostasis was achieved with gentle pressure using saline-soaked gauze.

A PMMA orbital implant was inserted into the muscle cone, and the posterior Tenon's capsule was closed. The rectus muscle tag sutures were then exteriorised through their corresponding conjunctival fornices and secured to the anterior Tenon's–conjunctival complex. The conjunctiva was closed with absorbable sutures, an appropriately sized conformer was inserted, and temporary median tarsorrhaphy was performed (Figure 1).

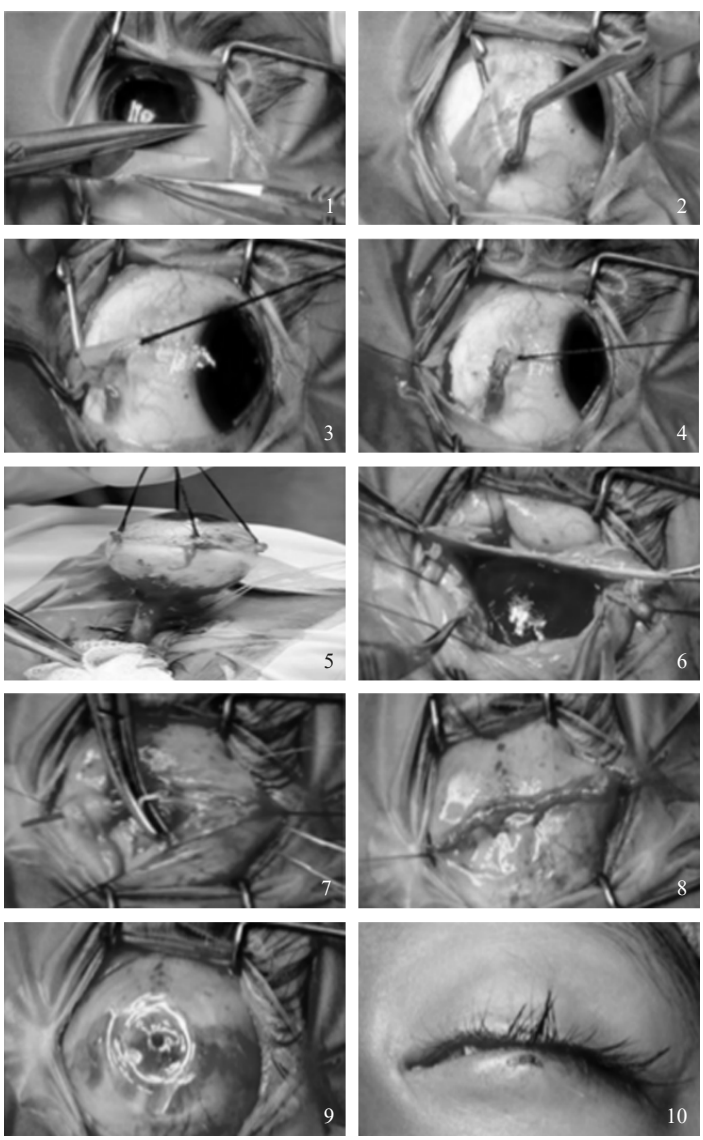


Figure 1. Steps of the myo-conjunctival enucleation technique.

Patients were examined on postoperative day 1 and subsequently at 2 weeks, 6 weeks, and 6 months. At each visit, cosmetic outcome, prosthetic motility, socket healing, and postoperative complications were assessed using predefined clinical criteria.

Data were checked for completeness before analysis. Descriptive statistics were used to summarize the findings and are presented as frequencies, percentages, means with standard deviations, tables, and figures. Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 24.0 (IBM Corp., Armonk, NY, USA).

3. Results

A total of 40 patients underwent myo-conjunctival enucleation with a PMMA orbital implant during the study period. The mean age was 9.63 ± 14.28 years (range: 1–70 years), with most patients (75.0%) belonging to the 1–10-year age group. Male patients predominated, accounting for 27 (67.5%) cases, while 13 (32.5%) were female (Figures 2 and 3).

Retinoblastoma was the most common indication for enucleation, observed in 25 patients (62.5%), followed by phthisis bulbi in 10 (25.0%), choroidal melanoma in 3 (7.5%), and Coats disease and endophthalmitis in one patient (2.5%) each (Table 1). Enucleation was performed in the right eye in 21 patients (52.5%) and in the left eye in 19 (47.5%).

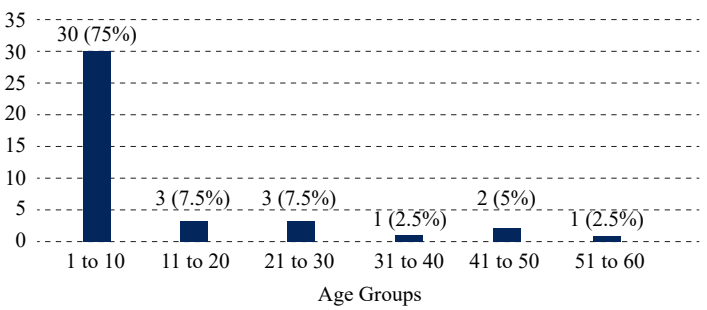


Figure 2. Distribution of the study population by age (n = 40).

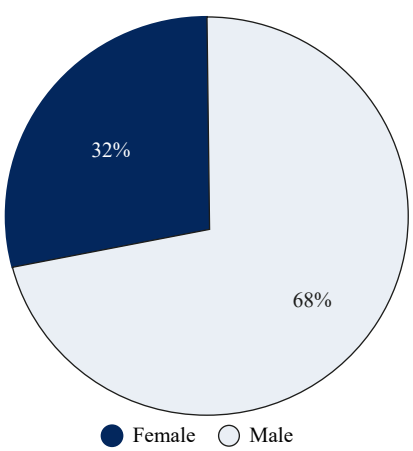


Figure 3. Distribution of the study population by gender (n = 40).

Table 1. Indications for enucleation (n = 40).

Indications	n (%)
Tumor	
Retinoblastoma	25 (62.5)
Choroidal melanoma	3 (7.5)
Phthisis bulbi	10 (25)
Leukocoria	
Coats disease	1 (2.5)
Endophthalmitis	1 (2.5)

The PMMA implant diameter ranged from 18 to 21 mm, with a mean size of 19.32 ± 0.61 mm. Among patients with retinoblastoma, the long optic nerve section (LONS) measured 15.19 ± 2.82 mm, ranging from 11 to 24 mm (Table 2).

Table 2. LONS measurement and implant.

	Minimum (mm)	Maximum (mm)	Mean ± SD (mm)
LONS (retinoblastoma patients)	11	24	15.19±2.82
PMMA implant diameter	18	21	19.32±0.61

Postoperative complications were uncommon and occurred in only 2 patients (5.0%), comprising one case of implant extrusion and one case of implant migration (Table 3). No patient developed orbital infection, wound dehiscence, or other major postoperative complications during follow-up.

Table 3. Postoperative complications (n = 2).

Complication	n (%)
Implant extrusion	1 (2.5)
Implant migration	1 (2.5)

Cosmetic assessment demonstrated favourable postoperative outcomes (Table 4). Mild superior sulcus deepening involving less than half of the fellow eye was observed in 21 patients (52.5%), while 16 patients (40.0%) achieved complete upper eyelid symmetry. Only 3 patients (7.5%) had marked superior sulcus deepening. Normal eyelid position was maintained in 27 patients (67.5%), whereas ptosis, upper eyelid retraction, lower eyelid laxity, and lower eyelid ectropion were observed in a small proportion of patients.

Table 4. Cosmetic outcomes following myo-conjunctival enucleation (n = 40).

Parameter	Category	n (%)
Upper eyelid sulcus symmetry	Deepening > half of the fellow eye	3 (7.5)
	Deepening < half of the fellow eye	21 (52.5)
	Symmetrical	16 (40)
Eyelid position	Normal	27 (67.5)
	Ptosis	5 (12.5)
	Upper eyelid retraction	3 (7.5)
	Lower eyelid ectropion	2 (5)
	Lower eyelid laxity	3 (7.5)

Assessment of prosthetic motility demonstrated better movement in the horizontal than in the vertical meridian (Table 5). Horizontal movement of up to 10° was observed in 31 patients (77.5%), while 4 patients (10.0%) achieved movement between 10° and 30°. No patient demonstrated horizontal movement exceeding 30°. In contrast, vertical prosthetic movement of up to 10° was observed in 14 patients (35.0%), whereas 26 patients (65.0%) had no measurable vertical movement.

Table 5. Prosthetic motility following myo-conjunctival enucleation (n = 40).

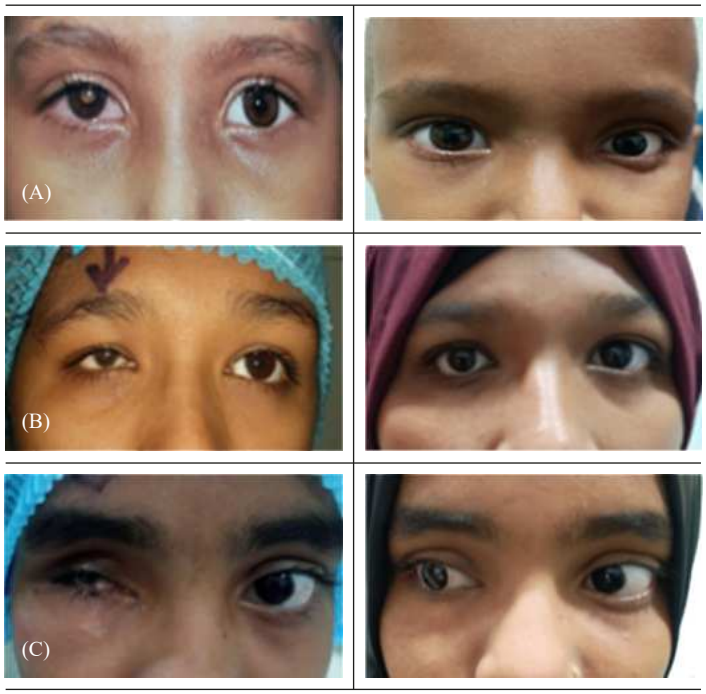
Grade	Horizontal, n (%)	Vertical, n (%)
Grade 0 (no motility)	5 (12.5%)	26 (65%)
Grade 1 (≤10°)	31 (77.5%)	14 (35%)
Grade 2 (10°–30°)	4 (10%)	0
Grade 3 (>30°)	0	0

Overall socket outcome was favourable (Table 6). The final socket status was graded as good in 34 patients (85.0%) and acceptable in 6 patients (15.0%). No patient had a poor socket outcome.

Table 6. Final socket status (n = 40).

Socket status	n (%)
Good	34 (85)
Acceptable	6 (15)
Poor	0 (0)

Representative post-operative cosmetic outcomes are illustrated in Figures 4 (A–C), while Figure 5 demonstrates a healthy anophthalmic socket following myo-conjunctival enucleation with a PMMA implant.



Figures 4 (A–C). Representative postoperative cosmetic outcomes following myo-conjunctival enucleation in three patients.

4. Discussion

The present prospective interventional study evaluated the outcomes of myo-conjunctival enucleation using a PMMA orbital implant in patients undergoing enucleation for malignant and non-malignant ocular conditions. The findings demonstrate favourable cosmetic rehabilitation, satisfactory prosthetic motility, and a low incidence of postoperative complications, supporting the use of this technique as an effective approach for primary orbital reconstruction following enucleation.

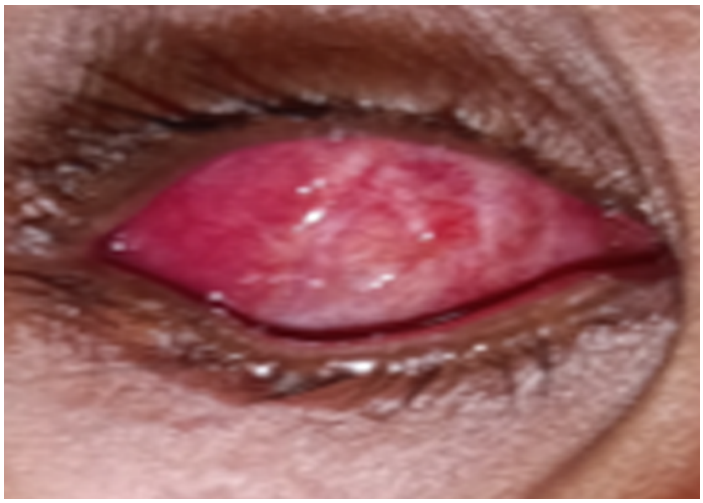


Figure 5. Healthy anophthalmic socket following myo-conjunctival enucleation with a PMMA implant.

The relatively young age of the study population reflects the predominance of retinoblastoma, which accounted for nearly two-thirds of all cases. Similar age distributions have been reported from tertiary eye centres in developing countries, where advanced retinoblastoma remains the leading indication for enucleation in children because of delayed presentation and limited access to specialised ocular oncology services [12,13]. In contrast, studies from developed countries more commonly identify ocular trauma, uveal melanoma, and painful blind eyes as the principal indications for enucleation [2,3].

Retinoblastoma was the most frequent indication for surgery (62.5%), followed by phthisis bulbi and choroidal melanoma. These findings are consistent with previous reports from South Asia and the Middle East, where retinoblastoma continues to represent a major cause of paediatric enucleation [11–13]. Differences in disease patterns between regions are likely influenced by variations in healthcare access, referral systems, and the availability of globe-salvaging treatment.

Appropriate orbital implant selection is essential for successful rehabilitation of the anophthalmic socket. The mean implant diameter in the present study was 19.32 ± 0.61 mm, which is comparable with previous reports using PMMA implants [8,11]. Adequate implant sizing helps restore orbital volume, minimise superior sulcus deformity, and improve prosthetic fitting and long-term cosmetic appearance.

Postoperative complications were infrequent, with only one case each of implant extrusion and implant migration. The overall complication rate of 5% compares favourably with previously published studies evaluating the myo-conjunctival technique [5,8,10]. Careful surgical technique, meticulous tissue handling, and appropriate implant selection probably contributed to the low rate of adverse outcomes observed in this series.

Cosmetic rehabilitation is a major determinant of patient satisfaction following enucleation. In the present study, most patients achieved either complete upper eyelid symmetry or only mild superior sulcus deepening, while normal eyelid position was preserved in more than two-thirds of cases. Similar cosmetic outcomes have been reported following successful orbital volume replacement and appropriate prosthetic fitting [16,17]. Although a small proportion of patients developed ptosis, eyelid retraction, or lower eyelid abnormalities, these complications were generally mild and did not substantially compromise the final cosmetic result.

Prosthetic motility was better in the horizontal than in the vertical meridian, with most patients demonstrating horizontal movement of up to 10°. Similar findings have been described previously and are attributable to the direct transmission of extraocular muscle movement through the conjunctival fornices to the orbital implant and prosthesis [5,8,15]. The myo-conjunctival technique avoids implant wrapping while maintaining efficient muscle coupling, thereby enhancing prosthetic movement without increasing surgical complexity.

Overall socket status was graded as good in 85% of patients, with no poor outcomes recorded. These findings indicate that the myo-conjunctival technique provides stable implant positioning and satisfactory socket rehabilitation in the majority of patients. Together with the low complication rate, the results support its continued use as a practical and cost-effective technique, particularly in resource-limited settings where affordable orbital implants remain important.

This study has several strengths. The prospective design, standardized surgical technique, predefined postoperative assessments, and uniform follow-up schedule enhance the reliability of the findings. Nevertheless, several limitations should be acknowledged. The study was conducted at a single tertiary centre with a relatively small sample size, which may limit generalisability. The follow-up period of six months was insufficient to evaluate long-term implant survival, late socket complications, or long-term prosthetic motility. In addition, the absence of a comparison group prevented direct evaluation of the myo-conjunctival technique against other enucleation methods or orbital implant materials.

Future multicentre prospective studies involving larger patient populations, longer follow-up periods, and comparative evaluation of different implant materials and surgical techniques would provide more robust evidence regarding long-term cosmetic, functional, and patient-reported outcomes.

The findings of this study demonstrate that myo-conjunctival enucleation with a PMMA orbital implant is a safe, effective, and economical technique that provides satisfactory cosmetic rehabilitation, good prosthetic motility, and a low rate of postoperative complications following enucleation.

5. Conclusion

Myo-conjunctival enucleation using a PMMA orbital implant is a safe, effective, and economical technique for primary orbital rehabilitation following enucleation. In this prospective study, the procedure achieved satisfactory cosmetic outcomes, favourable prosthetic motility, and a low incidence of postoperative complications.

The technique provided stable implant positioning and acceptable eyelid symmetry in the majority of patients, with minimal implant-related complications during follow-up. These findings support the use of the myo-conjunctival technique as a reliable surgical option for patients requiring enucleation, particularly in resource-limited settings where cost-effective orbital implants remain important.

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Author Contributions

Sheikh Mohammad Rashedul Haque conceived and designed the study, performed the surgical procedures, collected and analysed the data, and drafted the manuscript. Sadia Sultana supervised the study, contributed to the study design, interpreted the findings, and critically revised the manuscript. Riffat Rashid, Farzana Afzal and Md. Naim Ibna Bashar participated in patient management, data collection, interpretation of the results, and critical revision of the manuscript. All authors reviewed and approved the final manuscript and agree to be accountable for all aspects of the work.

Conflict of Interest

The authors declare that they have no competing interests or conflicts of interest related to this study.

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Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. Requests will be considered in accordance with institutional policies and patient confidentiality requirements.

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Clinical Features and Management of Combined Retinal Artery and Vein Occlusion: A Case Series from a Tertiary Eye Hospital in Bangladesh

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ORIGINAL ARTICLE

Keywords:
Branch retinal artery occlusion
Branch retinal vein occlusion
Central retinal artery occlusion
Central retinal vein occlusion
Combined retinal artery and vein occlusion
Fluorescein angiography
Optical coherence tomography

ABSTRACT

Purpose

To describe the clinical presentation, multimodal retinal imaging findings, systemic associations, management strategies, and short-term outcomes of three cases of combined retinal artery and vein occlusion (CRAVO) managed at a tertiary eye hospital in Bangladesh.

