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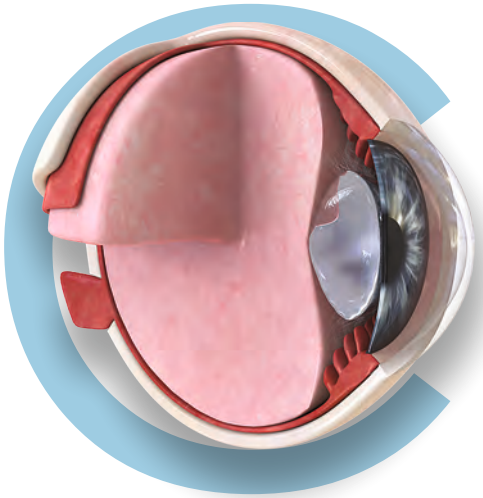

Indian Journal of Cataract and Refractive Surgery

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The journal

Indian Journal of Cataract and Refractive Surgery is a quarterly peer reviewed The Indian Academy of Ophthalmology commenced its conferences termed as Eye Advance which was held biennially with a host of Foreign Faculty and Foremost Indian faculty participating in LIVE Surgeries thereby providing a surgical training platform for Indian ophthalmologists to enhance their skills.

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LETTERS TO EDITOR

AU REVOIR DR FINE ..

I first met Dr Fine when I walked into his office in Eugene in the spring of 2001. I'd read his work and seen his pioneering videos of power modulation and clear corneal cataract surgery. I was pleasantly surprised by the ever smiling gentleman obviously a leader among men loved by his doctors staff and patients.I'd heard of his Harley collection. When he heard I was a biker off we went to the basement where I first saw part of his gleaming bike collection."Arent they beautiful", he remarked, I had to agree.
"You mustve ridden one before ", yeah sure many time.. the only bike I had ridden was a small 100 cc Yamaha."
Lets go", he said at 4 in the afternoon when the centre closed, "you ride this one ,its small and manageable". That was the new 2001, 993 sportster, that you see me on in the pictures, and off we went. Over the three months I learnt ophthalmology from him we must've had more than 50 rides.. Ranging from a quick 20 min spin to over 200 miles across the Oregon backroads .Coming from a city of 2 million people jammed with chaotic traffic it was a refreshing change to see an just an old pickup now and then and not much else."I change my collection every 2 or 3 years as soon as they get a bit old". Yes, I nodded, great idea. In the mornings I witnessed outstanding surgery on hard cataracts, small pupils subluxed lenses and other tough cases referred to him from across the continental US and abroad.. "dyu know why we like Keiki so much", he asked me one day. I was silent. "because he is a mild mannered gentleman and not a shameless self promoter …" Well,I thought, lucky for me. Uncle Howard took me for the best steak dinners ever, A grade grass fed Oregon cattle he would say with pictures of the cows looking down at me from the walls. He had a few other International fellows at the same time as me, one from Sudan and a friendly chap from Korea,"no motorcycle they said", too dangerous! Naturally this is like wanting to learn from Roger Federer but disliking tennis.. I think I was his favourite student.
Three months passed by in a flash, armed with my ASCRS fellowship, he was the President then,I returned to India.
I met him several times after that at ESCRS and ASCRS where he always consented to speak at my courses and at his favourite IIIC meeting.He won every award they had to give and then some and I attended most of them. I was honoured that he consented to come to India and speak at my EyeAdvance meeting where it was our proud privilege to present him with our highest honor.
Behind his chair was a plaque "You canna expect to be baith grand and comfortable."
My condolences to Vicky, Edward and Bill.
We will meet again Dr Fine, Probably on electric bikes though.

Editorial

Advancements in Keratoconus Management

Keratoconus, traditionally recognized as the most common noninflammatory ectatic corneal disorder, has been associated with underlying cellular inflammation over the past decade. It involves progressive corneal steepening accompanied by concurrent stromal thinning, leading to blurred vision and irregular corneal astigmatism. The management focuses on alleviating risk factors for disease progression and visual rehabilitation, based on the grade of ectasia. Various methods are employed to treat the refractive astigmatism caused by corneal steepening and irregularity, including refractive correction using glasses and contact lenses. The choice of contact lens – whether soft, rigid gas-permeable (RGP), hybrid, semi-scleral, or scleral – is determined based on corneal topography. Newer contact lens designs include those with customized curvatures or variable thickness (e.g., NovaKone by Bausch + Lomb). In the early or mild stages of keratoconus, RGP lenses are a viable option; however, as ectasia progresses, fitting contact lenses often becomes challenging.[1]

Intra-corneal ring segments (ICRSs) are a less commonly used treatment modality due to prerequisites for implantation, such as a minimum corneal thickness and the absence of corneal scarring, autoimmune diseases, or herpetic eye disease. In addition, the results of ICRS vary widely in the literature, with some reports indicating worse postoperative visual outcomes in cases undergoing ICRS. Recently, corneal allogenic intrastromal ring segments (CAIRSs) have been introduced. This technique involves the implantation of mid-peripheral intrastromal ring segments made from donor corneal tissue in keratoconic eyes to flatten the cone. CAIRS is a less extensive and reversible procedure with a minimal risk of graft rejection.[1,2]

Collagen crosslinking (CXL) is now an established technique to halt the progression of corneal ectasia by inducing new chemical bonds between the collagen fibers in the stroma and thereby enhancing biomechanical strength. Accelerated CXL has largely replaced the conventional Dresden protocol by increasing UV irradiation and reducing procedural time, all while maintaining the procedure's efficacy. Epithelium-off CXL is preferred over epithelium-on CXL due to the lower permeability of riboflavin and oxygen diffusion in the latter. Iontophoresis-assisted CXL has been described for cases where the epithelium has not been removed; in this method, a mild electric current is applied through electrodes to enhance riboflavin penetration. Various techniques, such as customized epithelium removal, hypo-osmolar riboflavin, contact lens-assisted CXL, lenticule-assisted CXL, and sub-400 CXL, have been developed for thin corneas. Unlike the accelerated protocol, the sub-400 protocol customizes the fluence based on corneal thickness while using fixed UV irradiation.[3,4]

IVMED-80 (iVeena Delivery Systems, Inc.) utilizes topical copper sulfate to enhance the activity of lysyl oxidase, an enzyme crucial for maintaining the stability of the extracellular matrix. This enzyme converts lysine into reactive aldehydes, promoting the cross-linking of collagen and elastin. This approach aims to address the dysregulation of collagen maturation pathways associated with keratoconus. However, IVMED-80 is still under trial, and long-term results are needed to determine its potential as a nonsurgical treatment modality for keratoconus in the future.[5]

A recent surgical advancement in keratoconus is intrastromal lamellar keratoplasty. This procedure begins with preparing the host bed through femtosecond laser-guided or manual stromal lamellar dissection. At the same time, the donor corneal stromal lenticule is prepared using either a femtosecond laser or an automated microkeratome to achieve the desired thickness and diameter. The prepared donor lenticule is then inserted into the lamellar pocket created in the host cornea, which is affected by keratoconus. Femtosecond intrastromal lenticule insertion uses lenticules extracted from SMILE procedures for intrastromal insertion. Researchers are also exploring the customization of donor lenticules with variable thicknesses and shapes to effectively flatten keratometry readings across different grades of keratoconus. In addition, bioengineered corneas, such as the innovative cell-free porcine construct (BPCDX), are being investigated for their equivalence to human donor corneal tissues in intrastromal implantation.[6,7]

During lenticule addition keratoplasty, performing intrastromal dissection can be particularly challenging due to the ectatic nature of the keratoconic cornea. This has led to the development of inlay and onlay Bowman layer grafts, which have proven effective in flattening corneal curvature, slowing disease progression, and delaying the need for more invasive procedures, such as penetrating or deep anterior lamellar keratoplasty (DALK). In addition, keratorefractive procedures and intrastromal keratoplasties have been combined with CXL to improve the biomechanical

strength at the cellular level while achieving targeted flattening of the cone.

For advanced cases, the final options are DALK and penetrating keratoplasty. Although DALK has a steep learning curve and its visual outcomes are dependent on the surgeon's skill, it offers several potential benefits, including the advantages of a closed globe procedure and a lower recurrence of postkeratoplasty corneal ectasia.

Future directions in the management of keratoconus include the development of gene therapy that targets specific disease biomarkers to predict progression and severity, as well as address mutations associated with advanced disease. The corneal stromal stem cell treatment, which utilizes autologous mesenchymal stem cells (MSCs), specifically a suspension of dormant autologous adipose-derived adult stem cells obtained through liposuction. These cells are injected into the mid-stromal layer through a lamellar pocket created by a femtosecond laser. In addition, researchers are exploring the transplantation of decellularized corneal segments that have been reseeded with autologous MSCs, aiming to restore the anatomical integrity of corneas affected by advanced keratoconus. The potential role of artificial intelligence in the early diagnosis and management of keratoconus is also under investigation.[8]

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Review Article

Innovative Keratoconus Surgical Algorithm: A Refractive Approach to Restoring Vision

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Abstract

Keratoconus is a progressive disease characterized by corneal protrusion and significant visual impairment. Influenced by genetic and environmental factors, the pathophysiology involves the abnormal apoptosis and overwork of keratocytes, resulting in corneal stromal thinning. Historically, keratoconus has had a dreary prognosis with traditional treatment options ranging from contact lenses to corneal cross-linking to corneal transplantation with patients rarely regaining adequate visual acuity. This manuscript outlines a paradigm shift with a novel keratoconus treatment algorithm that advocates for corneal transplants as a last resort, aiming for optimal visual outcomes regardless of the disease severity. This treatment algorithm introduces concepts such as the "think outside the cone" approach and the "LEGO Concept," which deconstructs keratoconus into a series of individual abnormalities. Cases are discussed demonstrating the successful application of specific surgical techniques, including LaZrPlastique®, INTACS®, and corneal cross-linking that have allowed patients to regain vision. By shifting the focus of keratoconus treatment from disease management to achieving the best vision potential, this innovative algorithm offers a comprehensive and patient-centered strategy with the goal of achieving emmetropia and reducing the need for invasive interventions.

Keywords: *Astigmatism, corneal cross-linking, keratoconus*

Introduction: Overview, Pathophysiology, and Etiology

Keratoconus is a progressive, typically bilateral yet often asymmetrical disease, characterized by the thinning of the corneal stroma and a subsequent steepening of the cornea into a conical shape. This structural anomaly leads to corneal protrusion and significant visual impairment.[1] Population-based studies have indicated a higher prevalence of keratoconus in Middle Eastern and Indian populations compared to white and East-Asian populations.[2] In the United States, a study utilizing a national database found the prevalence of keratoconus to be 0.15% nationally, with the highest prevalence among Western states.[3]

A primary pathologic feature of keratoconus is the abnormal behavior of keratocytes, the stromal fibroblasts responsible for maintaining the extracellular matrix. Increased keratocyte apoptosis leads to heightened vulnerability of the stroma to stress. The remaining few keratocytes become overworked to maintain the matrix, further perpetuating the cycle of stress and apoptosis.[4] As a result, thinning of the corneal stroma occurs. The pathogenesis of keratoconus involves the differential expression of several proteins. Conventionally, keratoconus was considered a noninflammatory disease, but emerging evidence has implicated pro-inflammatory molecules such as interleukin-1, interleukin-6, tumor necrosis factor-alpha, transforming growth factor beta, and matrix metalloproteinase-9 in the inflammatory process affecting the ocular surface.[5-7]

Keratoconus is a complex condition influenced both by genetic and environmental factors. The pathogenesis of keratoconus may be conceptualized through a two-hit hypothesis, in which a genetic predisposition in conjunction with environmental

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BCVA	REF ERR	PACH	STABILITY	TOPO	PATHO	
> 20/40	Astigm > Myopia	> 400	Stable	Regular	None	Laser
> 20/40	Myopia > Astigm	> 400	Stable	Regular	None	ICL
> 20/40	Astigm, Hyperopia Myopia	> 400	Stable	Regular	Cataract	IOL

Figure 1: Gulanl keratoconus surgical algorithm: visual cases. BCVA: Best-corrected visual acuity, ICL: Implantable contact lens, IOL: Intraocular lens

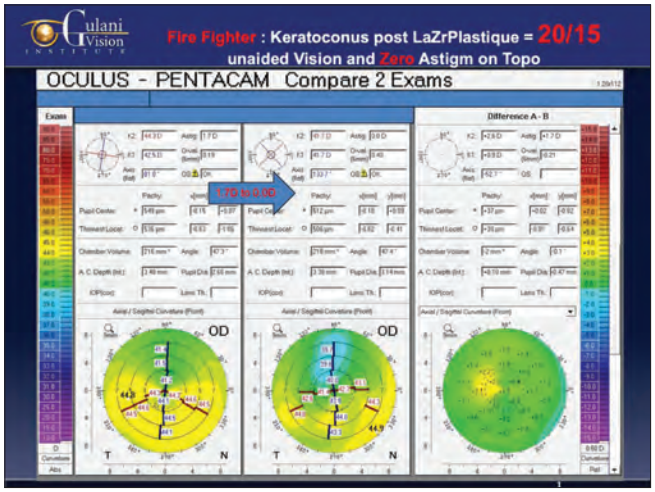

Figure 2: LaZrPlastique® in a visual case of a firefighter to better than 2020 unaided vision

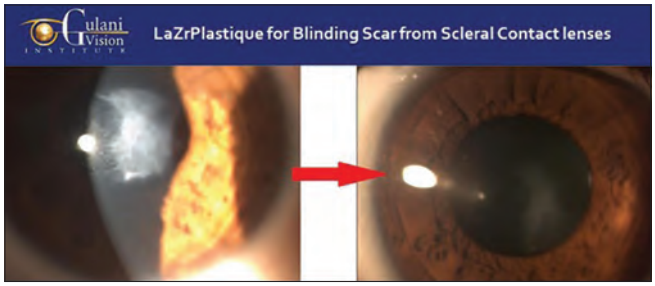

Figure 3: LaZrPlastique® In a corneal scar case straight to unaided vision with a welcome side effect of resolved corneal scar

triggers results in disease manifestation. Genetic risk factors include having a first-degree relative with keratoconus, genetic syndromes (e.g. Ehlers-Danlos Syndrome, Marfan Syndrome, and Down Syndrome), and involvement of specific genetic loci.[2,8-10] Environmental factors implicated in keratoconus progression include eye rubbing, atopy, contact lens use, floppy eyelid syndrome, and exposure to ultraviolet (UV) light.[11-17]

The Paradigm Shift: A Novel Keratoconus Treatment Algorithm

An innovative treatment algorithm advocates for corneal transplant as the last resort treatment. The concept champions a vision-based, holistic approach to keratoconus management with innovative and least interventional surgical techniques and combinations, along with unlimited ground-breaking technology applications, underscored by a globally recognized algorithm "think outside the cone."

Keratoconus philosophy

Management of keratoconus patients involves a shift in mindset among eye surgeons, requiring the belief in the potential for keratoconus patients to achieve good vision and superior patient outcomes. Rather than utilizing surgical interventions to manage disease, they should be regarded as a means to aspire for the patient's best vision potential (BVP). Success in ophthalmology transcends mere disease management or surgical procedures and should incorporate a commitment to achieving the best visual outcomes regardless of the patient's starting point or disease complexities. If the eye retains the potential for vision, it is the surgeon's responsibility to stabilize the disease and aim to achieve unaided emmetropia, whenever possible.

Corneoplastique® and comprehensive ocular surgery

Corneoplastique® is a revolutionary approach that integrates aesthetic, functional, and minimally invasive, vision-oriented techniques that encompass the full spectrum of kerato-lenticulo-refractive surgery (KLEAR™ System). The KLEAR™ system is a customized approach involving all levels of laser-based LaZrPlastique®, Lens-based (LenzOplastique®), and Cornea-based Corneoplastique® techniques and combination surgeries to stabilize keratoconus corneas and strive for emmetropic outcomes. The backbone of this approach is based on the 5S system.[18]

Reframing the keratoconus narrative

Keratoconus often evokes immediate gloom and anxiety among patients and lowered visual prognoses among diagnosing surgeons. Patients diagnosed with keratoconus are often compelled to seek information online due to an existent lack of options, understanding,