Methods

This descriptive case series included three consecutive cases of CRAVO managed at the Department of Vitreo-Retina, Ispahani Islamia Eye Institute & Hospital (IIEI&H), Dhaka, Bangladesh, between January 2025 and January 2026. All cases underwent comprehensive ophthalmic assessment, including best-corrected visual acuity (BCVA), slit-lamp biomicroscopy, dilated fundus examination, fluorescein angiography (FA), and optical coherence tomography (OCT). Systemic evaluation was performed to identify associated cardiovascular and metabolic risk factors. Management was individualized according to the clinical presentation and multimodal retinal imaging findings.

Results

The three cases (two females and one male; age range, 18–50 years) represented three distinct patterns of combined retinal vascular occlusion: central retinal vein occlusion (CRVO) with central retinal artery occlusion (CRAO), CRVO with cilioretinal artery occlusion, and branch retinal vein occlusion (BRVO) with branch retinal artery occlusion (BRAO). Multimodal retinal imaging demonstrated retinal whitening, venous dilatation and tortuosity, delayed retinal vascular filling on FA, and inner retinal hyperreflectivity with variable macular oedema on OCT. Associated systemic conditions included migraine, hyperlipidaemia, diabetes mellitus, hypertension, dyslipidaemia, and carotid atherosclerotic disease. Two cases were managed conservatively, whereas one underwent intravitreal aflibercept therapy followed by sectoral retinal laser photocoagulation. Anatomical improvement was observed in all cases, although visual recovery varied according to the severity of retinal ischaemia.

Conclusion

Combined retinal artery and vein occlusion is a rare but potentially sight-threatening retinal vascular disorder requiring prompt diagnosis, multimodal retinal imaging, comprehensive systemic evaluation, and individualized multidisciplinary management. Although favourable anatomical outcomes may be achieved with appropriate treatment, visual prognosis remains guarded in cases with extensive retinal ischaemia.

1. Introduction

Combined retinal artery and vein occlusion (CRAVO) is an uncommon but potentially devastating retinal vascular disorder characterized by simultaneous obstruction of the retinal arterial and venous circulation. Compared with isolated retinal artery or retinal vein occlusion, CRAVO results in more extensive retinal ischaemia, leading to poorer visual outcomes and an increased risk of irreversible vision loss and other sight-threatening complications [1–3]. Owing to its rarity, the current understanding of this condition is based largely on isolated case reports and small case series.

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The exact pathophysiological mechanisms underlying CRAVO remain incompletely understood. Several hypotheses have been proposed, including haemodynamic alterations following central retinal vein occlusion (CRVO) resulting in secondary arterial hypoperfusion, shared thromboembolic risk factors, inflammatory vasculopathy, hypercoagulable states, and mechanical compression of retinal vessels at the level of the lamina cribrosa [4,5]. The severity and duration of retinal ischaemia, together with the timing of intervention, are considered the principal determinants of anatomical and visual outcomes.

Combined retinal vascular occlusion is frequently associated with systemic disorders such as hypertension, diabetes mellitus, dyslipidaemia, carotid artery disease, autoimmune disorders, and inherited or acquired thrombophilic conditions [6–8]. Accordingly, comprehensive systemic evaluation is essential to identify potentially modifiable risk factors and reduce the likelihood of future ocular, cerebrovascular, and cardiovascular events. Optimal patient care therefore requires close collaboration among ophthalmologists, physicians, neurologists, cardiologists, and other relevant specialists.

Contemporary multimodal retinal imaging plays a pivotal role in the diagnosis and management of retinal vascular occlusive disorders. Fluorescein angiography (FA) provides detailed assessment of retinal perfusion, arterial filling, venous circulation, and areas of capillary non-perfusion, whereas optical coherence tomography (OCT) enables high-resolution evaluation of retinal architecture, inner retinal ischaemic changes, macular oedema, and treatment response [9–11]. The complementary information obtained from these imaging modalities facilitates accurate diagnosis, guides individualized treatment, and enables objective monitoring during follow-up.

Although isolated central retinal artery occlusion (CRAO), branch retinal artery occlusion (BRAO), central retinal vein occlusion (CRVO), and branch retinal vein occlusion (BRVO) are well-recognized retinal vascular disorders, reports describing their combined occurrence remain limited, particularly in South Asia. Furthermore, the increasing prevalence of diabetes mellitus, hypertension, dyslipidaemia, and other vascular risk factors in the region underscores the importance of documenting these uncommon clinical presentations and their management.

In this case series, we describe three cases of CRAVO managed at a tertiary eye hospital in Bangladesh. We present their clinical characteristics, multimodal imaging findings, associated systemic risk factors, management strategies, and short-term outcomes to improve recognition of this uncommon condition and contribute to the growing body of evidence regarding its diagnosis and management.

2. Materials and Methods

Study Design and Setting

This descriptive case series was conducted at the Department of Vitreo-Retina, Ispahani Islamia Eye Institute & Hospital (IIEI&H), Dhaka, Bangladesh. Three consecutive cases of combined retinal artery and vein occlusion (CRAVO) diagnosed between January 2025 and January 2026 were included.

Ophthalmic Evaluation

The diagnosis of CRAVO was established on the basis of comprehensive clinical examination supported by multimodal retinal imaging. All cases underwent measurement of best-corrected visual acuity (BCVA) using a Snellen visual acuity chart, slit-lamp biomicroscopy of the anterior segment, intraocular pressure (IOP) measurement by Goldmann applanation tonometry, assessment for a relative afferent pupillary defect (RAPD), and dilated fundus examination using slit-lamp biomicroscopy with a non-contact fundus lens.

Colour fundus photography, fluorescein angiography (FA), and optical coherence tomography (OCT) were performed in all cases to assess retinal perfusion, vascular abnormalities, retinal morphology, macular involvement, and the extent of retinal ischaemia. Automated visual field testing was undertaken when clinically indicated.

Systemic Evaluation

A comprehensive systemic evaluation was performed in all cases to identify potential cardiovascular and metabolic risk factors associated with retinal vascular occlusion. Investigations included measurement of blood pressure, complete blood count, fasting blood glucose, glycated haemoglobin (HbA1c), where appropriate, serum lipid profile, carotid Doppler ultrasonography, electrocardiography, and echocardiography. Additional laboratory investigations and neuroimaging were requested whenever clinically indicated to exclude inflammatory, autoimmune, thromboembolic, or hypercoagulable disorders. Consultation with physicians, neurologists, cardiologists, and other relevant specialists was arranged according to the clinical findings.

Management

Management was individualized according to the type of retinal vascular occlusion, multimodal imaging findings, presenting visual status, and associated systemic conditions. Depending on the clinical presentation, treatment included conservative medical therapy, intravitreal anti-vascular endothelial growth factor (anti-VEGF) injection, retinal laser photocoagulation, or a combination of these modalities. Systemic vascular risk factors were managed concurrently through a multidisciplinary approach.

Follow-up and Outcome Measures

Cases were followed to evaluate changes in BCVA, retinal morphology on OCT, retinal perfusion on FA, resolution of macular oedema, and the occurrence of ocular complications, including retinal neovascularization, iris neovascularization, and neovascular glaucoma.

Because of the descriptive nature of the study and the limited number of cases, no formal statistical analysis was undertaken. Clinical findings are presented descriptively, with emphasis on clinical presentation, multimodal imaging characteristics, management strategies, and short-term outcomes.

Ethical Considerations

According to the Research Policy of Ispahani Islamia Eye Institute & Hospital (IIEI&H), case reports and case series describing routine clinical practice are exempt from prior approval by the Institutional Review Board (IRB). The study was conducted in accordance with the tenets of the Declaration of Helsinki. Written informed consent for publication of anonymized clinical information and retinal images was obtained from all participants before preparation of the manuscript.

3. Results

Clinical Findings

Three consecutive cases were included in this case series. The cases comprised two females and one male, aged 18–50 years. Although all presented with unilateral visual symptoms, the pattern of retinal vascular involvement, associated systemic conditions, management strategies, and clinical outcomes varied among the cases. A comparative summary of the clinical characteristics is presented in Table 1.

Table 1. Clinical characteristics, management, and outcomes of the three Cases.

Variable	Case 1	Case 2	Case 3
Age (years)	25	18	50
Sex	Female	Male	Female
Affected eye	Left	Left	Left
Diagnosis	CRVO + CRAO	CRVO + Cilioretinal artery occlusion	BRVO + BRAO
Presenting BCVA	3/36	20/20	20/125
Major retinal findings	Retinal whitening, cherry-red spot, venous tortuosity	Retinal whitening, optic disc oedema, venous tortuosity	Retinal haemorrhages, cotton-wool spots, macular oedema
Principal systemic associations	Migraine	Hyperlipidaemia	Diabetes mellitus, hypertension, dyslipidaemia, carotid atherosclerosis
Treatment	Conservative medical management	Conservative medical management	Intravitreal aflibercept + sectoral laser photocoagulation
Clinical outcome	Stable vision	Stable vision	Anatomical and functional improvement

Abbreviations: Anti-VEGF, anti-vascular endothelial growth factor; BCVA, best-corrected visual acuity; BRAO, branch retinal artery occlusion; BRVO, branch retinal vein occlusion; CRAO, central retinal artery occlusion; CRVO, central retinal vein occlusion; FA, fluorescein angiography; OCT, optical coherence tomography.

Case 1

A 25-year-old female presented with sudden, painless diminution of vision in the left eye one week after the onset of a severe migraine attack. Her presenting best-corrected visual acuity (BCVA) was 3/36 in the affected eye. Anterior segment examination was unremarkable, and intraocular pressure (IOP) was within normal limits.

Fundus examination revealed diffuse retinal whitening involving the posterior pole, a prominent cherry-red spot at the macula, marked retinal venous dilatation and tortuosity, and scattered retinal haemorrhages (Figure 1). Fluorescein angiography (FA) demonstrated delayed retinal arterial filling together with prolonged venous circulation, confirming combined central retinal artery occlusion (CRAO) and central retinal vein occlusion (CRVO). Optical coherence tomography (OCT) revealed diffuse thickening and hyperreflectivity of the inner retinal layers, consistent with acute retinal ischaemia (Figure 2).

Comprehensive systemic evaluation, including neurological assessment, revealed no evidence of acute cerebrovascular disease. Migraine was considered the principal associated systemic condition. The case was managed conservatively with antiplatelet therapy and close ophthalmic follow-up. Visual acuity remained stable during follow-up; however, no significant functional improvement was observed.

Figure 1. Colour fundus photograph of Case 1 demonstrating diffuse retinal whitening, a cherry-red spot at the macula, and marked retinal venous dilatation and tortuosity, consistent with combined central retinal artery and central retinal vein occlusion. (Image courtesy of Bangladesh Eye Hospital, Dhaka, reproduced with permission)

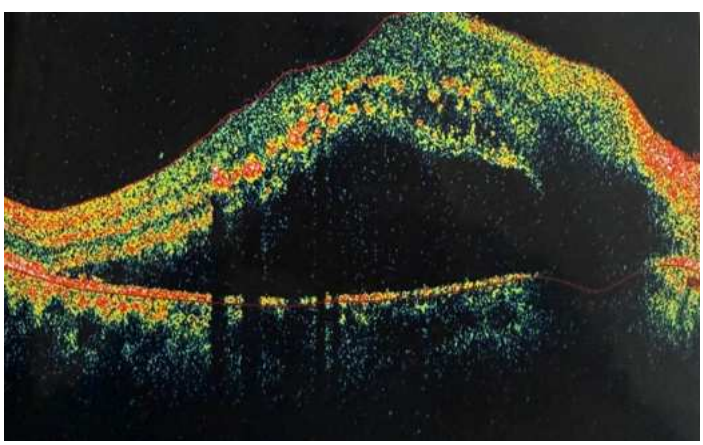

Figure 2. Optical coherence tomography of Case 1 demonstrating diffuse thickening and hyperreflectivity of the inner retinal layers, consistent with acute retinal ischaemia secondary to central retinal artery occlusion.

Case 2

An 18-year-old male presented with recurrent episodes of blurred vision and ocular discomfort in the left eye. His presenting BCVA was 20/20, although impaired colour vision and a positive relative afferent pupillary defect (RAPD) were noted.

Fundus examination revealed diffuse retinal venous tortuosity, optic disc oedema, and retinal whitening confined to the distribution of the cilioretinal artery (Figure 3). Fluorescein angiography confirmed delayed filling of the cilioretinal artery together with impaired retinal venous circulation, consistent with combined CRVO and cilioretinal artery occlusion (Figure 4). Optical coherence tomography demonstrated localized inner retinal oedema and hyperreflectivity corresponding to the affected vascular territory.

Comprehensive systemic evaluation excluded cerebrovascular disease and inherited thrombophilic disorders. Hyperlipidaemia was identified, and antinuclear antibody testing was positive; however, no underlying systemic autoimmune disease was diagnosed. The case was managed conservatively with antiplatelet therapy and regular follow-up. Visual function remained stable throughout the follow-up period without further deterioration.

Figure 3. Colour fundus photograph of Case 2 demonstrating retinal whitening within the distribution of the cilioretinal artery, optic disc oedema, and diffuse retinal venous tortuosity.

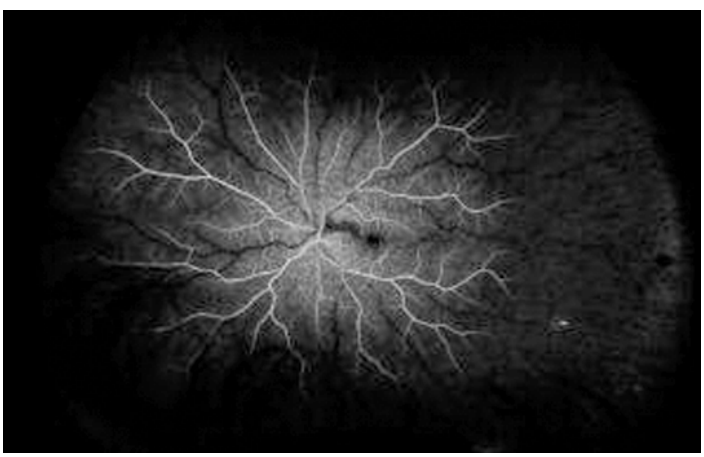

Figure 4. Fluorescein angiography (FA) of Case 2 demonstrating delayed filling of the cilioretinal artery together with impaired retinal venous circulation, confirming combined central retinal vein occlusion and cilioretinal artery occlusion.

Case 3

A 50-year-old female presented with progressive blurring of vision in the left eye over three months. Her presenting BCVA was 20/125.

Fundus examination revealed flame-shaped and blot retinal haemorrhages, cotton-wool spots, hard exudates, and cystoid macular oedema involving the superotemporal retinal arcade (Figure 5). Fluorescein angiography demonstrated delayed arterial filling, prolonged venous circulation, and extensive capillary non-perfusion, confirming combined branch retinal vein occlusion (BRVO) and branch retinal artery occlusion (BRAO). Optical coherence tomography demonstrated inner retinal hyperreflectivity with cystoid macular oedema and a central macular thickness of 302 µm.

Systemic evaluation identified multiple vascular risk factors, including poorly controlled diabetes mellitus, hypertension, dyslipidaemia, and carotid atherosclerotic disease. The case was treated with an intravitreal aflibercept injection followed by angiography-guided sectoral retinal laser photocoagulation, together with optimization of systemic medical therapy. At the three-month follow-up, BCVA improved, central macular thickness decreased from 302 µm to 180 µm, and intraretinal fluid had completely resolved on OCT.

Comparative Clinical Findings

Despite differences in age, systemic associations, and the anatomical pattern of retinal vascular involvement, all three cases shared characteristic multimodal imaging features of combined retinal artery and vein occlusion. Common findings included retinal whitening, retinal venous dilatation and tortuosity, delayed retinal vascular filling on FA, and varying degrees of inner retinal hyperreflectivity with macular oedema on OCT.

Comprehensive systemic evaluation identified one or more vascular risk factors in each case, emphasizing the importance of multidisciplinary assessment in this uncommon retinal vascular disorder.

Management was individualized according to the type of vascular occlusion, retinal imaging findings, presenting visual status, and associated systemic disease. Two cases were managed conservatively following systemic evaluation, whereas one case with significant cystoid macular oedema underwent intravitreal anti-vascular endothelial growth

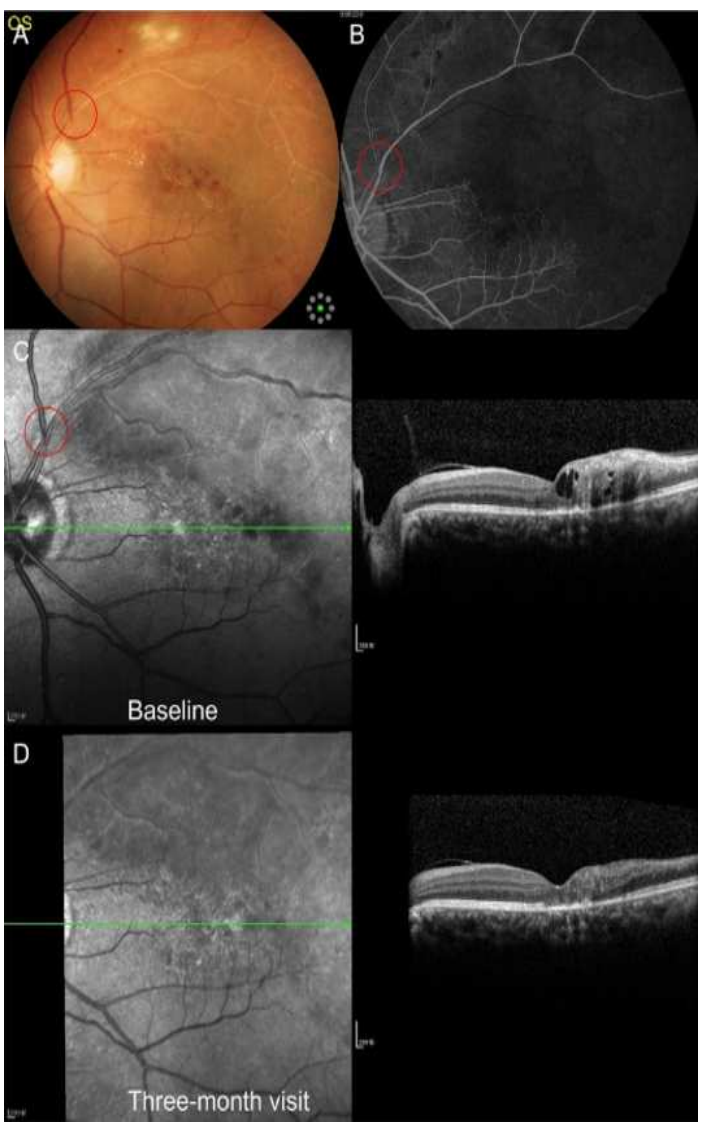

Figure 5. Multimodal imaging of Case 3 before and after treatment. Colour fundus photography, fluorescein angiography, and optical coherence tomography demonstrate combined branch retinal artery and branch retinal vein occlusion with cystoid macular oedema and subsequent anatomical improvement following intravitreal aflibercept therapy and angiography-guided sectoral retinal laser photocoagulation.

factor (anti-VEGF) therapy followed by angiography-guided sectoral retinal laser photocoagulation.