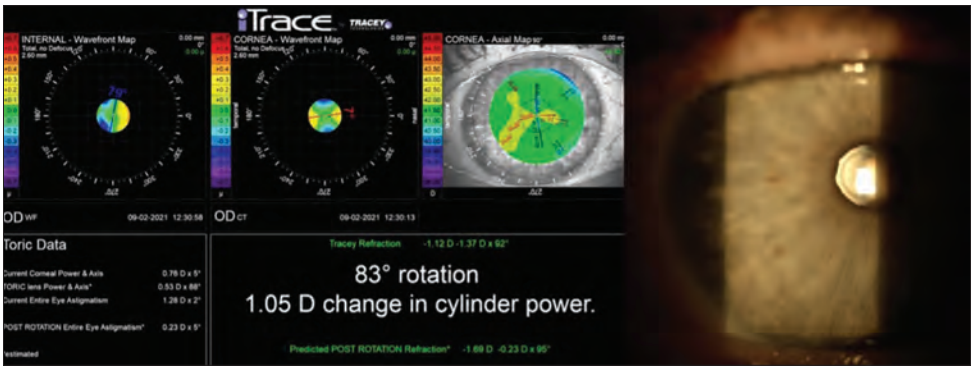

Figure 4: LaZrPlastique® to correct X-wave premium lens cataract surgery to unaided 20/20/Happy visual outcome

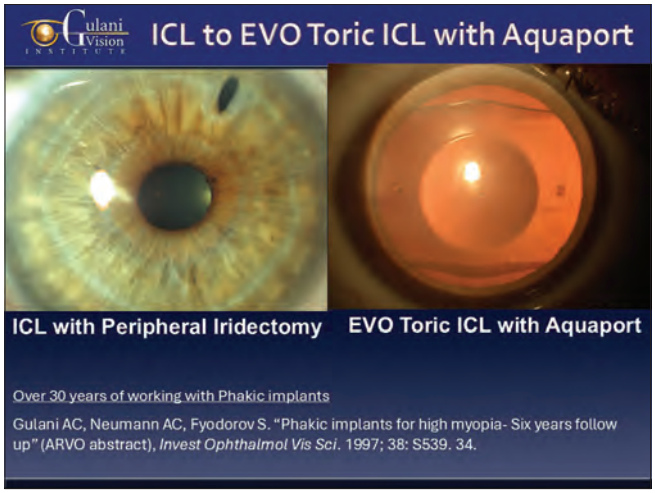

Figure 5: Phakic implants like Visian ICL and EVO Toric ICL in keratoconus eyes to unaided, emmetropic 20/20 outcomes

or empathy, leading to two choices: Either undergoing invasive/hyped/advertised surgeries or resorting to uncomfortable, high-maintenance contact lenses, creating a dual issue of visual disability from suboptimal vision while also dependency on contact lenses. Meanwhile, eye surgeons may focus on advanced corneal transplant techniques as the automatic treatment for keratoconus, inadvertently ignoring the fact that many of these patients do not require such drastic interventions and are able to achieve clear vision without transplantation.

Strategic breakdown and solution design: The LEGO concept

To avoid this reactionary approach, keratoconus should be broken down methodically into manageable components using the 5S system. Keratoconus can be conceptualized as a series of individual abnormalities, including a thin cornea, high keratometry, de-centered apex, irregular astigmatism, and associated ametropia (myopia or hyperopia). By deconstructing the disease into these elements (like Lego pieces), keratoconus becomes less intimidating and more approachable, making it easier to visualize as a refractive surgery-like approach. Consider the example of a patient with keratoconus with a corneal thickness of 450 µm, a documented cone on topography, and high astigmatism (up to seven diopters) with anterior scarring. Using the 5S system, the first goal is ensuring the patient has the potential for functional vision. If the patient has a visual acuity of 20/25, the surgeon's goal should be to ensure the visual acuity remains 20/25 or better. In this example, the patient has visual potential, no corneal scarring, and an unaffected site (center or periphery). Since the patient has a thin cornea (strength) and high astigmatism (shape), the 5S system states that sight and shape should be corrected. Such a patient can therefore undergo LaZrPlastique® straight to vision without glasses or contact lenses.

The "think outside the cone" approach for keratoconus

The most common symptoms patients with keratoconus complain of include blurred vision, halos around lights, starbursts, double or distorted vision, difficulty driving at night, and vision fatigue. Many patients may not experience any symptoms in the early stages of the disease, and others may present post-Lasik surgery with a condition called Lasik Ectasia (cone-like bulging of the cornea analogous to keratoconus) as a complication of LASIK surgery.

Often, patients presenting for a keratoconus evaluation are given the discouraging news that nothing can be done for their disease. However, there is concern that many patients are undergoing corneal collagen crosslinking indiscriminately under the premise of preventing progression. This is akin to applying cement to a scoliotic spine (Kerato-Scoliosis concept) to prevent worsening of the spine curvature without addressing the underlying misalignment. The ideal strategy for keratoconus management should correct the primary corneal deformation before utilizing corneal crosslinking to stabilize the condition (except in those cases where patients are underage or have keratoconus fluctuation and progression that is so rapid and excessive that it

BCVA	REF ERR	PACH	STABILITY	TOPO	PATHO	
< 20/60	Astigm Hyperopia Myopia	> 250	Unstable	Irregular	Ectasia Ant Scar	INTACS
< 20/100	Irreg NI	< 200	Unstable	Irregular	Scar Ectasia	LKplasty
> 20/40	Astigm Hyperopia Myopia	> 300	Stable	Regular	None	CXL

Figure 6: Gulanl keratoconus surgical algorithm: structural cases. BCVA: Best-corrected visual acuity

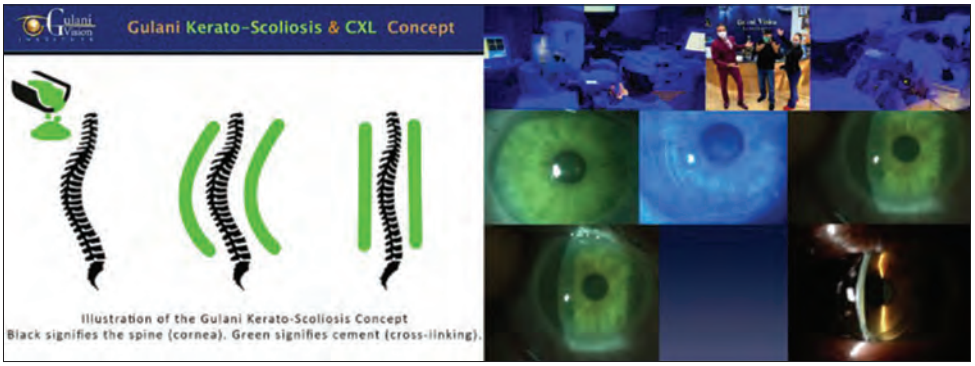

Figure 7: Gulani Kerato-Scoliosis concept to explain how just cross- linking a crooked spine (Keratoconus shaped cornea) does not help unaided vision, while straightening or reshaping the spine (Keratoconus cornea) and then crosslinking it makes unaided vision a real possibility. Associated image with it shows collagen crosslinking in a full range of cases from natural keratoconus to post- lasik and radial keratotomy corneal ectasias

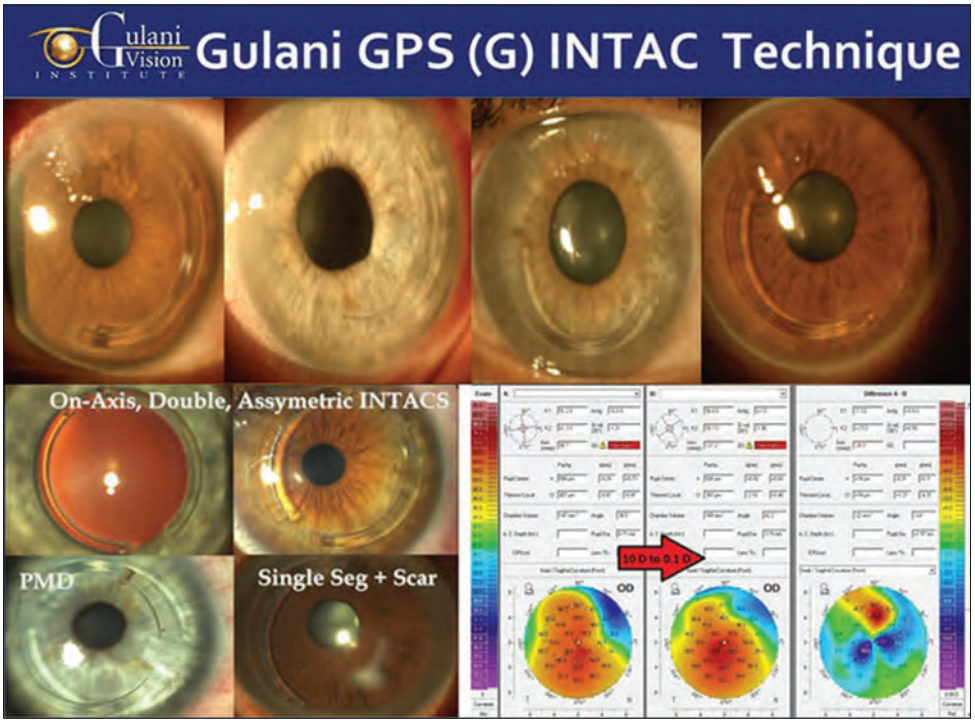

Figure 8: Structural Gulani GPS (G) INTAC techniques with single, paired, Asymmetric and differential Zone and Depth applications, for a full range of moderate to extreme Keratoconus.

needs to be immediately arrested before intervention). In addition, corneal transplants should be reserved as a last intervention for keratoconus, due to inherent risks of graft rejection and the fact that transplantation does not restore vision itself, often requiring the continued use of corrective lenses or glasses.

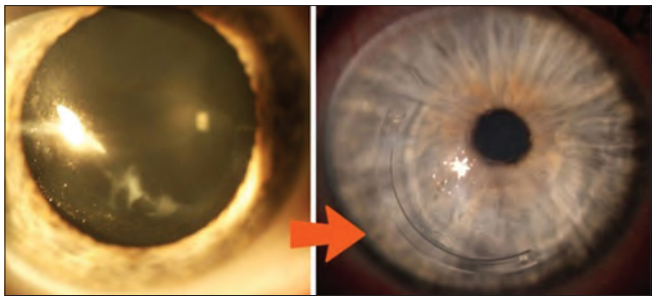

Figure 9: CAIRS complication corrected with G-INTAC technique

Contact lenses are a valuable adjunct in keratoconus management, however, fitting stable, adult keratoconus patients with contact lenses before surgical correction of the keratoconus cornea is comparable to solely placing a brace/crutch on a fractured bone. Although that crutch/brace may allow for ambulation, it does not address or heal the fracture or the misaligned bone, therewith leaving that patient with a permanent handicap while also allowing for further progression of that broken and weak bone to the point of needing amputation (corneal replacement).

Concepts in the keratoconus treatment algorithm

The keratoconus treatment algorithm is based on over three decades of refined proprietary protocols integrating a comprehensive array of anatomical, physiological, and optical parameters following thorough clinical examinations with advanced diagnostic technologies. These parameters include refractive error (REF ERR), lower and higher-order polynomials, BVP, pachymetry, corneal topography and tomographic stability, and associated ocular pathologies. These data points are analyzed within the 5S System to customize treatment into two primary categories: "Visual" and "Structural."

Hard or scleral contact lenses can dramatically improve vision in keratoconus patients, even when the cornea is significantly compromised. Despite the underlying structural irregularities of the cornea and poor visual potential, the hard-surfaced contact lenses override the abnormality and visual incapacity by creating a new, smooth refractive surface to improve visual acuity. These lenses simply act as a bandage over a wound rather than correcting the underlying abnormality.

Visual, structural, and combination techniques

Simply put, visual cases are those patients who can see well with their glasses and include patients who retain good potential for vision despite the severity of their keratoconus or previous surgical interventions. The three visual techniques encompassed by the Keratoconus Treatment Algorithm include[1] LaZrplastique®,[2] Phakic Implants: Visian® and EVO® implantable contact lens (ICL), and[11] Pseudophakic Lens Implants: Monofocal, Toric, X-Wave Technology, etc.

Structural cases are those patients who cannot see well with glasses – in some cases, they may still see well with hard contact lenses or scleral contact lenses. These are patients who no longer possess visual potential due to advanced keratoconus or other complicating factors. Structural techniques within the algorithm for these patients include[1] Corneal Collagen Cross-linking,[2] Intracorneal Implants: Intacs, Kera Ring, Ferrara Ring, etc., and[11] Keratoplasty: anterior, midstromal, deep lamellar, and penetrating.

Unique to the Keratoconus Treatment Algorithm is the combination of Visual and Structural techniques, used to provide customized management approaches for the full range of keratoconus patients.

LaZrplastique® Candidacy Classification System

Level I: Laser as primary treatment

In cases in which laser treatment is indicated as the primary intervention, patients are informed of the objective of achieving visual correction through laser therapy. Surgical interventions outlined in Level II can serve as contingency plans and can be employed in a single or combination approach to manage complications or progression of keratoconus if necessary.

Class A (clear cornea)

Patients with a clear cornea can be treated directly with laser refractive surgery to correct keratoconus and associated REF ERRs.

Class B: (scarred cornea)

Patients with corneal scarring can be treated with LaZrplastique® using Corneoplastique® principles. This corrects the corneal scar, structurally stabilizing the cornea and making it measurable for future premium cataract surgery with advanced intraocular lens (IOLs) to achieve optimal visual outcomes.

Level II: Laser as staged secondary treatment

Class A (after corneal surgery)

1. INTACS®
2. Lamellar Keratoplasty (femtosecond laser or manual techniques)
3. Penetrating Keratoplasty
4. CXL
5. Conductive Keratoplasty.

Class B (after intraocular surgery)

1. Phakic Implantation (anterior or posterior)
2. Cataract Surgery with IOL implantation (monofocal, toric, accommodative, X-Wave technology, or piggyback lenses).

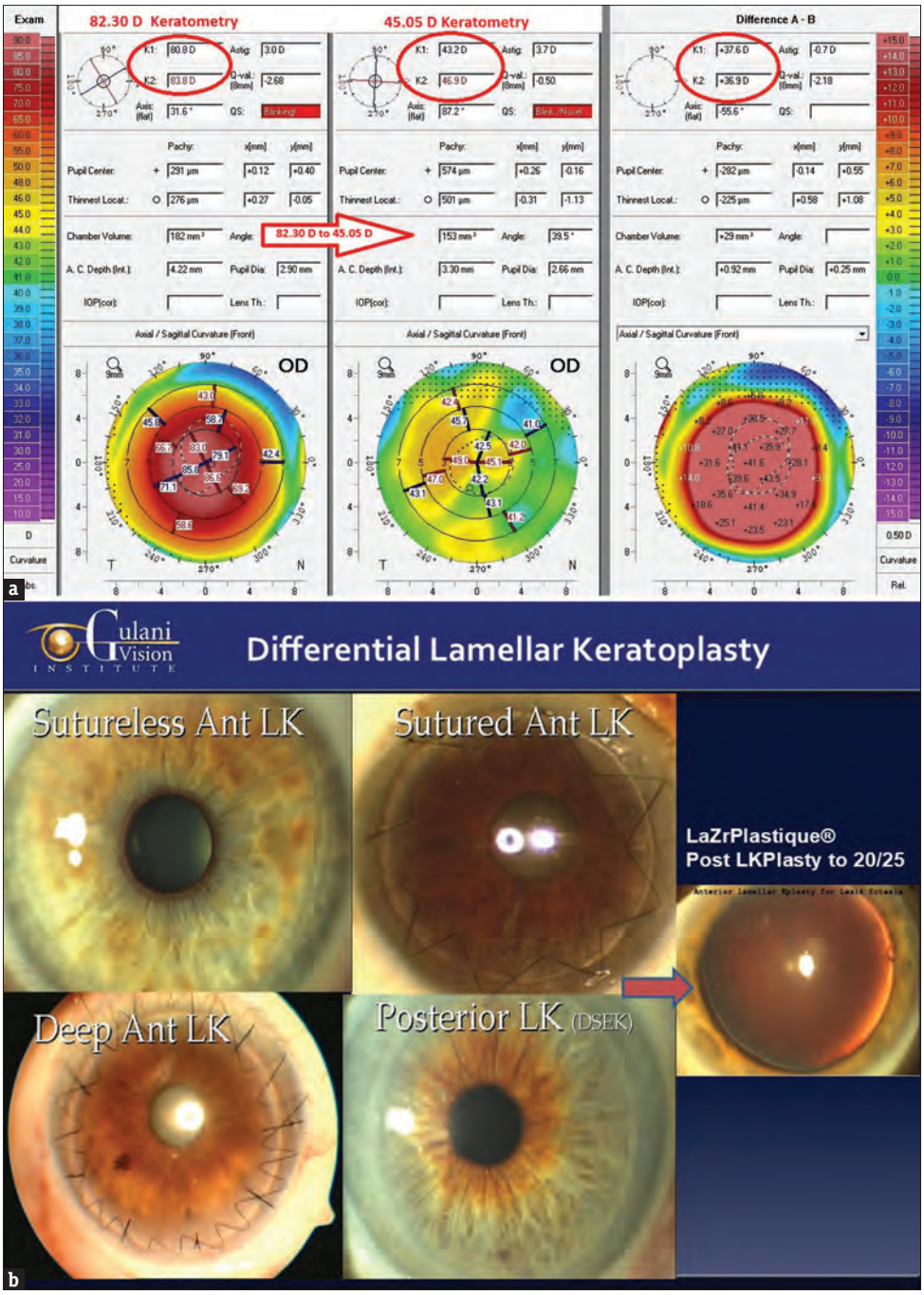

Figure 10: (a) Gulani differential Lamellar keratoplasty techniques following the 5-S system where extreme keratoconus cases can be structurally improved by adding tissue, removing the scar and decreasing the ectasia (note pre and post op astigmatism stays the same, therefore allowing future Visual LaZrPlastique® for Unaided Vision). (b) Associated image shows all levels of lamellar keratoplasty from anterior to posterior in extreme cases of keratoconus