Anatomical improvement was observed in all three cases. However, functional visual recovery varied according to the severity of retinal ischaemia, the vascular territory involved, and the interval between symptom onset and treatment. No case developed retinal neovascularization, iris neovascularization, or neovascular glaucoma during the follow-up period.

4. Discussion

Combined retinal artery and vein occlusion (CRAVO) is an uncommon but vision-threatening retinal vascular disorder characterized by simultaneous obstruction of the retinal arterial inflow and venous outflow. Compared with isolated retinal artery or retinal vein occlusion, CRAVO is associated with more extensive retinal ischaemia, resulting in poorer visual outcomes and an increased risk of irreversible visual loss and other sight-threatening complications [1–5]. Owing to its rarity, current evidence is derived primarily from isolated case reports and small case series.

The present case series illustrates the heterogeneous clinical spectrum of CRAVO. Although all three cases presented with unilateral visual symptoms, they demonstrated distinct patterns of vascular involvement, including combined central retinal artery occlusion (CRAO) and central retinal vein occlusion (CRVO), CRVO with cilioretinal artery occlusion, and combined branch retinal artery occlusion (BRAO) and branch retinal vein occlusion (BRVO). These observations support previous reports suggesting that CRAVO represents a spectrum of retinal vascular disorders rather than a single clinicopathological entity, with the clinical presentation influenced by the location and extent of vascular compromise [2–4].

Multimodal imaging played a pivotal role in establishing the diagnosis and guiding management in all cases. Colour fundus photography demonstrated the characteristic coexistence of retinal whitening and venous congestion, while fluorescein angiography (FA) identified delayed arterial filling, prolonged venous circulation, and areas of retinal capillary non-perfusion. Optical coherence tomography (OCT) provided detailed assessment of inner retinal ischaemic changes and macular oedema, enabling objective evaluation of disease severity and treatment response. These findings are consistent with previous reports highlighting the complementary roles of FA and OCT in the assessment of retinal vascular occlusive disorders [9–11].

Comprehensive systemic evaluation identified one or more vascular risk factors in each case, including migraine, hyperlipidaemia, diabetes mellitus, hypertension, dyslipidaemia, and carotid atherosclerotic disease. These findings reinforce the concept that retinal vascular occlusion may represent an ocular manifestation of underlying systemic vascular pathology [6–8]. Accordingly, comprehensive medical assessment is essential not only to identify modifiable risk factors but also to reduce the risk of subsequent cerebrovascular and cardiovascular events. Close collaboration among ophthalmologists, physicians, neurologists, cardiologists, and other relevant specialists is therefore fundamental to optimizing patient outcomes.

Management of CRAVO remains challenging because robust evidence-based treatment guidelines are lacking. Therapeutic strategies should be individualized according to the pattern of vascular occlusion, severity of retinal ischaemia, presence of macular oedema, and associated systemic disease. In the present series, conservative medical management was appropriate for two cases, whereas one case with significant cystoid macular oedema underwent intravitreal aflibercept injection followed by angiography-guided sectoral retinal laser photocoagulation. This approach resulted in complete resolution of intraretinal fluid, reduction in central macular thickness, and improvement in visual acuity, findings that are consistent with published evidence supporting anti-vascular endothelial growth factor (anti-VEGF) therapy for macular oedema secondary to retinal vein occlusion [12–15]. Although anti-VEGF therapy cannot reverse retinal arterial ischaemia, it remains an important adjunctive treatment in selected cases with concurrent venous involvement and macular oedema.

Visual outcomes varied among the three cases. The two cases with central retinal arterial involvement experienced limited functional recovery despite anatomical stabilization, whereas the case with branch retinal vascular occlusion achieved both anatomical and functional improvement following treatment. These observations are consistent with previous studies demonstrating that the extent of retinal ischaemia, duration of vascular occlusion, and timeliness of intervention are the principal determinants of visual prognosis [10,13–15]. Early recognition, prompt referral, and timely management therefore remain essential to maximize visual outcomes.

None of the cases developed retinal neovascularization, iris neovascularization, or neovascular glaucoma during the follow-up period. Nevertheless, eyes with extensive retinal ischaemia remain at risk of delayed neovascular complications. Careful long-term surveillance using serial clinical examinations and multimodal imaging is therefore recommended to facilitate early detection and timely intervention should neovascularization develop.

5. Conclusion

Combined retinal artery and vein occlusion (CRAVO) is a rare but potentially devastating retinal vascular disorder associated with extensive retinal ischaemia and variable visual outcomes. This case series demonstrates the diverse clinical presentations, multimodal imaging characteristics, and systemic associations encountered in cases managed at a tertiary eye hospital in Bangladesh.

Multimodal imaging, particularly fluorescein angiography (FA) and optical coherence tomography (OCT), plays a pivotal role in establishing the diagnosis, determining the extent of retinal ischaemia, guiding treatment decisions, and monitoring therapeutic response. Equally, a comprehensive systemic evaluation to identify underlying cardiovascular and metabolic risk factors that may influence both ocular and systemic prognosis.

Individualized management, including optimization of systemic risk factors together with intravitreal anti-vascular endothelial growth factor (anti-VEGF) therapy and retinal laser photocoagulation when indicated, may achieve favourable anatomical outcomes. Nevertheless, visual prognosis remains largely dependent on the severity and extent of retinal ischaemia, the vascular territory involved, and the timeliness of intervention. Larger multicentre studies with longer follow-up are required to better define prognostic factors and establish evidence-based management strategies for this uncommon retinal vascular disorder.

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Author Contributions

Nazmus Sakeb conceived the study, managed the cases, interpreted the clinical findings, and prepared the initial manuscript. Md. Mostafizur Rahman, Md. Mominul Islam, and Omar Jafarullah contributed to patient management, interpretation of retinal imaging, and critical revision of the manuscript. M. M. Aeorangajeb Al Hossain contributed to the study design, scientific writing, interpretation of the findings, editorial revision, and overall coordination of manuscript development. Mohammad Shamsal Islam contributed to data organization, literature review, methodological support, and manuscript revision. All authors critically reviewed the manuscript, approved the final version, and agree to be accountable for all aspects of the work.

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Conflict of Interest

The authors declare that they have no competing interests.

Data Availability Statement

All data generated or analysed during this study are included in this published article. Additional information may be obtained from the corresponding author upon reasonable request.

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Outcomes of Therapeutic Penetrating Keratoplasty in the Management of Infectious Corneal Ulcers: A Narrative Review

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REVIEW ARTICLE

Keywords:
Therapeutic penetrating keratoplasty
Infectious keratitis
Corneal ulcer
Corneal transplantation
Graft survival
Visual rehabilitation

ABSTRACT

Background
Infectious keratitis is a major cause of corneal blindness worldwide and remains an ophthalmic emergency because of its potential to progress to stromal melting, descemetocele formation, corneal perforation, and irreversible visual loss. Although most cases respond to intensive antimicrobial therapy, advanced disease frequently requires therapeutic penetrating keratoplasty (TPK) to eradicate infection and preserve globe integrity. This review summarizes the current evidence regarding the indications, outcomes, prognostic factors, postoperative complications, and future perspectives of TPK in the management of infectious corneal ulcers.

Methods
A narrative review of English-language literature published between January 2010 and January 2024 was conducted using PubMed/MEDLINE, Scopus, Web of Science, Google Scholar, and the Cochrane Library. Studies evaluating clinical outcomes of TPK for infectious keratitis were critically reviewed and synthesized according to indications for surgery, anatomical and therapeutic outcomes, visual rehabilitation, postoperative complications, prognostic factors, and emerging advances.

Results
Current evidence supports TPK as the definitive surgical option for advanced infectious keratitis unresponsive to medical therapy. The principal indications include refractory microbial keratitis, progressive stromal melting, descemetocele formation, and corneal perforation. Published studies consistently demonstrate high rates of globe preservation and infection control; however, visual outcomes vary according to microbial aetiology, disease severity, surgical timing, donor tissue quality, and postoperative complications. Graft rejection, graft failure, recurrent infection, secondary glaucoma, cataract, and persistent epithelial defects remain the major factors limiting long-term graft survival and visual rehabilitation.

Conclusion
TPK remains an indispensable globe-preserving procedure for severe infectious corneal ulcers. Early diagnosis, timely surgical intervention, meticulous operative technique, appropriate antimicrobial therapy, and structured postoperative care are essential for favourable outcomes. Future advances in microbiological diagnostics, corneal imaging, eye banking, and regenerative medicine are expected to further improve graft survival and visual rehabilitation.

1. Introduction

Infectious keratitis is one of the leading causes of corneal blindness worldwide and represents a major public health challenge, particularly in low- and middle-income countries where delayed presentation, limited access to specialised eye care, and inadequate microbiological diagnostic facilities contribute to poor clinical outcomes. The condition is characterized by microbial invasion of the corneal stroma, resulting in inflammation, stromal necrosis, tissue destruction, and, if left untreated, corneal perforation, endophthalmitis, or permanent visual impairment. Bacteria, fungi, viruses, and protozoa are the principal causative pathogens, with their distribution varying according to geographical region, climate, occupation, and host-related risk factors [1–4].

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The primary objective in the management of infectious keratitis is rapid eradication of the causative organism while preserving corneal integrity and visual function. Early diagnosis, microbiological identification, and prompt initiation of targeted antimicrobial therapy remain the cornerstones of treatment. Although most cases respond favourably to intensive medical management, a substantial proportion progress despite appropriate therapy because of virulent organisms, delayed presentation, antimicrobial resistance, or impaired host immunity. Such cases frequently develop progressive stromal melting, descemetocele formation, or corneal perforation, necessitating urgent surgical intervention [5–8].

Therapeutic penetrating keratoplasty (TPK) is the definitive surgical procedure for severe infectious keratitis when medical treatment fails or when structural integrity of the globe is threatened. Unlike optical penetrating keratoplasty, which is performed primarily for visual rehabilitation, the principal objectives of TPK are complete excision of infected corneal tissue, eradication of the infective focus, restoration of globe integrity, and prevention of intraocular extension of infection. Successful infection control may subsequently permit secondary procedures aimed at visual rehabilitation [9–11].

Despite its vision-saving role, TPK remains a technically demanding procedure with variable anatomical and functional outcomes. Prognosis is influenced by several factors, including the causative microorganism, extent and location of corneal involvement, timing of surgical intervention, donor tissue quality, postoperative antimicrobial therapy, and the occurrence of complications such as recurrent infection, graft rejection, graft failure, glaucoma, cataract, and persistent epithelial defects. Although anatomical success is generally satisfactory, long-term graft survival and visual recovery remain challenging, particularly in eyes with extensive infection or delayed referral [12–16].

Recent advances in corneal imaging, microbiological diagnostics, molecular techniques, antimicrobial therapy, eye banking, and regenerative medicine have expanded the therapeutic options for severe infectious keratitis and may improve the outcomes of TPK. Emerging technologies, including anterior segment optical coherence tomography, next-generation sequencing, and artificial intelligence-assisted diagnostic systems, have shown promise in facilitating earlier diagnosis, improving pathogen identification, and supporting individualized treatment strategies [17–21].

This narrative review critically appraises the current evidence on the role of TPK in the management of infectious corneal ulcers. It summarizes the indications for surgery, anatomical, therapeutic, and visual outcomes, postoperative complications, prognostic factors, and recent advances, with the aim of providing clinicians with an evidence-based overview to support clinical decision-making and optimize patient care.

2. Methods

Literature Search Strategy

This narrative review was conducted to summarize the contemporary evidence regarding the role of TPK in the management of infectious corneal ulcers. A structured literature search was performed using PubMed/MEDLINE, Scopus, Web of Science, Google Scholar, and the Cochrane Library to identify relevant publications published between January 2010 and January 2024 (Figure 1).

The search strategy combined Medical Subject Headings (MeSH) and free-text terms, including "therapeutic penetrating keratoplasty," "infectious keratitis," "microbial keratitis," "corneal ulcer," "corneal perforation," "corneal transplantation," "graft survival," and "visual outcome." Boolean operators ("AND" and "OR") were used to optimize the search, and the reference lists of eligible articles were manually screened to identify additional relevant studies [17–19].

Study Selection

English-language publications evaluating the clinical outcomes of TPK for infectious keratitis were considered eligible. Original research articles, prospective and retrospective observational studies, randomized controlled trials, systematic reviews, meta-analyses, and high-quality narrative reviews were included. Preference was given to studies with adequate sample sizes, clearly defined outcome measures, and clinically relevant follow-up.

Studies focusing exclusively on optical penetrating keratoplasty, endothelial keratoplasty, keratoconus, corneal dystrophies, or other non-infectious corneal disorders were excluded. Editorials, conference abstracts, letters to the editor, duplicate publications, and studies lacking sufficient clinical outcome data were also excluded.

Evidence Synthesis

The selected literature was critically appraised and synthesized narratively. Evidence was organized into clinically relevant themes, including the burden of infectious keratitis, indications for TPK, anatomical and therapeutic outcomes, visual rehabilitation, postoperative complications, prognostic factors, and emerging surgical strategies. Owing to the heterogeneity of study populations, microbial aetiologies, surgical techniques, outcome measures, and follow-up durations, quantitative meta-analysis was not undertaken. Instead, the findings were integrated into an evidence-based narrative to provide a practical overview of contemporary clinical practice

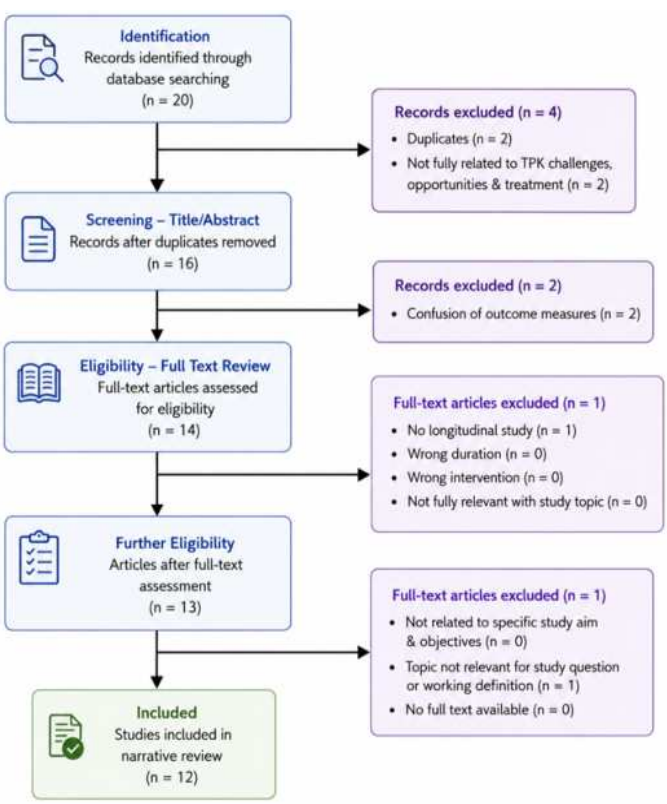

Figure 1. . Literature search and study selection process.

3. Current Evidence on TPK

Burden of Infectious Keratitis

Infectious keratitis remains a leading cause of corneal blindness worldwide and continues to pose a significant public health challenge, particularly in low and middle-income countries where delayed presentation and limited access to specialised ophthalmic care contribute to poor outcomes [1–4]. Corneal infection may progress rapidly from epithelial involvement to stromal inflammation, tissue necrosis, descemetocele formation, corneal perforation, endophthalmitis, and irreversible visual loss if appropriate treatment is delayed [2,3].

The epidemiology of infectious keratitis varies considerably according to geographic region, climate, socioeconomic status, and healthcare accessibility. Bacterial keratitis predominates in high-income countries and is strongly associated with contact lens wear, ocular surface disease, and previous ocular surgery. In contrast, fungal keratitis is more prevalent in tropical and subtropical regions, where ocular trauma involving vegetative matter is a major predisposing factor. Other important pathogens include Acanthamoeba spp. and herpes simplex virus, both of which may cause severe or recurrent corneal infection requiring prolonged treatment and, in selected cases, surgical intervention [5–8].

Several local and systemic factors increase susceptibility to infectious keratitis, including ocular trauma, contact lens misuse, chronic ocular surface disorders, previous corneal transplantation, prolonged topical corticosteroid use, diabetes mellitus, immunosuppression, and malnutrition [6,9,10]. These factors not only increase the risk of infection but also influence disease severity, response to antimicrobial therapy, and the likelihood of requiring surgical management (Table 1).

Although intensive medical therapy successfully controls most cases, approximately 10–30% of severe infections progress despite appropriate treatment, particularly those caused by fungal organisms or highly virulent bacteria [9–12]. Progressive stromal necrosis, descemetocele formation, and corneal perforation threaten globe integrity and remain the principal indications for emergency therapeutic keratoplasty. Early recognition of treatment failure and timely referral to specialised corneal centres are therefore essential to improve anatomical preservation and long-term visual outcomes [11–15].

In South Asia, including Bangladesh, fungal keratitis represents a substantial proportion of severe corneal ulcers because of the high frequency of agricultural ocular trauma, delayed presentation, and limited availability of specialised corneal services and donor tissue [5,6,15]. Strengthening microbiological diagnostic capacity, expanding eye banking services, improving public awareness, and establishing effective referral pathways remain important strategies for reducing the burden of corneal blindness in resource-limited settings (Figure 2).

Table 1. Major risk factors for Infectious Keratitis.