For patients with adequate corneal strength and absence of scarring, lamellar keratoplasty is unnecessary. Instead, LaZrplastique® can be performed to modify the corneal contour and correct astigmatism, aiming for emmetropia. Although outcomes are more predictable with this methodology, patients are informed that they may not achieve the visual acuity of an untreated eye. Thus, INTACS® is discussed as a backup in situations, in which keratoconus progresses due to natural factors or laser treatment.

Corneal Collagen cross lining (CXL) can be integrated as a staged component of the Corneal Contour Modification [(C^2M™)] surgical plan . CXL stabilizes the corneal shape post-LaZrplastique®, making the new shape permanent. It is recommended that in "Measurable" and "Stable" cases, refractive surgical correction precedes CXL unless prior stabilization is necessary.

For thinner corneas with a best-corrected visual acuity of <20/40, INTACS® surgery is preferable. INTACS®

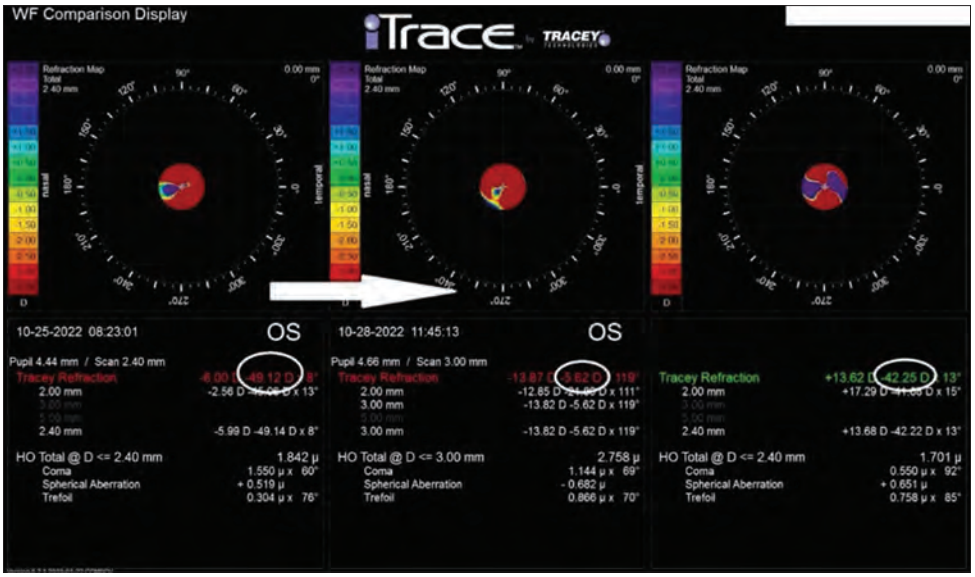

Figure 11: i-Trace topography showing reduction of preoperative irregular astigmatism from over 49.00 diopters to5.00D

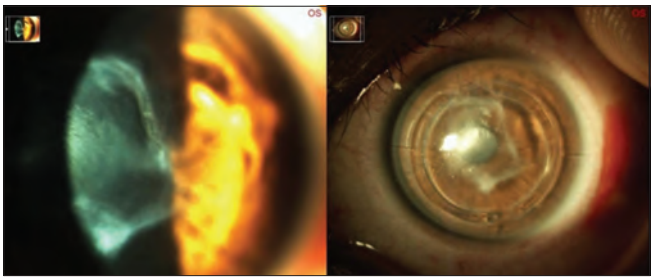

Figure 12: Clinical image (of figure 9) shows the G -INTAC technique for such a profound outcome in extreme keratoconus cases

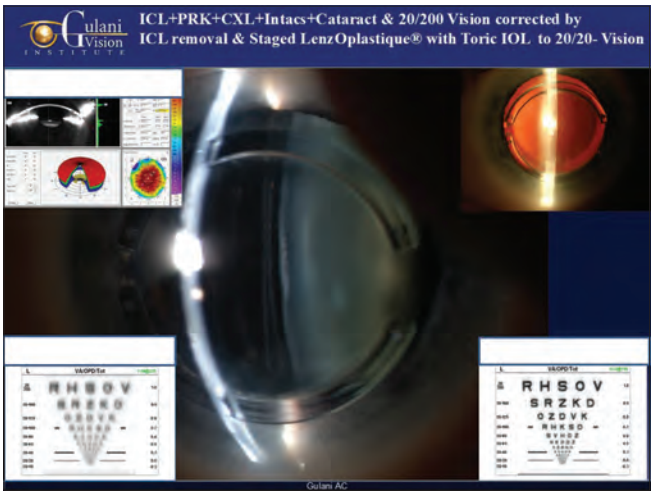

Figure 14: Staged techniques to reverse failed corneal and refractive surgical procedures in a keratoconus patient to 20/20 unaided vision

is the most common Intrastromal Corneal Ring Segments, which are semicircular inserts made of polymethylmethacrylate. INTACS® acts as braces that adjust the corneal height, allowing patients to wear glasses or contact lenses more effectively. INTACS® application may be customized with considerations for

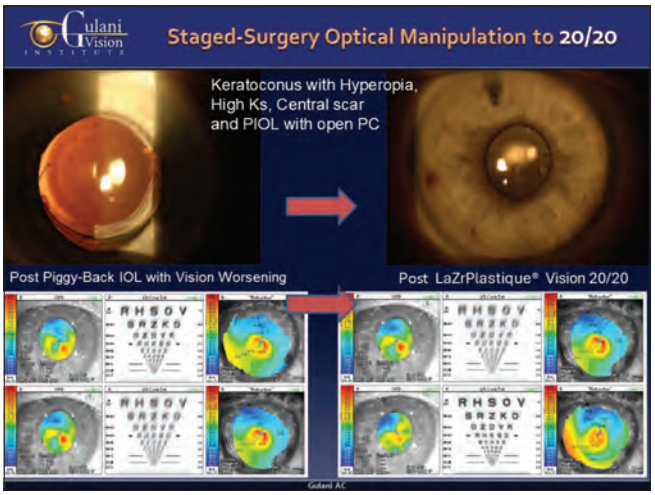

Figure 13: Staged optical manipulation, using topical, brief, and aesthetically pleasing techniques, to correct failed Premium Cataract surgery in a keratoconus patient straight to unaided 20/20 vision

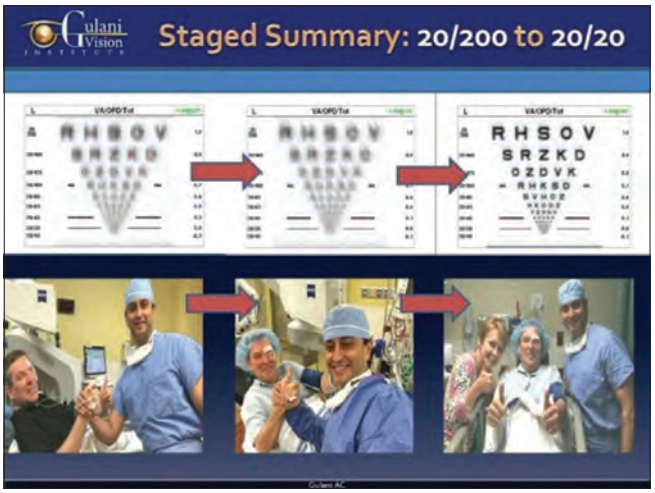

Figure 15: Shows real world patient (of Figure 12 case) reaction right out of surgery stages and vision perception change in sequence to final outcome.

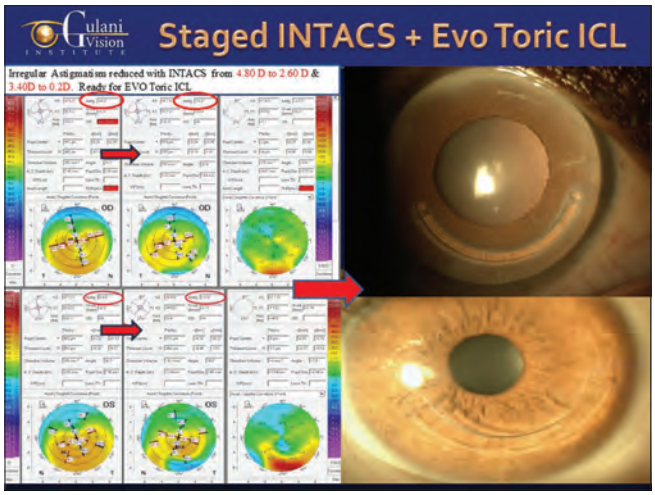

Figure 16: Staging "Structural" G-INTAC technique to be followed by "Visual" EVO Toric ICL to unaided 20/20 vision

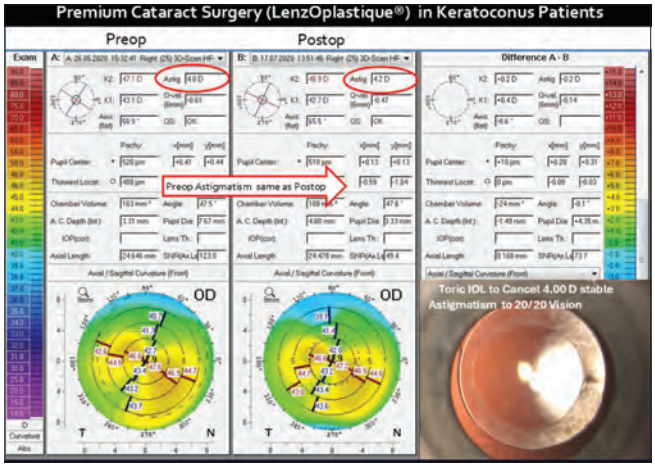

Figure 17: Premium cataract surgery with LenzOplastique® concepts for Keratoconus cases to 20/20 unaided vision (notice how the pre and postoperative corneal astigmatism is the same, but since it is measurable, and stable, one can confidently proceed with intraocular lens-based surgery.)

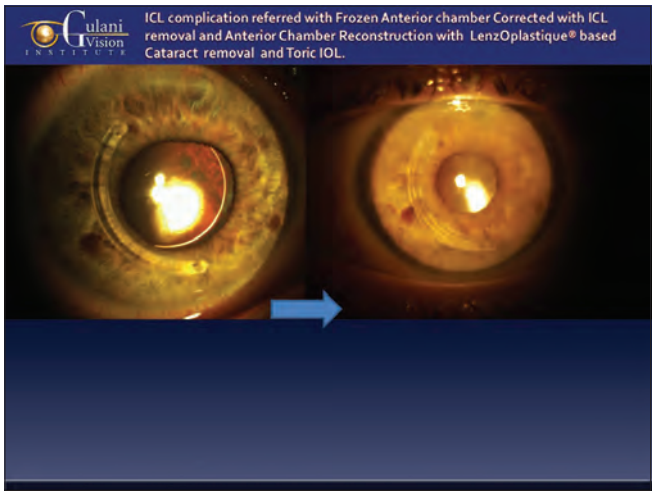

Figure 18: The refractive mindset for artistic and least interventional techniques towards unaided vision goals allows any complication of keratoconus surgeries (like in this case of ICL complication referred with Frozen anterior segment) to be reversed to 20/20 unaided vision

single or paired inserts, steep axis alignment, and varied thicknesses to optimize corneal shape. LaZrPlastique® may also be performed over INTACS® to address residual astigmatism while removing minimal tissue. CXL may then follow to provide structural stability. When a scar is present, the 5S system can be used to remove the scar and correct the corneal shape. LaZrPlastique® then follows using the established protocol.

For patients with a scar, thinner cornea, and structural instability, the 5S system can be employed to clear the central scar and add strength (i.e., thickness). Patients can undergo a variety of Corneoplastique® based Lamellar corneal transplants to address these deficits. Subsequently, LaZrPlastique® can be performed to reshape the cornea and correct the REF ERR, aiming for an emmetropic outcome. High myopia with associated astigmatism may be addressed with phakic IOL implantation ([ICL®/EVO®]) or cataract surgery with advanced IOL options (Monofocal/toric/X-Wave technology), depending on the patient age.

As part of the Kerato-Scoliosis concept, CXL is proposed as the final step in keratorefractive surgery. CXL may also precede refractive surgery in cases of fluctuating refractions and topographies to ensure corneal stability. The procedure involves riboflavin (Vitamin B2) application to the corneal stroma followed by activation with UV light, resulting in a photochemical reaction that creates additional covalent bonds and strengthens the collagen structure within the stroma.[19-23]

Clinical Applications of a Novel Keratoconus Treatment Algorithm for Advanced Keratoconus Management.

The following prototypical cases illustrate the broad applications of the Keratoconus Treatment Algorithm.

Visual cases

Figure 1 shows schematic representing the treatment algorithm for visual cases with final treatment of laser, ICL, or IOL dependent on patients' best-corrected visual acuity (BCVA), REF ERRs, pachymetry, stability, topography, and other relevant pathologies.

Case 1

A young firefighter underwent LaZrplastique® surgery, improving his visual acuity beyond 20/20 without the use of corrective lenses or glasses, resulting in zero astigmatism, and improved night vision, allowing him to continue excelling in his profession [Figure 2]. LaZrplastique® is a No-Cut, No-Blade, No-Flap laser technique that removes minimal corneal tissue to preserve the weakened keratoconus corneal tissue and uses a customized blend laser optical zone to significantly improve patients' visual acuity.

Case 2

Patients who have developed corneal scars because of prolonged contact lens wear or contact lens-related infections for keratoconus management can still benefit from LaZrplastique® treatment using Corneoplastique® principles, allowing for rehabilitation of the cornea without the need for transplantation. This approach allows for the scarred cornea to be refractively sculpted to achieve functional visual endpoints [Figure 3].

Case 3

Patients referred after undergoing premium cataract surgery, such as with Vivity X-Wave technology, can also benefit from LaZrplastique®. After evaluation of the visual potential and confirmation of the stability of the ocular structures, patients can undergo LaZrplastique® surgery while avoiding invasive procedures. Thus, patients can achieve improvement in visual acuity without the need for corrective lenses [Figure 4].

Case 4

In cases of keratoconus with myopia and regular astigmatism, phakic IOLs such as Visian ICL and EVO® Toric ICL have been employed to improve visual acuity [Figure 5]. This approach is advantageous when the keratoconus cornea exhibits significant thinness, circumventing the risks associated with further manipulation of the damaged cornea by instead implanting a phakic IOL, which essentially functions as a permanent contact lens within the eye.

Structural cases

Figure 6 shows a schematic representing the treatment algorithm for structural cases with final treatment of laser, ICL, or IOL dependent on patients' BCVA, REF ERR, pachymetry, stability, topography, and other relevant pathologies.

Case 1

The Kerato-Scoliosis concept [Figure 7] involves proprietary Corneal contour modification (C^2M™) techniques designed for patients with unstable corneas before visual techniques or those which need to be stabilized to make their vision improvements permanent posttreatment. This concept has been applied to the full spectrum of keratoconus, keratoglobus, and pellucid marginal degeneration in addition to cases of surgical keratoconus (LASIK ectasia, Radial Keratotomy, Photorefractive Keratectomy [PRK], and SMILE complications). This technique is noted for its "no pain" approach, providing a comfortable experience for patients.

Case 2

The G-INTAC technique utilizes intracorneal micro INTACS® in customized single or paired combinations [Figure 8]. The technique involves surgical planning concerning entry, axis, alignment, optical zone, and ring segment thickness. This custom-designed Corneal Contour Modification™ (C^2M) employs Femtosecond laser technology and, in some extreme cases, even manual techniques. This can successfully decrease irregular Astigmatism, arrest the progression of keratoconus, and provide structural support for future vision rehabilitation options.

Case 3

Complications arising from Corneal Allogenic Intrastromal Ring Segments (CAIRS), such as corneal scars and unstable corneas, can result in poor visual outcomes and unmeasurable corneas. In these cases, the management strategy consists of assessing the level of complication and visual impact caused by CAIRS, correction of the previous CAIRS channel, and insertion of a designed, single INTACS® ring using Corneoplastique® techniques [Figure 9]. This allows for the modification of the keratoconus corneal contour and removal of the previous scar, improving visual acuity in such patients.