Category	Examples
Ocular trauma	Agricultural injury, foreign body, vegetative matter
Contact lens-related	Poor lens hygiene, overnight wear
Ocular surface disease	Dry eye disease, neurotrophic keratopathy, exposure keratopathy
Previous ocular surgery	Cataract surgery, corneal transplantation, refractive surgery
Medication-related	Prolonged topical corticosteroid use
Systemic conditions	Diabetes mellitus, malnutrition, immunosuppression

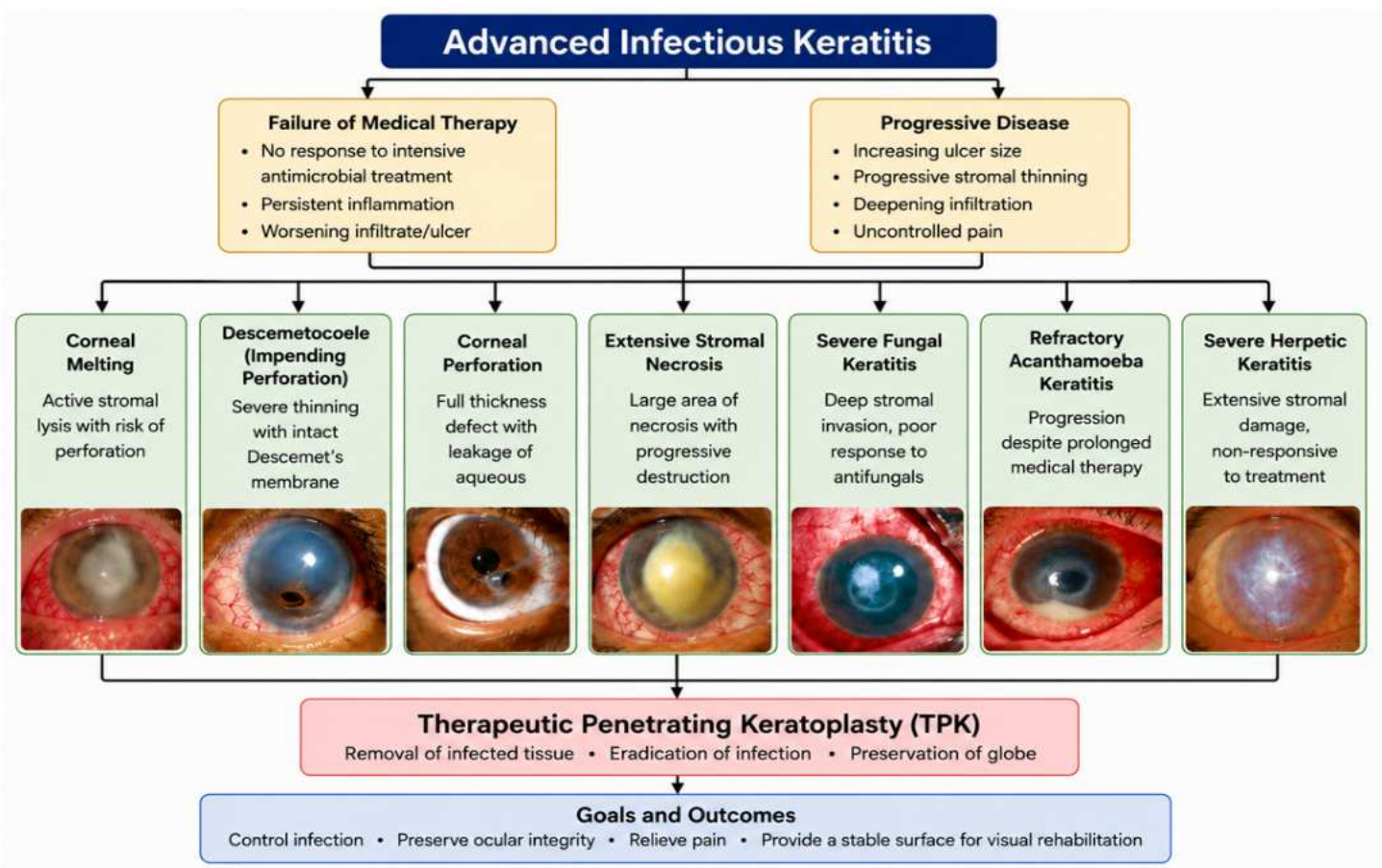

Figure 2. Pathogenesis and progression of Infectious Keratitis leading to TPK.

Indications for TPK

TPK is indicated when infectious keratitis progresses despite appropriate antimicrobial therapy or when corneal integrity is threatened. The primary objectives of the procedure are eradication of the infective focus, preservation of globe integrity, prevention of intraocular extension of infection, and creation of a stable ocular surface for subsequent visual rehabilitation [11–15].

The most common indication is refractory infectious keratitis, in which progressive stromal infiltration or enlargement of the corneal ulcer occurs despite intensive medical treatment. Persistent microbial proliferation, increasing stromal necrosis, or failure to respond to targeted antimicrobial agents often necessitates surgical excision of the infected corneal tissue to achieve infection control [12,16,17] and (Table 2).

Impending or established corneal perforation is another major indication. Progressive stromal melting may lead to descemetocele formation and eventual perforation, resulting in aqueous leakage, anterior chamber collapse, and an increased risk of endophthalmitis. In these situations, urgent keratoplasty is required to restore structural integrity of the globe and preserve the eye [13,18].

The procedure is also recommended for deep stromal abscesses or infections involving the posterior cornea that are unlikely to respond adequately to medical therapy because of limited drug penetration. Similarly, persistent fungal keratitis, particularly infections caused by filamentous fungi, frequently requires early surgical intervention owing to extensive stromal invasion and poor response to antifungal agents [5,14,19].

In selected cases, TPK may be indicated for recurrent or progressive infection after previous corneal surgery, severe polymicrobial keratitis, or microbial keratitis associated with significant ocular surface disease. Clinical decision-making should consider the causative organism, rate of disease progression, ulcer size and location, depth of stromal involvement, anterior chamber inflammation, and the patient's overall ocular and systemic condition [9,15,20].

The timing of surgery remains a critical determinant of outcome. Delaying intervention until advanced tissue destruction has occurred may reduce graft survival and increase the risk of postoperative complications. Conversely, premature surgery before adequate antimicrobial therapy may increase the likelihood of persistent or recurrent infection. Current evidence therefore supports timely intervention once there is clear evidence of treatment failure or an imminent threat to globe integrity [14,18,21].

Although TPK is performed primarily to eradicate infection and preserve the globe rather than to improve vision, successful infection control provides the foundation for subsequent visual rehabilitation through secondary optical keratoplasty when clinically appropriate [11,15,21] and (Figure 3).

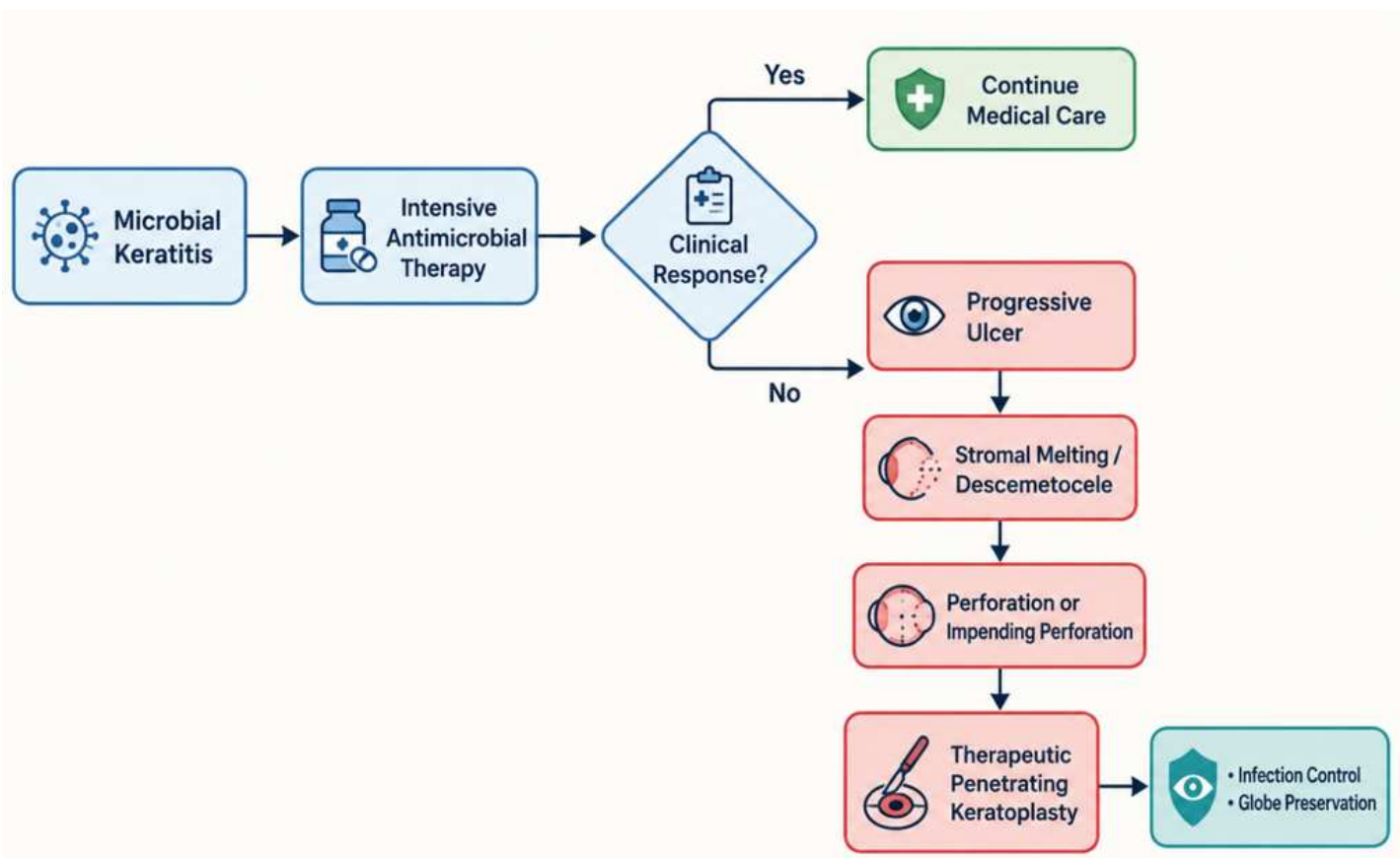

Figure 3. Clinical decision pathway for TPK.

Table 2. Common Indications for TPK.

Indication	Clinical Significance
Refractory infectious keratitis	Failure of intensive antimicrobial therapy
Progressive corneal ulcer	Increasing stromal infiltration or ulcer size despite treatment
Corneal perforation	Emergency globe-preserving indication
Impending perforation (Descemetocele)	Severe stromal thinning with high risk of perforation
Progressive corneal melting	Ongoing stromal necrosis threatening ocular integrity
Severe fungal keratitis	Poor response to antifungal therapy and deep stromal invasion
Refractory Acanthamoeba keratitis	Progressive infection despite prolonged treatment
Severe herpetic keratitis	Extensive stromal destruction with failure of medical therapy

Anatomical Outcomes of TPK

The primary objective of TPK is preservation of globe integrity through complete excision of infected corneal tissue and restoration of corneal tectonic stability. Unlike optical penetrating keratoplasty, where visual improvement is the principal goal, the immediate success of TPK is determined by anatomical preservation of the eye, eradication of the infective focus, and prevention of further ocular destruction [12–15].

Published studies consistently report favourable anatomical outcomes, with globe preservation achieved in approximately 85%–98% of cases, although reported success rates vary according to microbial aetiology, disease severity, surgical timing, and duration of follow-up [13–17]. Successful anatomical outcomes are generally characterized by restoration of corneal integrity, maintenance of anterior chamber depth, resolution of corneal perforation or stromal melting, and avoidance of evisceration or enucleation.

Several factors influence anatomical success. Early surgical intervention remains one of the strongest predictors of favourable outcomes because it limits progression of infection and reduces the risk of extensive ocular damage. In contrast, delayed presentation, limbal extension of infection, large corneal perforations, severe stromal necrosis, and endophthalmitis are consistently associated with poorer anatomical outcomes [14,16,18]. Microbial aetiology also plays an important role; fungal keratitis generally demonstrates lower anatomical success than bacterial keratitis because of deeper stromal invasion, delayed diagnosis, and a greater tendency for recurrent infection [10,14,19] and (Table 3).

Surgical technique and donor tissue characteristics further influence postoperative outcomes. Complete excision of infected tissue with an adequate safety margin minimizes the risk of residual infection, while appropriate donor graft sizing facilitates secure wound closure and reconstruction of the anterior segment. High-quality donor tissue, meticulous suturing, effective anterior chamber reformation, and appropriate postoperative antimicrobial therapy all contribute to improved anatomical stability and reduced postoperative complications [15,17,20].

Although preservation of globe integrity is achieved in most cases, graft clarity should not be regarded as the primary measure of success following TPK. Because the procedure is performed in eyes with active infection and severe inflammation, postoperative graft oedema, vascularization, and corneal scarring are relatively common. These findings do not necessarily indicate treatment failure if infection has been eradicated and structural integrity has been maintained. Visual rehabilitation can often be addressed through secondary procedures after complete resolution of inflammation and stabilization of the ocular surface [16,18,21].

Overall, the available evidence supports TPK as an effective globe-preserving procedure for advanced infectious keratitis. Timely surgical intervention, complete removal of infected tissue, appropriate donor tissue selection, and meticulous postoperative care remain the principal determinants of favourable anatomical outcomes (Figure 4).

Table 3. Factors Influencing Anatomical Outcomes After TPK.

Factor	Influence on anatomical outcome
Early surgical intervention	Improves globe preservation and infection control
Delayed surgery	Associated with poorer anatomical success
Small localized ulcer	Better prognosis
Large perforation or extensive stromal involvement	Increased risk of graft failure
Fungal keratitis	Higher recurrence and lower graft survival
Adequate donor graft size	Improves complete excision of infected tissue
Good donor tissue quality	Enhances graft survival
Effective postoperative antimicrobial therapy	Reduces recurrence of infection
Careful postoperative follow-up	Facilitates early detection of complications

Figure 4. Factors influencing anatomical outcomes of TPK.

Therapeutic Outcomes of TPK

Following anatomical preservation of the globe, the principal therapeutic objective of TPK is complete eradication of active infection. Successful infection control prevents further corneal destruction, limits intraocular spread of microorganisms, and establishes a stable ocular environment for healing and subsequent visual rehabilitation. Therapeutic success is therefore defined by sustained resolution of infection without recurrence during postoperative follow-up [13–16].

Published studies consistently report high rates of infection control following TPK, with therapeutic success ranging from 80% to 95%, although outcomes vary according to microbial aetiology, disease severity, timing of surgery, and postoperative management [14–18]. Differences in reported success rates largely reflect variation in patient populations, infecting organisms, surgical indications, and duration of follow-up (Table 4).

The causative organism is one of the strongest determinants of therapeutic outcome. Bacterial keratitis generally demonstrates favourable postoperative infection control because most bacterial pathogens respond rapidly to appropriate antimicrobial therapy following surgical excision of infected tissue. In contrast, fungal keratitis, particularly infections caused by Fusarium and Aspergillus species, is associated with a higher risk of persistent or recurrent infection owing to deep stromal invasion, delayed diagnosis, and reduced penetration of antifungal agents. Similarly, Acanthamoeba keratitis may require prolonged antiamoebic therapy after surgery because residual cysts can remain within adjacent corneal tissue [10,12,19].

Successful infection eradication depends not only on the surgical procedure but also on meticulous postoperative management. Complete removal of infected tissue with an adequate safety margin reduces the likelihood of residual microorganisms at the graft–host interface, while continuation of culture-guided antimicrobial therapy after surgery is essential to minimize recurrence. Careful postoperative monitoring allows early detection of persistent inflammation or recurrent infection, enabling timely modification of treatment when required [15,17,20].

Despite favourable overall outcomes, recurrent infection remains an important cause of graft failure, particularly in fungal and protozoal keratitis. Delayed surgical intervention, incomplete excision of infected tissue, severe ocular surface disease, and poor adherence to postoperative therapy have all been associated with an increased risk of recurrence [16,18,21].

Overall, current evidence supports TPK as an effective procedure for controlling severe infectious keratitis when medical therapy fails. Therapeutic success depends on timely intervention, complete excision of infected tissue, appropriate antimicrobial therapy, and vigilant postoperative surveillance (Figure 5).

Table 4. Factors Influencing Therapeutic Outcomes Following TPK

Factor	Influence on therapeutic outcome
Early surgical intervention	Improves eradication of infection
Complete excision of infected tissue	Reduces recurrence
Adequate donor graft size	Facilitates complete removal of diseased cornea
Culture-guided antimicrobial therapy	Improves microbial eradication
Bacterial keratitis	Generally better therapeutic response
Fungal keratitis	Higher risk of recurrent infection
Acanthamoeba keratitis	May require prolonged therapy or repeat surgery
Good postoperative compliance	Improves infection control and graft survival
Regular follow-up	Facilitates early detection of recurrent infection

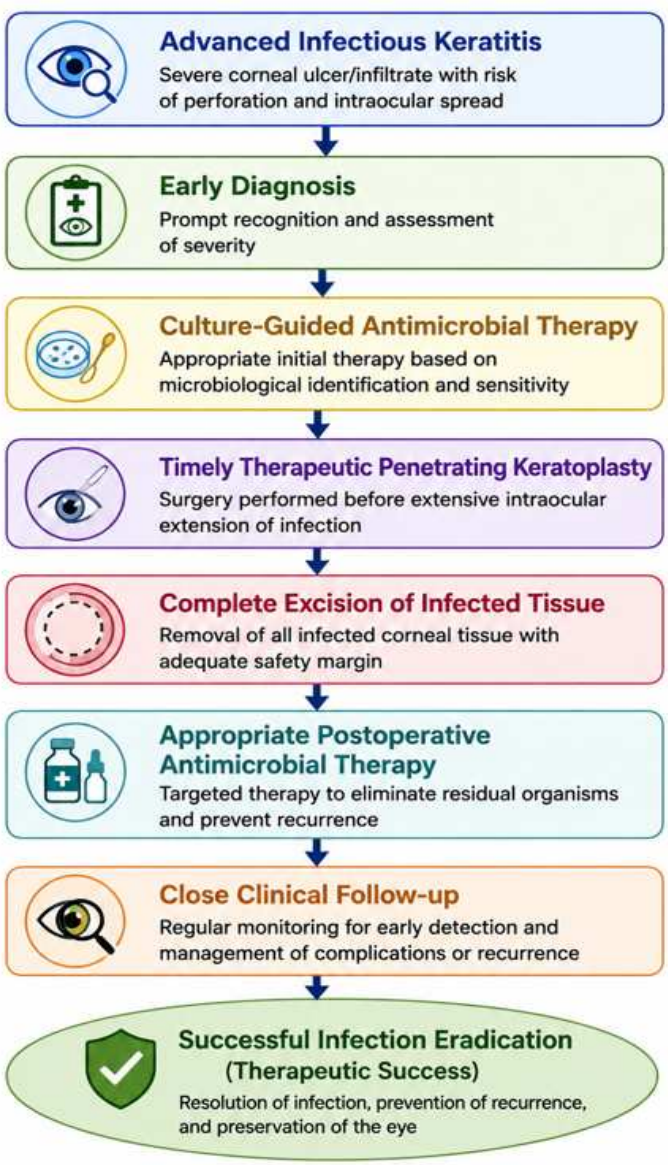

Figure 5. Factors influencing therapeutic outcomes of TPK.