Case 4

In cases in which the keratoconus cornea is significantly anatomically compromised such that it can no longer provide visual function, lamellar keratoplasty techniques can be utilized to restructure the corneas, serving as the foundation for future visual rehabilitation techniques [Figure 10]. In this approach, the thinned and scarred layers of the cornea are removed with the rest of the cornea left in place, and layers from a donor cornea are grafted, clearing the scar, augmenting corneal strength and thickness, and reducing corneal protrusion. This procedure sets the stage for future corrective techniques to then be used to improve visual acuity.

Staged and combination techniques

Salvage cases

Case 1

In this patient who traveled from Asia with Extreme Keratoconus, Unmeasurable and fully Scarred, but given his young age, we performed a high-level Corneoplastique® based Micro segment INTACS in a differential manner and brought his over 49.00 Diopter Irregular Astigmatism to 5.00 D, so he can wear contact lens and avoid a corneal transplant [Figures 11 and 12].

Staged cases

In cases of advanced keratoconus, interventional strategy involves a staged approach, aiming to restore optimal visual function, tailored to the specific needs of each patient.

Case 1

This keratoconus patient presented with poor vision

following cataract extraction complicated by a suboptimal visual outcome, including farsightedness, corneal scarring, high keratometry, and irregular astigmatism. In addition, the cataract extraction had resulted in the inadvertent opening of the patient's capsular bag, complicating subsequent IOL exchange. Despite these challenges, this case exemplifies the pursuit of visual perfection through an alternative, less invasive approach utilizing a comprehensive 5S system, or a single surgical intervention to address all five complications with the least invasiveness. Generally, this would be through a myopic LaZrplastique® technique. However, given this patient's hyperopia, a uniquely tailored approach was required.

Notably, an additional IOL was implanted in a piggyback configuration to the patient's prior lens implant, inducing myopia while degrading the patient's vision. Subsequently, the myopic LaZrplastique® surgery was applied to correct all five complications within minutes, allowing the patient to achieve emmetropia without reliance on corrective glasses or lenses. Despite the many complexities of this case, this staged technique transitioned the patient from a significant visual defect to optimal visual acuity within minutes without pain or needles [Figure 13].

Case 2

This keratoconus patient presented after experiencing 12 surgical failures, including CXL, laser PTK, PRK, INTACS, and ICL insertion. Despite the many complexities and challenges of the case, intervention was attempted to provide optimal vision. As part of this intervention, the existing INTACS was preserved, and the ICL was removed to then stage a cataract surgery (LenzOplastique®) and allow the patient to achieve emmetropia without corrective lenses or glasses. This strategy aims at reversing the complications of previous failed surgeries to achieve optimal outcomes [Figures 14 and 15].[24]

Case 3

Corneoplastique®-based INTACS microsegments can be used to tame very irregular keratoconus eyes to make them "Measurable" and once determining "Stability," these patients can undergo "Visual" surgery like EVO® Toric ICL, straight to vision without glasses [Figure 16].

Conclusion

Keratoconus is a condition that visually disables patients, many of them in their youth, and alters the direction of their life where many of them give up on their dreams in their professional and personal lives, especially because they are provided with very few options other than to accept the diagnosis, left dependent on expensive and difficult to maintain contact lenses while awaiting the dreaded corneal transplant.

The novel Keratoconus Surgical Algorithm offers a comprehensive approach for a spectrum of ocular conditions, ranging from virgin REF ERRs to extreme, including keratoconus. Viewing keratoconus with the goal of attaining optimal visual outcomes, this system advocates for a new standard in keratoconus management matching the optimism and commitment to that of refractive surgery cases [Figure 17]. New-generation contact lenses, including scleral lenses and three-dimensional printed lenses, offer solutions to patients with advanced keratoconus, but correcting the corneal situation surgically remains essential to preventing the progression of keratoconus and maintain and preserve or enhance the visual function.

Collaboration with the patient's existing eye care team provides a complete status of their refractive stability, history, and visual potential, which can then be utilized for tailored surgical planning to maintain or improve that level of vision. In cases with extreme levels of keratoconus that require corneal transplantation, a staged approach from structural to visual restoration should be emphasized. Although every extreme structural case need not necessarily become visual, every eye surgeon must strive with optimistic dedication no matter how complex or complicated that patient's level of keratoconus is [Figure 18]. This refractive surgery-oriented approach with safety protocols and observations for keratoconus promises to revolutionize the management of this condition with a new era of relieving while also enhancing the lifestyle of this deserving patient population.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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Review Article

Review on Cataract

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Abstract

Cataracts are a type of lens degeneration that is among the primary causes of preventable blindness worldwide and is characterized by clouding and blurry vision. The prevalence of cataracts is expected to increase as life expectancies rise around the world, especially in low-income countries with inadequate accessibility to therapy. Although detachment of retina which is side effect of cataract surgery is generally safe and this condition can treated with less expensive treatments. Many complex enzymes and nonenzymes are found in the lens, and they remove reactive oxygen compounds to safeguard lens proteins. This major antioxidant defense system's depletion and/or failure contribute to the lenticular molecules and their repair processes damage, which in turn leads to cataracts. Treatments have been used to prevent cataracts caused by artificial means *in vivo*, *in vitro*, and *ex vivo*. Many anti-cataract substances are under investigation which are extracts from plants possessing anti-inflammatory, antioxidant properties.

Keywords: *Antioxidant, cataract, cataract surgery, lens degradation, treatments*

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Introduction

Cataract, a prevalent ophthalmic condition, represents the progressive clouding of the eye's natural lens, leading to visual impairment. The lens, responsible for focusing light onto the retina, undergoes changes over time, resulting in a loss of transparency. This natural aging process, compounded by environmental factors, can give rise to cataracts. Beyond age-related cataracts, traumatic injuries, genetic predisposition, and certain medical conditions such as diabetes can accelerate their development.[1]

Manifesting initially with subtle vision changes, cataracts eventually cause symptoms such as blurred or hazy vision, sensitivity to glare, difficulty discerning colors, and reduced night vision. These visual disturbances often necessitate intervention to restore optimal eyesight, and cataract surgery emerges as the primary and highly effective treatment.[1]

Cataract surgery is a sophisticated procedure aimed at removing the clouded lens and replacing it with an artificial intraocular lens (IOL). This surgical technique has evolved significantly over the years, with modern advancements such as phacoemulsification, a method employing ultrasound energy to break up the cloudy lens for easier removal. This minimally invasive approach has substantially reduced recovery times and enhanced surgical outcomes.[1]

The decision to undergo cataract surgery is based on the degree of visual impairment and its impact on daily activities. Before the surgery, a thorough eye examination is conducted to assess the specific characteristics of the cataract and determine the most suitable IOL for the patient's needs. IOL options include confocal lenses for clear distance vision and multifocal lenses for improved near and far vision.[1]

Cataract surgery is generally considered safe, with a high success rate in restoring vision. It is an outpatient procedure that typically requires only local anesthesia, contributing to the convenience of the surgery. Patients often experience a significant improvement in vision shortly after the surgery, and postoperative care involves the use of prescribed eye drops and periodic follow-up appointments to monitor healing.[1]

In conclusion, cataracts, while a common consequence of aging, can be effectively addressed through advanced

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and precise surgical interventions. The evolution of cataract surgery techniques underscores the commitment to enhancing visual outcomes and improving the overall quality of life for individuals affected by this prevalent eye condition.[1]

Pathophysiology of Eye

Vision, the act of seeing, is extremely important to human survival because it allows us to view potentially dangerous objects in our surroundings. Our retinas contain over 50% of the physique's sensory organs, and a significant portion of the central nervous system is dedicated to analyzing visual data. Ophthalmology (ophthalmic- = eye; -logy = study of) is the science that deals with the eyes and their disorders.[1]

The sun emits rayon, which is power that takes the form of waves. There are many types of electromagnetic radiation, including gamma rays, X-rays, ultraviolet (UV)-rays, visible light, infrared radiation, microwaves, and radio waves. This range of electromagnetic radiation is known as the electromagnetic spectrum. The distance between two consecutive peaks of an electromagnetic wave is the wavelength. The eyes are responsible for the detection of visible light, the part of the electromagnetic spectrum with wavelengths ranging from about 400–700 nm. Visible light exhibits colors. The length of time of light that is visible influences the color.[1]