Functional (Visual) Outcomes of TPK

Although TPK is primarily performed to eradicate infection and preserve globe integrity, restoration of useful vision remains an important long-term objective. Functional outcomes are generally less favourable than anatomical or therapeutic outcomes because the procedure is undertaken in eyes with severe infection, extensive corneal destruction, and marked intraocular inflammation. Consequently, postoperative visual acuity varies considerably among published studies [13–16].

Visual recovery following TPK is influenced by multiple preoperative, intraoperative, and postoperative factors. The extent and location of corneal involvement, microbial aetiology, duration of infection before surgery, and associated intraocular complications all contribute to the final visual outcome. Central corneal ulcers, large grafts, limbal involvement, and delayed surgical intervention are consistently associated with poorer visual prognosis [14,17,18].

The causative organism also plays a significant role. Eyes with bacterial keratitis generally achieve better postoperative visual outcomes than those with fungal or protozoal infections because bacterial disease typically responds more rapidly to treatment and causes less extensive stromal destruction. In contrast, fungal keratitis frequently results in deeper tissue involvement, recurrent inflammation, corneal vascularization, and postoperative scarring, all of which may limit visual rehabilitation [10,15,19].

Postoperative complications further influence functional recovery. Graft rejection, graft failure, persistent epithelial defects, secondary glaucoma, cataract formation, irregular astigmatism, and recurrent infection may all impair visual improvement despite successful infection control [16,18,20]. Appropriate postoperative management, including continued antimicrobial therapy, corticosteroid administration when indicated, suture adjustment or removal, and close clinical follow-up, is therefore essential to optimize visual outcomes (Table 5).

Visual rehabilitation should be considered a staged process rather than an immediate objective. Once infection has been eradicated and the ocular surface has stabilized, selected patients may benefit from additional interventions, including optical penetrating keratoplasty, cataract surgery, rigid gas-permeable or scleral contact lenses, and other refractive rehabilitation strategies to improve visual function [15,20,21].

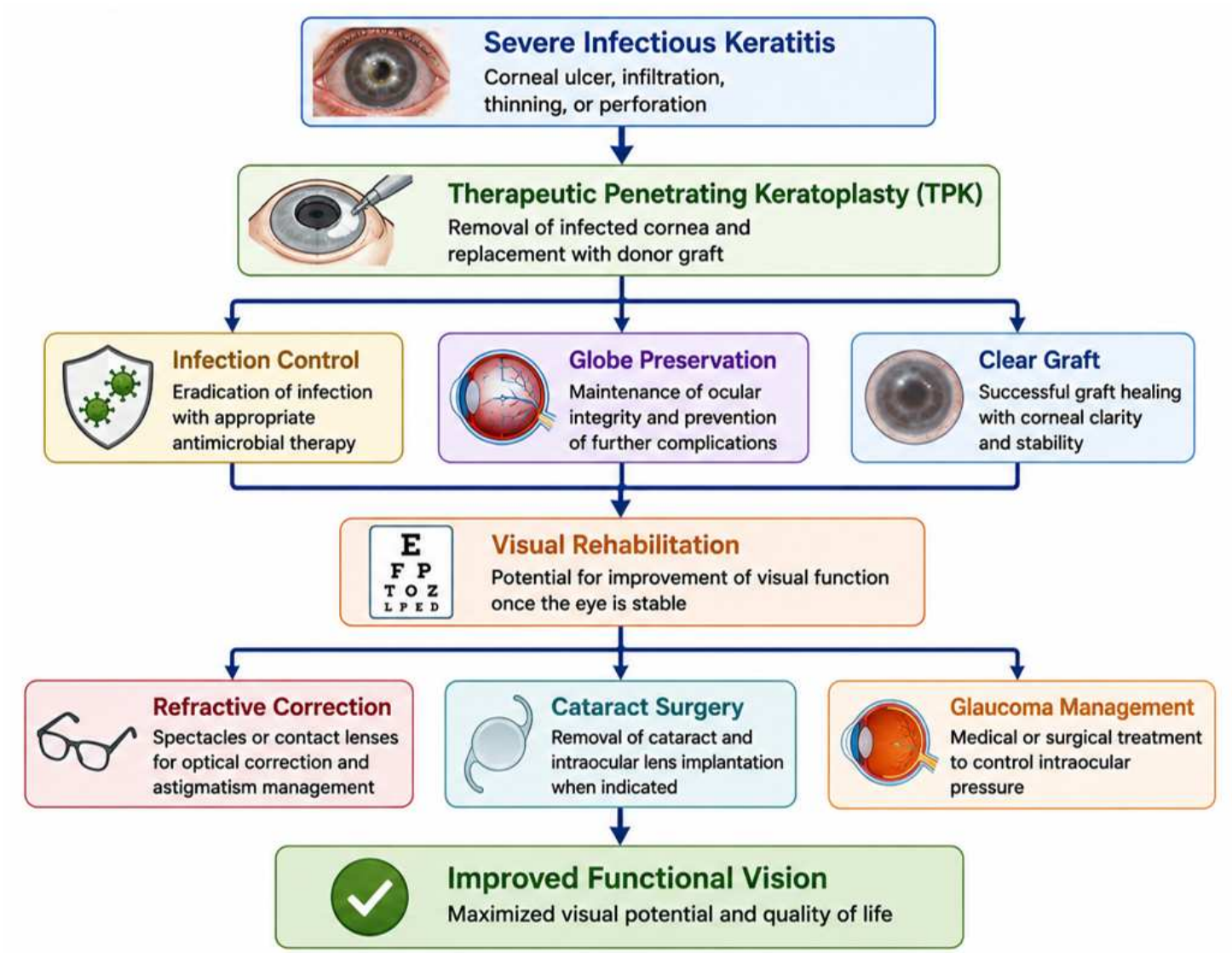

Figure 6. Factors influencing functional outcomes of TPK.

Overall, current evidence indicates that successful infection eradication and globe preservation do not necessarily translate into satisfactory visual acuity. Functional outcomes depend on disease severity at presentation, prompt surgical intervention, meticulous postoperative care, and appropriate secondary rehabilitation. Patient counselling should therefore emphasize that the principal aim of TPK is preservation of the eye, with visual recovery representing a secondary goal that may require further treatment (Figure 6).

Table 5. Factors Influencing Functional (Visual) Outcomes Following TPK.

Factor	Influence on Visual Outcome
Better preoperative visual acuity	Improved postoperative vision
Early surgical intervention	Better functional prognosis
Clear donor graft	Improved visual rehabilitation
Extensive corneal destruction	Poorer visual outcome
Endophthalmitis or posterior segment involvement	Significantly reduced visual potential
Graft rejection or graft failure	Reduced visual acuity
Postoperative glaucoma	Adversely affects optic nerve function
Cataract formation	May require secondary surgery
High postoperative astigmatism	Limits visual quality
Successful secondary optical rehabilitation	Enhances long-term vision

Postoperative Complications of TPK

Despite favourable rates of infection control and globe preservation, postoperative complications remain a major challenge following TPK and may adversely affect graft survival and visual rehabilitation. The frequency and severity of complications are influenced by the underlying microbial aetiology, severity of corneal disease, ocular surface status, surgical technique, and postoperative management [15–18].

Graft rejection is one of the most common late complications and remains a leading cause of graft failure. Eyes undergoing TPK often exhibit extensive corneal neovascularization and active inflammation, both of which increase the risk of immune-mediated graft rejection. Early recognition and prompt treatment with topical or systemic corticosteroids, after adequate control of infection, are essential to improve graft survival [17,19,20].

Graft failure may occur because of irreversible endothelial decompensation, persistent inflammation, recurrent infection, or severe ocular surface disease. Although the therapeutic objective of TPK is infection eradication rather than maintenance of graft clarity, graft failure may significantly compromise visual rehabilitation and necessitate repeat keratoplasty [14,18,21].

Recurrent infection remains a significant concern, particularly in fungal and protozoal keratitis. Residual microorganisms at the graft–host interface, incomplete excision of infected tissue, delayed diagnosis, or inadequate postoperative antimicrobial therapy may contribute to recurrence. Continued culture-guided antimicrobial treatment and close postoperative surveillance are therefore essential to minimize this risk [10,16,19].

Other important complications include persistent epithelial defects, secondary glaucoma, cataract formation, wound dehiscence, high postoperative astigmatism, and endophthalmitis. Persistent epithelial defects increase the risk of secondary infection and delayed wound healing, whereas elevated intraocular pressure may result from postoperative inflammation, corticosteroid therapy, or angle compromise. Cataract progression is particularly common in eyes with prolonged intraocular inflammation or repeated corticosteroid exposure [15,18,20].

Appropriate postoperative management plays a pivotal role in reducing complication rates. Regular follow-up, careful monitoring of graft clarity and intraocular pressure, timely suture management, prolonged antimicrobial therapy when indicated, and judicious use of corticosteroids following adequate infection control contribute substantially to favourable long-term outcomes [17,20,21].

Although postoperative complications cannot be eliminated completely, their incidence and severity can be minimized through meticulous surgical technique, individualized postoperative care, and early recognition of adverse events. A multidisciplinary approach involving corneal specialists, microbiologists, and physicians may further improve graft survival and long-term visual outcomes in patients undergoing TPK for severe infectious keratitis (Table 6).

Table 6. Major Postoperative Complications Following TPK.

Complication	Clinical significance	Management
Graft rejection	Reduced graft clarity and visual acuity	Topical/systemic corticosteroids after infection control
Graft failure	Loss of graft function	Repeat keratoplasty when indicated
Recurrent infection	Persistent or recurrent microbial keratitis	Culture-guided antimicrobial therapy
Secondary glaucoma	Optic nerve damage and graft compromise	Medical or surgical intraocular pressure control
Persistent epithelial defect	Delayed healing and increased infection risk	Lubrication, bandage contact lens, amniotic membrane transplantation
Cataract	Reduced visual acuity	Cataract extraction after ocular stabilization
High postoperative astigmatism	Poor optical quality	Spectacles, rigid gas-permeable or scleral contact lenses, selective suture removal
Suture-related complications	Infection, vascularization, irritation	Selective suture adjustment or removal

Prognostic Factors Influencing Outcomes Following TPK

The prognosis following TPK depends on multiple preoperative, intraoperative, and postoperative factors. Although the procedure is highly effective in preserving globe integrity and controlling infection, graft survival and visual rehabilitation vary considerably according to disease severity, microbial characteristics, surgical timing, and postoperative management [13–17].

The timing of surgical intervention is among the most important prognostic determinants. Early surgery before extensive stromal destruction or intraocular extension of infection is consistently associated with improved infection control, better anatomical preservation, and higher graft survival. Conversely, delayed intervention after corneal perforation, severe stromal necrosis, or endophthalmitis is associated with less favourable outcomes [14,18,19].

The causative microorganism also significantly influences prognosis. Bacterial keratitis generally has better anatomical and functional outcomes than fungal or protozoal keratitis because of more rapid response to antimicrobial therapy and less extensive stromal invasion. In contrast, fungal infections frequently demonstrate delayed diagnosis,

deeper tissue penetration, and a greater risk of recurrent infection and graft failure. Protozoal keratitis, particularly Acanthamoeba infection, may require prolonged postoperative antimicrobial therapy owing to the persistence of resistant cysts within corneal tissue [10,15,20].

The extent of corneal involvement is another key predictor of outcome. Large infiltrates, limbal extension, corneal perforation, significant anterior chamber inflammation, and associated endophthalmitis are consistently associated with poorer prognosis. Eyes requiring larger grafts generally experience lower graft survival because of increased surgical complexity and a higher risk of postoperative immune rejection [16,18,21].

Patient-related factors also influence surgical outcomes. Diabetes mellitus, immunosuppression, chronic ocular surface disease, poor tear film quality, and inadequate adherence to postoperative treatment may impair epithelial healing, increase susceptibility to recurrent infection, and reduce graft survival. Furthermore, donor tissue quality, meticulous surgical technique, and appropriate postoperative antimicrobial therapy contribute substantially to favourable long-term outcomes [15,17,20].

Close postoperative follow-up remains essential for optimizing prognosis. Early recognition of graft rejection, recurrent infection, elevated intraocular pressure, or persistent epithelial defects allows timely intervention and may substantially improve graft survival and visual outcomes. Current evidence therefore supports a multidisciplinary approach that integrates prompt diagnosis, individualized surgical planning, and structured postoperative care to maximize both anatomical and functional success following TPK (Table 7).

Table 7. Major Prognostic Factors Influencing Outcomes Following TPK.

Prognostic factor	Influence on outcome
Early surgical intervention	Improved infection control and graft survival
Delayed presentation	Poorer anatomical and visual outcomes
Bacterial keratitis	Generally favourable prognosis
Fungal or protozoal keratitis	Increased risk of recurrence and graft failure
Large corneal infiltrate or perforation	Reduced graft survival
Endophthalmitis	Poor visual and anatomical prognosis
Good donor tissue quality	Improved graft survival
Diabetes mellitus or immunosuppression	Delayed healing and increased postoperative complications
Appropriate postoperative therapy	Improved long-term outcomes
Regular follow-up	Early detection and management of complications

4. Future Perspectives and Emerging Strategies

Despite significant advances in antimicrobial therapy and corneal transplantation, the management of severe infectious keratitis remains challenging, particularly in cases presenting with extensive stromal destruction, antimicrobial resistance, or delayed referral. Recent developments in diagnostic technologies, surgical techniques, eye banking, and regenerative medicine have the potential to improve patient selection, optimize surgical outcomes, and enhance long-term graft survival following TPK [17–21].

Rapid and accurate pathogen identification remains fundamental to successful management. Conventional microbiological techniques are often time-consuming and may have limited sensitivity, particularly after prior antimicrobial treatment. Emerging molecular diagnostic methods, including polymerase chain reaction (PCR) and next-generation sequencing (NGS), enable earlier and more accurate identification of causative microorganisms, facilitating targeted antimicrobial therapy and potentially reducing disease progression before surgical intervention becomes necessary [22–25].

Advances in ophthalmic imaging have also improved the evaluation of infectious keratitis. Anterior segment optical coherence tomography (AS-OCT) allows non-invasive assessment of corneal thickness, stromal infiltration, and healing, while in vivo confocal microscopy provides high-resolution visualization of fungal hyphae and Acanthamoeba cysts. These modalities support disease monitoring, assessment of treatment response, and surgical planning [24–27].

Artificial intelligence (AI) has emerged as a promising adjunct in corneal disease management. Deep learning algorithms have demonstrated encouraging accuracy in detecting infectious keratitis, differentiating microbial aetiologies, and predicting disease severity from slit-lamp photographs and anterior segment imaging. Although these technologies remain under clinical evaluation, they may facilitate earlier diagnosis and improve referral pathways, particularly in resource-limited settings [26–29].

Progress in eye banking and tissue engineering is expected to expand the availability of donor tissue for therapeutic keratoplasty. Improved preservation techniques, lamellar graft preparation, bioengineered corneal substitutes, and cell-based regenerative therapies may provide alternative treatment options for patients in regions where donor corneas remain scarce [28–31].

Future research should focus on prospective multicentre studies evaluating standardized surgical techniques, postoperative treatment protocols, and long-term clinical outcomes. Greater integration of molecular diagnostics, advanced imaging, AI-assisted decision support, and regenerative technologies may further improve infection control, graft survival, and visual rehabilitation. Continued collaboration between corneal surgeons, microbiologists, infectious disease specialists, and eye banks will be essential to translate these innovations into routine clinical practice (Table 8).

Table 8. Emerging Technologies with Potential to Improve Outcomes Following TPK.

Technology	Potential clinical application
Polymerase chain reaction (PCR)	Rapid identification of microbial pathogens
Next-generation sequencing (NGS)	Comprehensive pathogen detection in culture-negative cases
Anterior segment optical coherence tomography (AS-OCT)	Assessment of corneal infiltration, thickness, and healing
In vivo confocal microscopy	Detection of fungal hyphae and Acanthamoeba cysts
Artificial intelligence (AI)	Early diagnosis, disease classification, and referral support
Bioengineered corneal substitutes	Alternative to donor corneal tissue
Regenerative medicine	Enhancement of corneal repair and graft survival

5. Clinical Implications

The findings of this review highlight the importance of early recognition and timely management of severe infectious keratitis to prevent irreversible ocular damage and visual loss. Prompt microbiological investigation, initiation of targeted antimicrobial therapy, and close clinical monitoring remain the cornerstones of treatment. Delayed diagnosis or inadequate response to medical therapy should prompt early referral to a tertiary corneal centre for consideration of TPK [5,9,15].

Successful outcomes require careful patient selection and individualized surgical planning. The decision to perform TPK should be based on disease progression, risk of corneal perforation, microbial aetiology, and the patient's overall ocular condition rather than waiting for complete failure of medical treatment. Timely intervention may improve infection control, preserve globe integrity, and reduce the risk of devastating complications [12–16].

Optimal postoperative management is equally important. Continued culture-guided antimicrobial therapy, regular monitoring for graft rejection, recurrent infection, elevated intraocular pressure, and epithelial healing, together with appropriate management of systemic comorbidities, contributes significantly to long-term graft survival and visual rehabilitation [17–20].

The review also emphasizes the importance of multidisciplinary collaboration involving corneal surgeons, microbiologists, infectious disease specialists, eye bank personnel, and primary care physicians. Such collaboration facilitates accurate diagnosis, appropriate antimicrobial selection, timely surgical intervention, and comprehensive postoperative care. In regions where donor corneal tissue is limited, strengthening eye banking services and improving access to specialised corneal care should remain important public health priorities [18–21].

Overall, successful management of severe infectious keratitis depends on integrating evidence-based medical therapy, timely surgical intervention, meticulous postoperative care, and coordinated multidisciplinary management to optimize both anatomical and functional outcomes.

6. Conclusion

Therapeutic penetrating keratoplasty (TPK) remains an indispensable surgical intervention for the management of advanced infectious keratitis when medical therapy fails or when corneal integrity is threatened. Although the procedure is performed primarily to eradicate infection and preserve globe integrity, favourable anatomical, therapeutic, and functional outcomes can be achieved through timely intervention, meticulous surgical technique, appropriate antimicrobial therapy, and comprehensive postoperative care.

Current evidence indicates that prognosis is influenced by multiple factors, including the causative microorganism, severity and extent of corneal involvement, timing of surgery, donor tissue quality, and postoperative management. Early diagnosis, prompt referral to specialised corneal centres, and individualized treatment strategies remain fundamental to improving graft survival and long-term visual rehabilitation.

Recent advances in molecular diagnostics, anterior segment imaging, artificial intelligence, eye banking, and regenerative medicine have the potential to improve patient selection, facilitate earlier intervention, and enhance clinical outcomes. Nevertheless, well-designed prospective multicentre studies are still needed to establish standardized surgical protocols, optimize postoperative management, and evaluate long-term outcomes.

In conclusion, TPK continues to play a pivotal role in the management of severe infectious keratitis. A multidisciplinary approach integrating evidence-based medical therapy, timely surgical intervention, and structured postoperative follow-up offers the greatest opportunity for successful infection control, preservation of globe integrity, and subsequent visual rehabilitation.

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Author Contributions

A. S. M. Moin Uddin conceptualized the review, provided clinical supervision, and critically reviewed the manuscript. Md. Raquib Rahman contributed to the literature review and interpretation of evidence related to eye banking and corneal transplantation. Md. Rajeeb Alam critically reviewed the clinical content and contributed to the interpretation of surgical outcomes. M. M. Aeorangajeb Al Hossain coordinated the review, designed the manuscript structure, conducted the literature search, synthesized the evidence, drafted and substantially revised the manuscript, designed the conceptual figures and tables, and supervised the scientific writing and editorial process. Mohammad Shamsal Islam contributed to evidence synthesis, manuscript editing, and critical review. All authors reviewed and approved the final manuscript and agree to be accountable for all aspects of the work.

Conflict of Interest

The authors declare that they have no competing financial, professional, or personal interests that could have influenced the work reported in this manuscript.

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Ethical Approval

Not applicable. This study is a narrative review based exclusively on previously published literature and did not involve human participants, patient data, or experimental animals.

Informed Consent

Not applicable.

Data Availability Statement

No new datasets were generated or analysed during this study. All information included in this review was obtained from published literature cited in the reference list.

Disclaimer

The views expressed in this review are those of the authors and are based on the available published evidence at the time of writing. They do not necessarily represent the official views or policies of Ispahani Islamia Eye Institute & Hospital.

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Surgical Management of Esotropia in Moebius Syndrome: A Case Report

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CASE REPORT

Keywords:
Moebius syndrome
Congenital cranial dysinnervation disorder
Esotropia
Bilateral medial rectus recession
Strabismus surgery

ABSTRACT

Background

Moebius syndrome is a rare congenital cranial dysinnervation disorder characterized primarily by congenital paralysis of the sixth (abducens) and seventh (facial) cranial nerves, resulting in facial diplegia, impaired ocular motility, and large-angle esotropia. Surgical correction of strabismus aims to improve ocular alignment and facial appearance; however, restoration of normal ocular motility remains challenging because of the underlying neurological deficit. We report the successful surgical management of severe congenital esotropia in a child with Moebius syndrome.

Case Presentation

A 12-year-old girl presented with congenital bilateral esotropia, complete limitation of horizontal eye movements, facial diplegia, right-sided lagophthalmos, incomplete mouth closure, tongue atrophy, and a history of surgically corrected lower limb deformity. Orthoptic evaluation demonstrated approximately 60 prism dioptres (PD) of esotropia with marked restriction of ocular motility in all cardinal positions of gaze. Intraoperative forced duction testing confirmed marked medial rectus tightness, and the patient underwent bilateral medial rectus recession (5 mm) under general anaesthesia.

Outcome

Postoperatively, ocular alignment improved from 60 PD esotropia to orthophoria in the primary position and remained stable throughout one year of follow-up. No postoperative diplopia developed. Although ocular motility remained markedly restricted because of congenital abducens nerve dysfunction, satisfactory cosmetic alignment, improved ocular comfort, and better social confidence were achieved with adjunctive lubrication, nocturnal eye patching, and refractive correction.

Conclusion

Bilateral medial rectus recession effectively corrected large-angle esotropia and achieved stable primary-position alignment in this patient with Moebius syndrome. Although extraocular motility could not be restored, surgical intervention provided substantial functional and cosmetic benefits. Early diagnosis and timely surgical management may optimize binocular alignment and improve long-term visual outcomes in appropriately selected patients.

1. Introduction

Moebius syndrome is a rare congenital cranial dysinnervation disorder characterized by congenital, non-progressive paralysis of the facial (VII) and abducens (VI) cranial nerves. The estimated incidence ranges from approximately 1 in 50,000 to 1 in 500,000 live births, although accurate epidemiological data remain limited because of the rarity of the condition [1–3]. The syndrome is clinically characterized by facial diplegia, impaired facial expression, limitation of ocular abduction, and large-angle esotropia. Additional manifestations may include involvement of other cranial nerves, limb anomalies, orofacial malformations, musculoskeletal deformities, and, less commonly, features of Poland syndrome [2,3].

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Ocular abnormalities are among the most prominent manifestations of Moebius syndrome and frequently represent the primary reason for ophthalmic consultation. Bilateral sixth nerve palsy typically results in severe limitation of ocular abduction and congenital esotropia, whereas associated seventh nerve palsy may lead to lagophthalmos, exposure keratopathy, reduced blink reflex, and chronic ocular surface disease. Depending on the extent of neurological involvement, patients may also present with impaired binocular vision, amblyopia, refractive errors, and complex ocular motility disorders that significantly affect visual function, facial appearance, and psychosocial well-being [3–6].

The principal objective of strabismus surgery in Moebius syndrome is to achieve satisfactory ocular alignment in the primary position, thereby improving functional vision, facial symmetry, and social interaction. As because the underlying cranial nerve dysfunction is congenital and irreversible, restoration of normal ocular motility is generally not expected. Several surgical approaches have been described, including bilateral medial rectus recession, lateral rectus resection, and vertical rectus muscle transposition, with the choice of procedure depending on the severity of ocular deviation, residual extraocular muscle function, and intraoperative findings [4–7].

We report the successful surgical management of a 12-year-old girl with Moebius syndrome presenting with large-angle congenital esotropia, bilateral limitation of ocular motility, facial diplegia, and exposure keratopathy. This case highlights the effectiveness of bilateral medial rectus recession in achieving stable ocular alignment despite persistent congenital ocular motor paralysis and emphasizes the importance of individualized surgical planning in patients with congenital cranial dysinnervation disorders.

2. Case Presentation

A 12-year-old girl presented to the Department of Paediatric Ophthalmology and Strabismus, Ispahani Islamia Eye Institute & Hospital (IIEI&H), Dhaka, Bangladesh, in August 2022 with a lifelong history of inward deviation of both eyes and inability to move either eye normally. According to her parents, she had been unable to produce normal facial expressions since birth and had persistent incomplete closure of the right eyelid and mouth. During the year preceding presentation, she developed excessive watering of the right eye associated with burning and foreign-body sensation. She also had a history of congenital lower limb deformity that had been surgically corrected during early childhood.

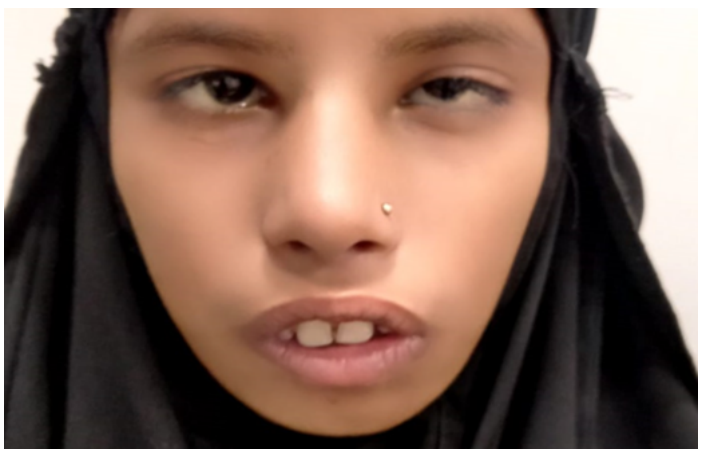
General physical examination revealed residual gait abnormality related to the previously corrected lower limb deformity. Facial examination demonstrated mild deviation of the nose towards the left, thickening of the lower lip, incomplete lip closure even on forceful attempt, and mild tongue atrophy, findings consistent with congenital cranial nerve dysfunction.

Ophthalmic examination revealed a best-corrected visual acuity (BCVA) of 6/12 in the right eye and 6/18 in the left eye. Cycloplegic refraction showed +0.50 DS/+0.50 DC ×180° in the right eye and +2.50 DC ×120° in the left eye.

Orthoptic evaluation demonstrated eccentric corneal light reflexes for both distance and near fixation. The Krimsky test measured approximately 60 prism dioptres (PD) of esotropia. Extraocular movements were markedly restricted in all cardinal positions of gaze, with complete limitation of abduction bilaterally (Figure 1A). No diplopia or nystagmus was observed, and binocular single vision was absent.

The right eye demonstrated lagophthalmos with a positive Bell's phenomenon, consistent with ipsilateral facial nerve palsy. Exposure keratopathy was evident with excessive tearing and loss of conjunctival lustre. Slit-lamp examination showed a quiet anterior chamber, normally reactive pupils, and clear crystalline lenses in both eyes. Fundus examination was unremarkable.

Based on the clinical findings, a diagnosis of Moebius syndrome with congenital bilateral sixth and seventh cranial nerve palsy associated with large-angle esotropia was established. After detailed counselling regarding the expected benefits and limitations of surgery, the patient was scheduled for strabismus correction.



(A) Large-angle bilateral congenital esotropia.

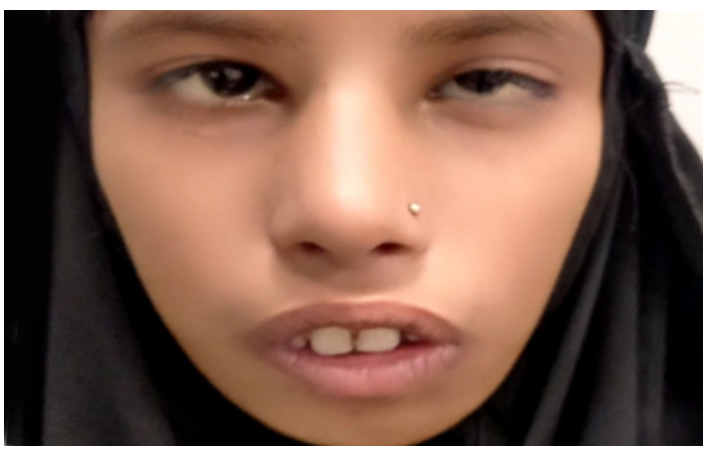
(B) Tongue deviation with mild atrophy.

(C) Right facial weakness showing incomplete eyelid and mouth closure.

Figures 1 (A-C). Clinical features of Moebius syndrome.

The patient underwent surgery on 18 January 2023 under general anaesthesia. Intraoperative forced duction testing (FDT) demonstrated marked restriction of abduction caused by tight medial rectus muscles bilaterally, whereas adduction, elevation, and depression showed only mild restriction. Based on these findings, bilateral medial rectus recession (5 mm) was performed.

On the first postoperative day, the corneal light reflexes were centrally positioned, and no residual deviation was detected on cover testing. The patient did not complain of postoperative diplopia, and ocular alignment in the primary position was satisfactory (Figures 2).



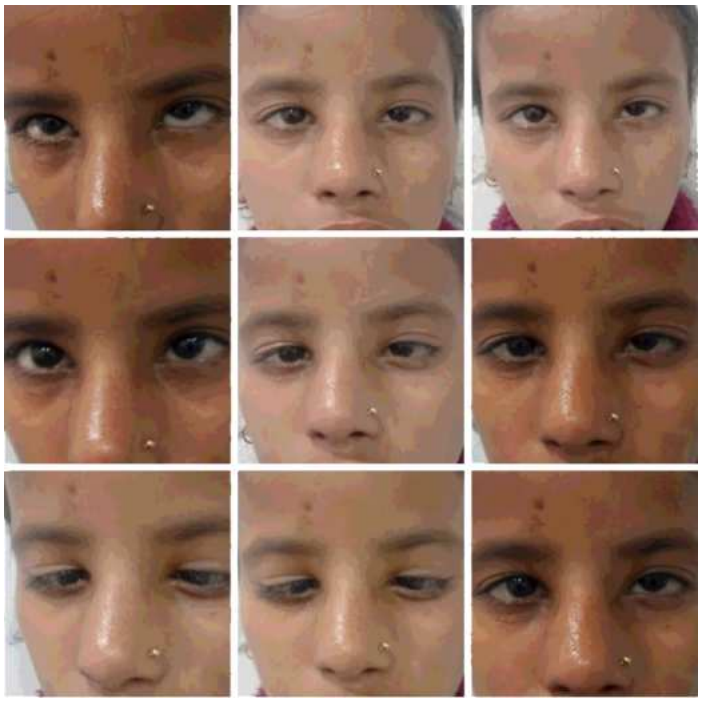
(A) Preoperative large-angle esotropia (approximately 60 prism dioptres).

(B) Postoperative orthophoria in the primary position.

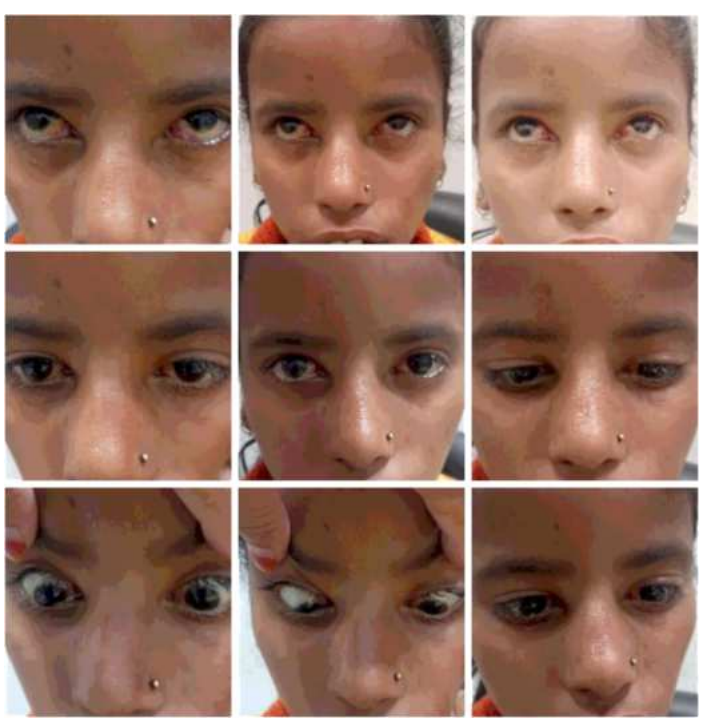
Figures 2 (A-B). Ocular alignment before and after bilateral medial rectus recession.

At the one-month follow-up, ocular alignment remained stable in the primary position, although limitation of ocular motility persisted in all directions of gaze because of the underlying congenital cranial nerve dysfunction. The patient was prescribed preservative-free lubricating eye drops, nocturnal patching of the right eye to minimize exposure-related symptoms, and updated spectacle correction. Best-corrected visual acuity improved to 6/9 in the right eye with +0.50 DS and 6/12 in the left eye with −2.00 DC ×35°.

At the one-year follow-up, the patient remained orthophoric in the primary position without recurrence of esotropia. Although extraocular movements remained markedly restricted, postoperative ocular alignment was cosmetically satisfactory (Figures 3). The patient also reported improvement in ocular comfort and greater confidence during social interactions.



(A) Preoperative ocular motility demonstrating severe limitation in all cardinal positions of gaze.



(B) One-year postoperative appearance showing stable primary-position alignment despite persistent limitation of ocular movements.

Figures 3 (A-B). Nine-gaze photographs before and after surgery.

3. Discussion

Moebius syndrome is a rare congenital cranial dysinnervation disorder characterized primarily by congenital paralysis of the sixth and seventh cranial nerves, resulting in facial weakness, impaired ocular motility, and large-angle congenital esotropia [1–3]. Because of its rarity and heterogeneous clinical presentation, most of the available evidence is derived from individual case reports and small case series. Consequently,

every well-documented case contributes valuable information to the understanding and management of this uncommon disorder.

The patient in the present report demonstrated the classical clinical features of Moebius syndrome, including congenital bilateral esotropia, complete limitation of ocular abduction, facial diplegia, lagophthalmos, tongue atrophy, and a history of congenital lower limb deformity. The coexistence of cranial nerve dysfunction with musculoskeletal anomalies supports the concept that Moebius syndrome represents a broader congenital developmental disorder rather than isolated sixth and seventh cranial nerve palsy [2,3].

Large-angle esotropia is among the most frequent ophthalmic manifestations of Moebius syndrome and is primarily attributed to congenital abducens nerve dysfunction with secondary medial rectus contracture [3,4]. In the present case, orthoptic evaluation demonstrated approximately 60 prism dioptres (PD) of esotropia with complete absence of ocular abduction. Intraoperative forced duction testing confirmed significant bilateral medial rectus tightness, indicating that mechanical muscle contracture contributed to the ocular deviation in addition to the underlying neurological deficit.

The principal goal of strabismus surgery in Moebius syndrome is to establish satisfactory ocular alignment in the primary position rather than to restore normal ocular motility. Since congenital paralysis of the abducens nerve is irreversible, persistent limitation of ocular movements should be anticipated despite successful realignment of the eyes [4–6]. This principle was clearly demonstrated in our patient. Bilateral medial rectus recession successfully corrected the large-angle esotropia and maintained stable orthophoria throughout one year of follow-up, while severe restriction of ocular movements remained unchanged.

Various surgical techniques have been described for the management of esotropia associated with Moebius syndrome. Bilateral medial rectus recession remains the most commonly performed procedure in patients with marked medial rectus contracture, whereas vertical rectus transposition procedures may be reserved for selected patients with profound abduction deficits or recurrent ocular deviation [7–11]. The choice of surgical procedure should therefore be individualized based on the degree of ocular deviation, residual extraocular muscle function, and intraoperative findings. In the present case, bilateral medial rectus recession alone achieved satisfactory long-term alignment without the need for additional muscle transposition.

Although postoperative ocular alignment was excellent, binocular single vision and stereopsis were not restored. This outcome is likely attributable to the delayed timing of surgery, as the patient underwent surgical correction at 12 years of age, well beyond the critical period for binocular visual development. Previous studies have suggested that earlier surgical intervention may improve the likelihood of developing binocular function and expanding the field of binocular single vision in selected patients with congenital esotropia associated with Moebius syndrome [12]. These observations underscore the importance of early diagnosis and timely referral to specialized strabismus services.

Another important aspect of management in Moebius syndrome is the treatment of ocular surface disease resulting from facial nerve dysfunction. The patient's lagophthalmos and exposure keratopathy required continuous lubrication and nocturnal eyelid protection following surgery. Long-term follow-up is therefore essential not only to monitor ocular alignment but also to preserve ocular surface integrity, manage refractive errors, and prevent exposure-related complications.

4. Conclusion

Moebius syndrome is a rare congenital cranial dysinnervation disorder associated with significant ophthalmic, functional, and psychosocial challenges. This case demonstrates that bilateral medial rectus recession is an effective surgical option for correcting large-angle congenital esotropia and achieving stable ocular alignment in the primary position. Although congenital abducens nerve dysfunction resulted in persistent limitation of ocular motility and binocular vision could not be restored because of delayed surgical intervention, the procedure provided substantial cosmetic improvement and enhanced ocular comfort.

Early diagnosis, comprehensive multidisciplinary evaluation, and timely surgical intervention are essential to optimize functional and psychosocial outcomes in patients with Moebius syndrome. Long-term follow-up remains important for monitoring ocular alignment, managing exposure keratopathy, correcting refractive errors, and preserving ocular surface health. This case contributes to the limited literature on the surgical management of Moebius syndrome and supports bilateral medial rectus recession as a safe and effective procedure for appropriately selected patients.

Acknowledgement

The authors express their sincere gratitude to the Department of Paediatric Ophthalmology and Strabismus and the Department of Research & Development of Ispahani Islamia Eye Institute & Hospital (IIEI&H), Dhaka, Bangladesh, for their academic support and encouragement during the preparation of this case report. The authors also thank the patient and her legal guardian for providing informed consent for publication and for their cooperation throughout the clinical management and follow-up.

Author contributions

Shifat Toufique conceived the case report, managed the patient, performed the surgical procedure, interpreted the clinical findings, and drafted the initial manuscript. Mohammad Mostafa Hossain contributed to clinical supervision, interpretation of the findings, and critical revision of the manuscript. Quazi Sazzad Iftekhar participated in patient management, manuscript revision, and overall supervision of the publication process. All authors critically reviewed the manuscript, approved the final version, and agree to be accountable for all aspects of the work.

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Conflict of Interest:

The authors declare that they have no competing interests.

Ethical Considerations

Institutional ethical approval was waived because this manuscript describes a single anonymized case report. The report was prepared in accordance with the ethical principles of the Declaration of Helsinki. All identifying patient information has been removed to maintain patient confidentiality.

Patient Consent

Written informed consent for publication of the clinical information and clinical photographs was obtained from the patient's legal guardian before preparation of this manuscript.

Data Availability Statement

All data generated or analysed during this study are included in this published article. Additional information is available from the corresponding author upon reasonable request.

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Surgical Management of Optic Disc Pit Maculopathy with an Inverted Internal Limiting Membrane Flap: A Case Report

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CASE REPORT

Keywords:
Optic disc pit maculopathy
Optic disc pit
Pars plana vitrectomy
Internal limiting membrane flap
Optical coherence tomography

ABSTRACT

Purpose

To describe the clinical presentation, surgical management, and postoperative anatomical and visual outcomes of optic disc pit maculopathy treated with pars plana vitrectomy (PPV), internal limiting membrane (ILM) peeling, an inverted ILM flap, and gas tamponade.

Case Presentation

A 16-year-old girl presented with a two-month history of painless, progressive visual impairment in her right eye. Her best-corrected visual acuity (BCVA) was 6/60 for distance and N12 for near vision. Fundus examination revealed an optic disc pit associated with serous macular detachment. Optical coherence tomography (OCT) demonstrated subretinal fluid with schisis-like retinal changes, while fundus fluorescein angiography (FFA) showed leakage from the optic disc without foveal leakage. The patient underwent PPV with ILM peeling, placement of an inverted ILM flap over the optic disc pit, and C_3F_8 gas tamponade, followed by seven days of postoperative face-down positioning. Serial OCT examinations demonstrated progressive resolution of subretinal fluid and restoration of macular anatomy. BCVA improved to 6/36 at six months and further to 6/12 at one year after surgery.

Conclusion

This case demonstrates that PPV combined with ILM peeling, an inverted ILM flap, and gas tamponade can achieve favourable anatomical and functional outcomes in optic disc pit maculopathy. OCT plays an essential role in diagnosis, surgical planning, and postoperative monitoring. Early surgical intervention may improve visual prognosis, although patients should be counselled regarding the gradual recovery of vision and the need for prolonged follow-up.

1. Introduction

Optic disc pit (ODP) is a rare congenital cavitary anomaly of the optic nerve head, with an estimated prevalence of less than 0.01% in the general population. First described by Wiethe in 1882, ODP is typically unilateral and occurs sporadically, although bilateral and familial cases have occasionally been reported. The lesion is most commonly located at the inferotemporal aspect of the optic disc but may also occur centrally or in other regions of the disc. While many individuals remain asymptomatic throughout life, visual impairment may develop when ODP is complicated by serous macular detachment, collectively termed optic disc pit maculopathy (ODPM) [1–4].

ODPM is the principal cause of visual loss associated with ODP and develops in approximately 25%–75% of affected eyes [2–4]. The condition is characterized by the accumulation of intraretinal and subretinal fluid, leading to schisis-like retinal changes, serous macular detachment, and progressive deterioration of central vision. Clinical diagnosis is based on fundus examination and multimodal retinal imaging, particularly optical coherence tomography (OCT), which provides detailed visualization of retinal architecture and facilitates both diagnosis and postoperative monitoring [5,6].

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The exact pathogenesis of ODPM remains incompletely understood. Several mechanisms have been proposed, including vitreous traction, direct communication between the subarachnoid and subretinal spaces, leakage from blood vessels within the optic disc pit, and fluid migration from the vitreous cavity or choroid [5–8]. Among these hypotheses, vitreoretinal traction has received considerable attention because posterior vitreous traction may facilitate the movement of fluid into the retinal layers. Nevertheless, current evidence suggests that ODPM is likely multifactorial, with vitreous traction and abnormal fluid dynamics acting together to produce progressive macular changes [6–9].

The management of ODPM remains challenging because of its rarity and the absence of universally accepted treatment guidelines. Reported surgical approaches include pars plana vitrectomy (PPV), induction of posterior vitreous detachment, internal limiting membrane (ILM) peeling, laser photocoagulation, gas tamponade, and placement of an inverted ILM flap over the optic disc pit. Although no single technique has demonstrated clear superiority, increasing evidence suggests that PPV combined with ILM peeling and an inverted ILM flap may facilitate anatomical reattachment of the macula by relieving vitreoretinal traction and limiting further fluid migration through the optic disc pit [7,9,10].

This case report describes the successful surgical management of ODPM in a young patient using PPV with ILM peeling, placement of an inverted ILM flap, and gas tamponade. Serial OCT imaging demonstrated progressive anatomical recovery accompanied by substantial improvement in visual acuity during one year of follow-up.

2. Case Report

A 16-year-old girl presented to the Department of Vitreo-Retina at Ispahani Islamia Eye Institute & Hospital, Dhaka, Bangladesh, with a two-month history of painless, progressive blurring of central vision in her right eye. She denied any history of ocular trauma, previous ocular surgery, or spectacle use. Her medical and family histories were unremarkable.

On examination, the best-corrected visual acuity (BCVA) was 6/60 for distance and N_{12} for near vision in the right eye, whereas the left eye had a BCVA of 6/6 for distance and N_6 for near vision. Pupillary reactions were normal, with no relative afferent pupillary defect. Intraocular pressure was within normal limits in both eyes, and anterior segment examination by slit-lamp biomicroscopy was unremarkable.

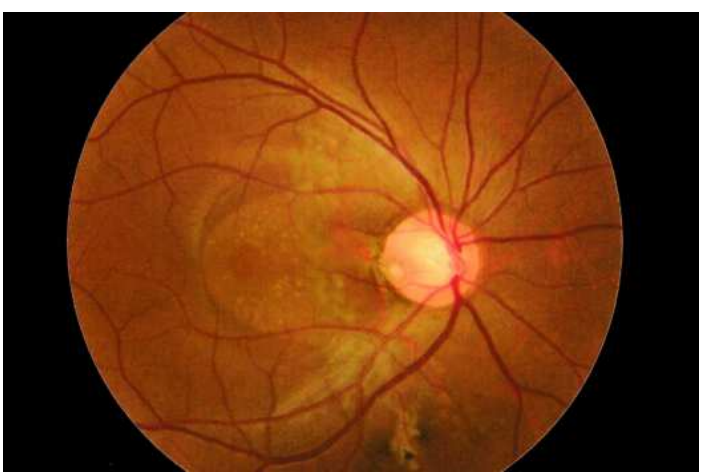

Figure 1. Colour fundus photograph of the right eye demonstrating an optic disc pit associated with serous macular detachment.

Dilated fundus examination of the right eye demonstrated a round, yellowish-grey excavation located on the temporal aspect of the optic disc, consistent with an optic disc pit. A well-defined serous macular detachment involving the posterior pole was also observed, with associated intraretinal and subretinal fluid extending towards the fovea (Figure 1). The left eye showed no abnormal findings.

Optical coherence tomography (OCT) confirmed the diagnosis by demonstrating a central macular thickness of 532 µm, together with marked subretinal fluid and schisis-like changes involving the outer retinal layers (Figure 2). Fundus fluorescein angiography (FFA) demonstrated late hyperfluorescence originating from the optic disc without evidence of leakage from the fovea, supporting the diagnosis of optic disc pit maculopathy.

Following detailed counselling regarding the disease, available treatment options, expected postoperative recovery, and guarded visual prognosis, the patient elected to undergo surgical intervention. A standard 23-gauge pars plana vitrectomy (PPV) was performed under local anaesthesia. Following induction of posterior vitreous detachment, the internal limiting membrane (ILM) was stained, carefully peeled, and inverted to create a flap covering the optic disc pit. Fluid–air exchange was subsequently performed, followed by tamponade with 14% perfluoropropane (C_3F_8) gas. The patient was instructed to maintain a strict face-down position for seven days after surgery.

The postoperative course was uneventful. At the 6-month follow-up, BCVA had improved to 6/36, and OCT demonstrated a substantial reduction in subretinal fluid, with central macular thickness decreasing to 374 µm (Figure 3). Continued anatomical improvement was observed throughout follow-up.

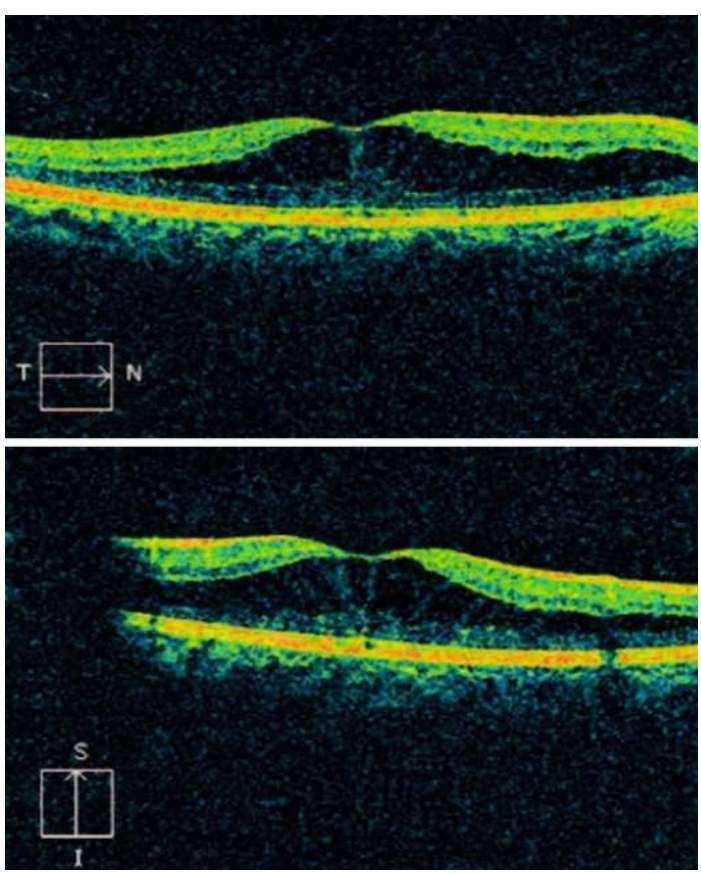

Figure 2. Optical coherence tomography at presentation demonstrating subretinal fluid, schisis-like retinal changes, and increased central macular thickness.

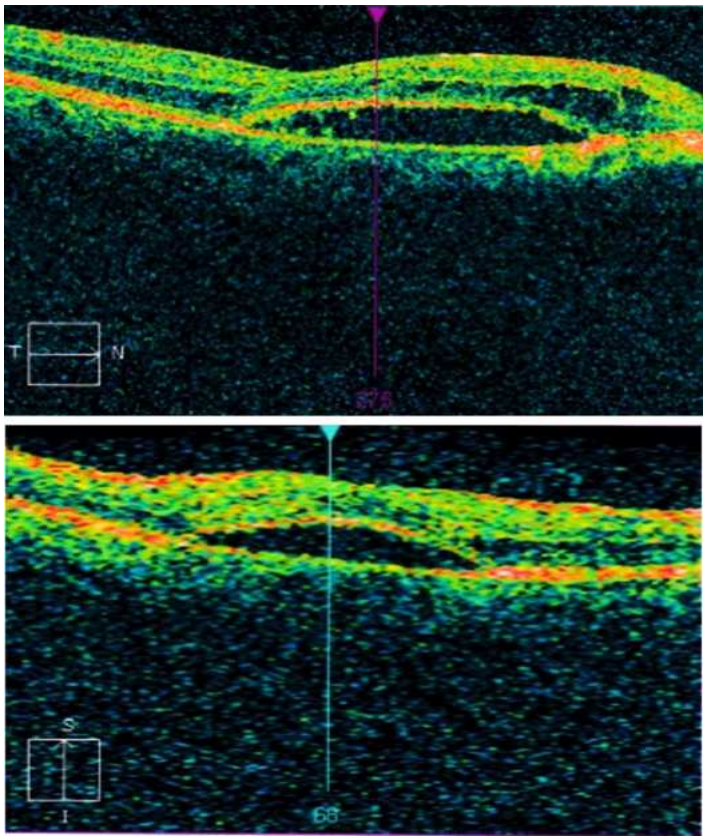

Figure 3. Optical coherence tomography obtained six months after surgery demonstrating marked reduction of subretinal fluid and partial restoration of macular architecture.

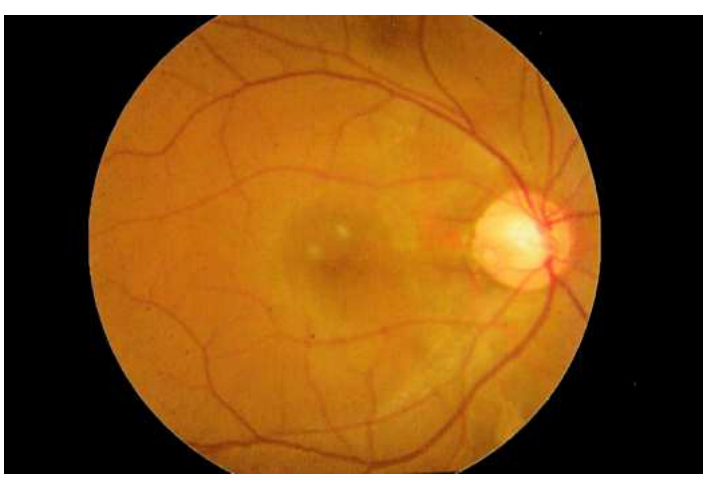

Figure 4. Colour fundus photograph obtained one year after surgery demonstrating near-complete resolution of the serous macular detachment.

At the 1-year follow-up, BCVA further improved to 6/12. Fundus examination showed near-complete resolution of the serous macular detachment (Figure 4), while OCT confirmed almost complete absorption of the subretinal fluid with restoration of normal foveal contour and a central macular thickness of 281 µm (Figure 5). These findings indicated successful anatomical recovery accompanied by marked functional improvement following surgery.

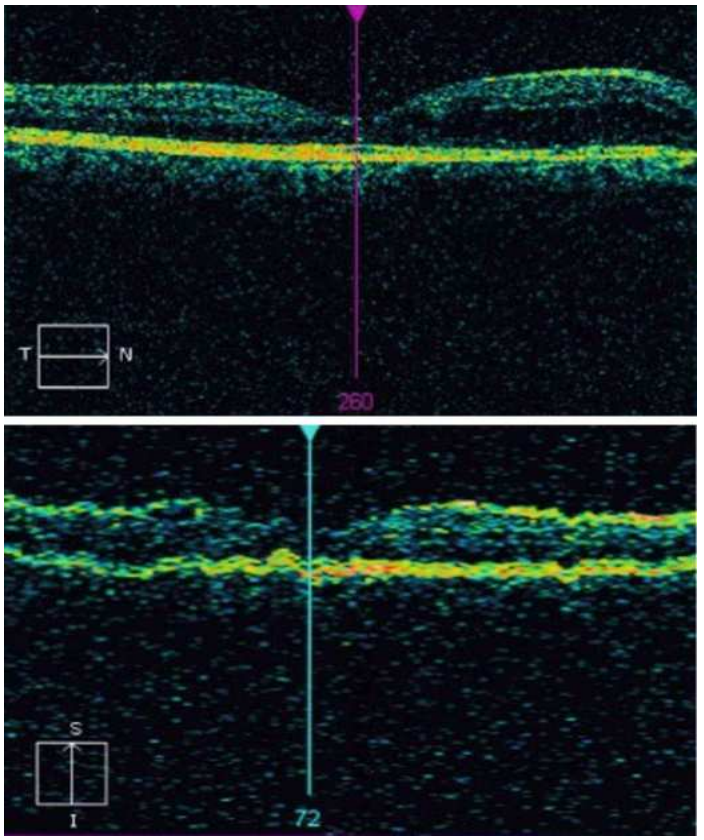

Figure 5. Optical coherence tomography obtained one year after surgery demonstrating near-complete resolution of subretinal fluid with restoration of the foveal contour.

3. Discussion

ODPM is an uncommon but potentially sight-threatening complication of ODP and remains one of the most challenging congenital optic nerve anomalies to manage. Although many individuals with ODP remain asymptomatic, the development of intraretinal schisis and serous macular detachment may result in progressive visual deterioration if left untreated [2,7,10]. Owing to its rarity, current management strategies are largely based on case reports, small case series, and retrospective studies, and no universally accepted treatment algorithm has been established.

The pathogenesis of ODPM remains controversial. Several mechanisms have been proposed, including vitreoretinal traction, direct communication between the subarachnoid and subretinal spaces, leakage from blood vessels within the optic disc pit, and migration of vitreous fluid into the retina [5,7,10]. Among these, vitreoretinal traction is considered a major contributing factor because relief of traction through PPV has consistently been associated with anatomical improvement in many published reports. Nevertheless, the exact source of subretinal fluid remains uncertain, suggesting that multiple mechanisms may contribute to disease development.

The principal objective of surgical treatment is to eliminate vitreoretinal traction, prevent further fluid migration through the optic disc pit, and facilitate gradual resorption of subretinal fluid. PPV combined with ILM peeling has become the most widely adopted surgical approach for ODPM because it relieves tangential traction and promotes retinal reattachment [6,7]. More recently, placement of an inverted ILM flap over the optic disc pit has gained increasing attention. The flap is thought to function as a biological scaffold or mechanical barrier that limits

communication between the optic disc pit and the subretinal space, thereby reducing continued fluid accumulation [7,9].

In the present case, PPV with ILM peeling, an inverted ILM flap, and C_3F_8 gas tamponade resulted in progressive anatomical recovery and substantial improvement in visual acuity during one year of follow-up. OCT demonstrated gradual resolution of subretinal fluid and schisis-like retinal changes, while BCVA improved from 6/60 preoperatively to 6/12 at one year. These findings are consistent with previous reports demonstrating favourable anatomical and functional outcomes following this surgical technique [6,7,9].

An important observation in this case was the gradual postoperative recovery. Anatomical restoration occurred progressively over several months rather than immediately after surgery, emphasising that retinal remodelling and visual improvement may continue long after successful intervention. Patients should therefore be counselled regarding realistic expectations, the need for prolonged follow-up, and the possibility that visual recovery may lag behind anatomical improvement.

The principal limitation of this report is that it describes a single case and therefore cannot establish the superiority of one surgical technique over another. Nevertheless, detailed clinical documentation, multimodal imaging, and one year of postoperative follow-up provide valuable evidence supporting the role of PPV with an inverted ILM flap in the management of ODPM. Larger prospective studies with longer follow-up are required to determine the optimal surgical approach and to clarify the long-term anatomical and visual outcomes of this uncommon condition.

4. Conclusion

Optic disc pit maculopathy (ODPM) is a rare but vision-threatening complication of ODP that requires early recognition and timely intervention to prevent irreversible visual loss. Multimodal retinal imaging, particularly OCT, is essential for accurate diagnosis, surgical planning, and postoperative monitoring.

This case demonstrates that PPV combined with ILM peeling, placement of an inverted ILM flap over the optic disc pit, and C_3F_8 gas tamponade can achieve favourable anatomical and functional outcomes. Progressive resolution of subretinal fluid, restoration of macular architecture, and marked improvement in visual acuity were observed during one year of follow-up. The findings also highlight that visual recovery may be gradual and can continue for several months after successful surgery.

Although larger prospective studies are required to establish the optimal surgical approach for ODPM, this case contributes to the growing body of evidence supporting the use of PPV with an inverted ILM flap as an effective treatment option in selected patients.

Patient Consent

Written informed consent was obtained from the patient and her legal guardian for publication of this case report and the accompanying clinical images.

Ethical Approval

Ethical approval was not required for this single case report according to institutional policy.

Acknowledgement

The authors sincerely thank the patient and her family for consenting to publication of this case. The authors also acknowledge the staff of the Department of Vitreo-Retina, Ispahani Islamia Eye Institute & Hospital, for their clinical support and assistance in patient management.

Author contributions

Farhana Yasmin conceived the study, managed the patient, performed the surgical procedure, collected the clinical data, interpreted the findings, and prepared the initial manuscript draft. Soheb Ahamed participated in patient management, assisted with data collection, conducted the literature review, and contributed to manuscript preparation. M. M. Aeorangajeb Al Hossain contributed to the study design, critically revised the manuscript for important intellectual content, improved the scientific writing, and supervised the research and publication process. Mohammad Shamsal Islam assisted with data analysis, literature review, manuscript editing, and preparation of the final version. All authors reviewed, critically revised, and approved the final manuscript and agree to be accountable for all aspects of the work.

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Conflict of Interest:

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Data Availability Statement

All data generated or analysed during this case report are included in this published article. Additional information may be obtained from the corresponding author upon reasonable request while maintaining patient confidentiality.

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Impact of Vision Therapy on Convergence Excess: A Case Report

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CASE REPORT

Keywords:
Convergence excess
Vision therapy
Binocular vision
Esophoria
Stereopsis

ABSTRACT

Purpose

To describe the clinical presentation, diagnosis, management, and clinical outcome of individualized vision therapy in an adolescent with convergence excess.

Case Presentation

A 16-year-old girl presented with a three-month history of headaches and eyestrain during prolonged reading. Her best-corrected visual acuity (BCVA) was 6/6 in the right eye and 6/9 in the left eye. Comprehensive binocular vision assessment included cycloplegic refraction, cover test, prism cover test, accommodative convergence/accommodation (AC/A) ratio, near point of convergence, near point of accommodation, relative accommodation, monocular estimate method retinoscopy, fusional vergence amplitudes, and stereopsis. The patient demonstrated orthophoria at distance, 6 prism dioptres of esophoria at near, an AC/A ratio of 6:1, and reduced fusional vergence reserves, consistent with convergence excess. She underwent six individualized office-based vision therapy sessions supplemented by daily home-based exercises. Following treatment, binocular vision function improved, with increased positive and negative fusional vergence amplitudes, improved stereopsis, and resolution of near esophoria. The patient reported complete resolution of headaches and eyestrain, together with improved concentration and visual comfort during prolonged near work.

Conclusion

This case demonstrates that individualized vision therapy can effectively improve binocular vision function and relieve symptoms associated with convergence excess. A comprehensive binocular vision assessment is essential for accurate diagnosis, treatment planning, and monitoring of therapeutic outcomes. Office-based vision therapy combined with regular home-based exercises may provide an effective non-surgical treatment option for appropriately selected patients.

1. Introduction

Convergence excess (CE) is a non-strabismic binocular vision disorder characterized by a greater esodeviation at near than at distance, primarily resulting from excessive accommodative convergence during near visual tasks. The condition commonly affects school-aged children and adolescents and may interfere with reading performance, academic activities, and quality of life if left untreated [1,2]. Alexander Duane first described the condition in relation to distance–near disparity in esodeviation, and it remains one of the recognised accommodative–vergence disorders encountered in clinical practice [1].

Patients with CE frequently present with symptoms of asthenopia, including headaches, eyestrain, intermittent blurred vision, difficulty sustaining near work, reduced reading efficiency, and, occasionally, intermittent diplopia. Because these symptoms overlap with those of other accommodative and binocular vision disorders, a comprehensive binocular vision assessment is essential to establish an accurate diagnosis and guide appropriate management [2,7,8].

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The diagnosis of CE is based on a combination of clinical findings rather than a single diagnostic test. Comprehensive evaluation typically includes assessment of ocular alignment, accommodative convergence/accommodation (AC/A) ratio, fusional vergence reserves, near point of convergence, accommodative function, and stereopsis. The presence of near esophoria or esotropia with a higher AC/A ratio, together with reduced compensatory fusional vergence and characteristic symptoms, supports the diagnosis [2,7].

Management depends on the severity of symptoms, refractive status, and binocular vision findings. Treatment options include appropriate refractive correction, bifocal lenses in selected cases, prism correction, and vision therapy. Among these approaches, individualized vision therapy has gained increasing acceptance as an effective non-surgical intervention because it aims to improve vergence control, accommodative performance, sensory fusion, and binocular coordination through structured office-based and home-based exercises [2–8].

This case report describes the successful management of symptomatic CE in an adolescent using a structured vision therapy programme. Significant improvements were observed in binocular vision function, fusional vergence amplitudes, stereopsis, and near visual comfort following six weeks of office-based therapy combined with regular home-based exercises.

2. Case Report

A 16-year-old girl presented to the Vision Therapy Clinic of the Department of Pediatric Ophthalmology & Strabismus at Ispahani Islamia Eye Institute & Hospital (IIEI&H), Dhaka, Bangladesh, with a three-month history of headaches and eyestrain during prolonged reading and other near visual activities. She had been wearing spectacles for the previous five years, and her spectacle prescription had been updated four months before presentation. Her medical and ocular histories were otherwise unremarkable.

On examination, the best-corrected visual acuity (BCVA) was 6/6 in the right eye (OD) and 6/9 in the left eye (OS). The presenting spectacle prescription was plano in the OD and +1.50/−1.50 × 135° in the OS. Cycloplegic refraction demonstrated latent hyperopia, and the spectacle prescription was revised to +0.50 DS in the OD (BCVA 6/6) and +2.25/−1.50 × 135° in the OS (BCVA 6/9).

Ocular motility was full in both eyes. The cover test demonstrated orthophoria at distance and esophoria at near. Prism cover test revealed orthophoria at distance and 6 prism dioptres (PD) of esophoria at near. The accommodative convergence/accommodation (AC/A) ratio was 6:1. The near point of convergence (NPC) was 6 cm, while the near point of accommodation (NPA) measured 10 cm in the OD, 12 cm in the OS, and 8 cm binocularly (OU). Negative relative accommodation (NRA) was +3.00 DS, positive relative accommodation (PRA) was −5.00 DS, and monocular estimate method (MEM) retinoscopy demonstrated a lead of accommodation. Fusional vergence amplitudes were reduced, with negative fusional vergence measuring 8 PD at distance and 10 PD at near, and positive fusional vergence measuring 12 PD at distance and 15 PD at near. Stereopsis was 60 seconds of arc.

Based on the patient's symptoms and comprehensive binocular vision assessment, a diagnosis of convergence excess was established.

The patient commenced an individualized vision therapy programme comprising six weekly office-based sessions, each lasting approximately 45 minutes. The programme included Brock string exercises, aperture rule training, Bernell O'scope exercises, tranaglyph training, and barrel card exercises to improve vergence control, accommodative function, binocular coordination, and sensory fusion (Figure 1). In addition, home-based vision therapy using the Mini Convergence and Divergence Tool (MCDT) was prescribed for 30 minutes daily to reinforce office-based training and enhance treatment compliance.

(A) Exercise by using Brock String.

B) Exercise by using Brock String Aperture Rule.Exercise by using Brock String.

(C) Exercise by using Bernell O'scope.

(D) Exercise by using Tranaglyph.

(E) Exercise by using Barrel Card.

Figure 1. Office-based vision therapy programme for convergence excess, including Brock string **(A)**, aperture rule **(B)**, Bernell O'scope **(C)**, tranaglyph **(D)**, and barrel card **(E)** exercises.

Treatment Outcome

The patient completed all six office-based sessions and demonstrated excellent adherence to the prescribed home-based exercises. At the completion of therapy, a repeat binocular vision assessment demonstrated clinically significant improvement in several binocular vision parameters (Table 1).

Near ocular alignment improved from 6 PD esophoria to orthophoria. Negative fusional vergence increased from 8 PD to 15 PD at distance and from 10 PD to 15 PD at near, while positive fusional vergence improved from 12 PD to 20 PD at distance and from 15 PD to 25 PD at near. Stereopsis improved from 60 to 40 seconds of arc. The NPA of the left eye improved from 12 cm to 10 cm, whereas other accommodative parameters remained stable.

Clinically, the patient reported complete resolution of headaches and eyestrain during prolonged reading, together with improved concentration, greater visual comfort, and no difficulty performing sustained near visual tasks. These findings indicated successful improvement in binocular vision function following individualized vision therapy.

3. Discussion

CE is a common accommodative–vergence disorder in children and adolescents and frequently presents with symptoms of asthenopia, including headaches, eyestrain, blurred vision, and difficulty performing prolonged near visual tasks. If left untreated, these symptoms may adversely affect reading efficiency, academic performance, and overall quality of life [2,7,8]. Accurate diagnosis requires a comprehensive binocular vision assessment because the clinical manifestations may overlap with those of other accommodative and vergence dysfunctions.

Table 1. Changes in binocular vision parameters before and after vision therapy.

Binocular Vision (BV) Parameters	Pre-VT	Post-VT
Ocular motility	OD: Full & Free OS: Full & Free	OD: Full & Free OS: Full & Free
Cover test	Distance: Orthophoria Near: 6 PD Esophoria	Distance: Orthophoria Near: Orthophoria
NPC (Break)	6 cm	6 cm
NPA	OD:10 cm OS:12 cm OU:8 cm	OD:10 cm OS:10 cm OU:8 cm
NRA	+3.00 DSP	+2.50 DSP
PRA	-5.00 DSP	-5.00 DSP
MEM	Lead	Lead
Negative Fusional Vergence (BI)	Distance: 8 PD Near: 10 PD	Distance:15 PD Near: 15 PD
Positive Fusional Vergence (BO)	Distance: 12 PD Near: 15 PD	Distance: 20 PD Near: 25 PD
Stereopsis (Stereo Fly Test)	60 seconds of arc	40 seconds of arc

Vision therapy has become an established non-surgical intervention for symptomatic binocular vision disorders. Structured therapy aims to improve vergence control, accommodative function, sensory fusion, and binocular coordination through repeated visual training exercises. Previous studies have demonstrated that individualized office-based vision therapy, particularly when combined with home-based exercises, produces greater improvements in binocular vision function and symptom relief than home-based therapy alone [2–6].

In the present case, six weeks of individualized office-based vision therapy combined with daily home-based exercises resulted in marked improvement in both objective clinical findings and subjective symptoms. Near esophoria resolved to orthophoria, positive and negative fusional vergence amplitudes increased substantially, and stereopsis improved from 60 to 40 seconds of arc. In addition, the patient reported complete resolution of headaches and eyestrain together with improved concentration and greater comfort during prolonged reading. These findings are consistent with previous reports demonstrating that vision therapy can effectively enhance vergence function and reduce symptoms in patients with binocular vision disorders [2,5–8].

Several factors may have contributed to the favourable outcome observed in this case. Appropriate cycloplegic refraction ensured full correction of latent hyperopia before initiating therapy, while the structured combination of office-based and home-based exercises likely enhanced treatment adherence and reinforced vergence training. Good patient compliance, together with regular follow-up, probably played an important role in achieving the observed clinical improvement.

The principal limitation of this report is that it describes a single patient with relatively short-term follow-up. Consequently, the findings cannot be generalized to all patients with CE or establish the superiority of one therapeutic approach over another. Nevertheless, this case demonstrates the potential effectiveness of individualized vision therapy as part of the management of symptomatic CE and highlights the importance of comprehensive binocular vision assessment, appropriate refractive correction, and structured follow-up. Larger prospective studies with longer follow-up are warranted to confirm the long-term effectiveness and sustainability of treatment outcomes.

4. Conclusion

This case highlights the importance of comprehensive binocular vision assessment in the accurate diagnosis of CE in adolescents presenting with symptoms of asthenopia during near visual tasks. Individualized vision therapy, combined with appropriate spectacle correction and structured home-based exercises, resulted in significant improvement in binocular vision function, vergence amplitudes, stereopsis, and symptom resolution.

The favourable clinical outcome observed in this patient supports the role of office-based vision therapy as an effective non-surgical management option for appropriately selected individuals with CE. Careful patient selection, treatment adherence, and regular follow-up are essential for achieving optimal clinical outcomes. Further prospective studies with larger patient populations and longer follow-up are required to evaluate the long-term effectiveness of vision therapy in the management of CE.

Patient Consent

Written informed consent for publication of this case report and the accompanying clinical data and images was obtained from the patient's parent/legal guardian.

Ethical Approval

Ethical approval was not required for this single case report in accordance with the institutional policy of Ispahani Islamia Eye Institute & Hospital (IIEI&H), Dhaka, Bangladesh.

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Author Contributions

Md. Mehedi Hasan conceived the case report, performed the clinical assessment and vision therapy, collected the clinical data, and prepared the initial manuscript. Quazi Sazzad Iftekhar and Shifat Toufique supervised the clinical management, critically reviewed the manuscript for important intellectual content, and contributed to the interpretation of the clinical findings. All authors read and approved the final version of the manuscript.

Conflict of Interest

The authors declare that they have no competing interests or conflicts of interest related to this case report.

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