Accessory structures of the eye

Human lacrimal (tear-producing) apparatus, eyebrows, the eyelids, lashes on the eyes, and external muscles around the eyes were characteristics of the various external structures of the eye.[1]

Eyelids

The upper and lower eyelids covers the eyes during sleep for protection from excessive light and foreign objects over the eyeballs. The upper eyelid is more movable than the lower eyelids. An irritation twitch on the eyelid or involuntarily shaking simulating spasms in the together, wrist, leg, or foot can happen frequently. Twitches are almost always harmless and usually last for only a few seconds. They are frequently related to tiredness and stress. Palpebral fissure encompasses the exposed area between the top and bottom eyelids. Its angles are known as the lateral commissure which is narrower and closer to the temporal bone and the medial commissure which is broader and nearer to the nasal bone. Lacrimal caruncle is reddish, nodular structure located in the lacrimal lake which is small triangular space that lies in the medial palpebral commissure. These glands produce the white substance that frequently gathers in the medial commissure. Eyelid is made up of the layers which contains skin, dermis, tarsal plate, etc. The eyelids' shape and balance are provided by the tarsal plate, a substantial fold of tissue that connects. Tarsal or meibomian gland is the elongated and modified sebaceous gland which extended through tarsal plates and it discharge the a fluid that keeps eyelid sticking to one another. A chalazion is an expansion or cyst on the eyelids caused by tarsal gland inflammation. The conjunctiva is a thin, protective mucous membrane composed of nonkeratinized stratified squamous epithelium with numerous goblet cells that is supported by areolar connective tissue. The cornea, a transparent region which makes up the outer anterior surface of the eyeball, is not enveloped by the palpebral conjunctiva, which lines the inner part of the eyelids, and the bulbar conjunctiva, which extends through the eyelids onto the surface of the eyeball, covering the sclera, or "white" of the eye. The conjunctiva is capillary through the sclera. We will discuss the cornea and the sclera in more detail shortly. Bloodshot eyes are triggered by dilation and congestion of the bulbar portion of the conjunctiva blood vessels as the outcome of local irritation or infection.[1]

Eyelashes and eyebrows

Eyelashes are grow from the border of eyelid and the eyebrows, which helps to protect the eyesight from foreign objects, perspiration, and direct sunlight. Sebaceous glands at the base of the hair follicles of the eyelashes, called sebaceous ciliary glands which release a lubricating fluid into the follicles. Infection of these glands, usually occurs due to bacteria's which causes a painful, pus-filled swelling called a stye.[1]

The lacrimal apparatus

The lacrimal apparatus (lacrim- = tears) is a group of structures that produces and drains lacrimal fluid or tears in a process called lacrimation. The lacrimal glands, each about the size and shape of an almond, secrete lacrimal fluid, which drains into 6–12 excretory lacrimal ducts that empty tears onto the surface of the conjunctiva of the upper lid. The tears pass medially over the anterior surface of the eyeball to enter two small openings called lacrimal punctual (singular is uncut). Tears then pass into two ducts, the superior and inferior lacrimal canaliculi, which lead into the lacrimal sac (within the lacrimal fossa) and then into the nasolacrimal duct. The lacrimal fluid travels through this duct into the nasal cavity, where it merges with mucus more above the inferior nasal concha. The expression dacryocystitis refers to an infection of the lacrimal pockets (dacryo- = lacrimal sac; -itis = inflammation of). It is usually caused by a bacterial infection and results in blockage of the nasolacrimal ducts. The lacrimal glands are supplied by

parasympathetic fibers of the facial (VII) nerves. These glands produce a watery fluid called lacrimal fluid that contains salts, some mucus, and a protective bactericidal protein lysozyme. The solution lubricates, moisturizes, cleans, and protects the eyeball. Blinking of the eyelids spreads lacrimal fluid, which is secreted from a gland called the lacrimal gland, medially over the outermost portion of the cornea. Each gland produces about 1 mL of lacrimal fluid per day. Normally, tears are cleared away as fast as they are produced, either by evaporation or by passing into the lacrimal canals and then into the nasal cavity. However, the glands that produce lacrimal fluid are caused to oversecrete when an irritating material gets into contact with the conjunctiva, which results in a buildup of tears (watery eyes). Because the irritating material is reduced and washed away by the tears, lacrimation serves as a means of defense. Watery eyes can also happen when the nasolacrimal ducts become blocked from draining tears due to infection of the nasal mucosa, which may occur with a cold. Crying is the sole means by which people express emotions, particularly happiness and depression. Only humans express happiness and sadness by crying. In response to parasympathetic stimulation, the lacrimal glands produce excessive lacrimal fluid that may spill over the edges of the eyelids and even fill the nasal cavity with fluid. This is how crying produces a runny nose.[1]

Extrinsic eye muscles

The orbits, a pair of bony depressions in the skull, are at which the eyes reside. In alongside giving protection, the orbits work as the eyes' docks to the muscles that produce their necessary motions and to stabilize them in all three directions. There is a significant sum of periorbital fat around the extrinsic eye muscles that run from the walls of the bony orbit to the sclera (white) of the lens of the eye. The eye may be shifted in nearly any position by these muscles. Each eye can be moved by six unique extrinsic eye muscles: the superior, inferior, lateral, medial, and superior oblique muscles.[1] Superior view of transverse section of right eyeball and Responses of the pupil to light of varying brightness was shown in Figures 1 and 2.

Anatomy of eye

The adult eyeball measures about 2.5 cm (1 in.) in diameter. Of its total surface area, only the anterior one-sixth is exposed; the remainder is recessed and protected by the orbit, into which it fits. Anatomically, the wall of the eyeball consists of three layers: fibrous tunic, vascular tunic, and retina (inner tunic).[1]

Fibrous tunic

Containing the anterior cornea and posterior sclera, the fibrous tunic is the outermost part of the eyeball. The colored iris is hidden behind a transparent layer termed the cornea. Cornea is the curved surface which acts like lens and begins to focus the light on retina. The middle coat of the cornea consists of collagen fibers and fibroblasts, and the inner surface is simple squamous epithelium. Since the central part of the cornea receives oxygen from the outside air, contact lenses that are worn for long periods of time must be permeable to permit oxygen to pass through them. The sclera (sclera- = hard), the "white" of the eye, is a layer of dense connective tissue made up mostly of collagen fibers and fibroblasts. Fibrous tunic: Containing the front cornea and posterior sclera, the fibrous tunic is the outermost portion of the eyeball. The colored iris is concealed by a transparent covering termed the cornea. The cornea helps in fixing light onto the lens of the retina because of its slight curve. Nonkeratinized layers of squamous epithelium comprise its outer surface.[1]

Vascular tunic

The vascular tunic is the center of the eyeball. It is composed of three parts: choroid, biliary body, and iris. The highly vascularized region of choroid, which is the posterior portion of the vascular tunic which lines most of the internal surface of the sclera with its countless veins of blood which provide nutrients. This layer's dark brown color is because of the melanocytes in the choroid, which also produce the pigment melanin. Stray light rays pass through melanin in the choroid, prevent light from scattering and disseminating across the eyeball. As a result, the image cast on the retina by the cornea and lens remains sharp and clear. In the anterior portion of the vascular tunic, the choroid becomes the ciliary body. It extends from the jagged anterior margin of the retina to a point just posterior to the junction of the sclera and cornea. Similar to the cartilage, the body of the cilia displays a dark brown color due to its abundance of melanocytes which generate melanin. In addition, ciliary channels and the muscle of cilia make the structure of the ciliary body. Zonular ligaments fibers or suspensory tendons that stick to the lens extend from the ciliary process. Elastic fibrous tissue fibers have a similarity of the thin, flat fibrils which compose form the fibers. The ciliary muscle is a circular band of smooth muscle. Contraction or relaxation of the ciliary muscle changes the tightness of the zonular fibers, which alters the shape of the lens, adapting it for near or far vision. The iris is a doughnut-shaped, muscular curtain that opens and closes to regulate the amount of light entering in the eye. It links to the ciliary processes at the outermost point and swings between the surface of the cornea and the lens. Melanocytes and radial and circular smoother muscle fibers create that framework. The color of the pupils is affected by the amount of pigmentation

in the iris. When the iris contains an excessive amount of melanin, the eyes appear brown to black; when the iris has a low concentration of melanin, the eyes appear blue; and when its amount of melanin is moderate, the eyes appear green. A principal function of the iris is to regulate the amount of light entering the eyeball through the pupil, the hole in the center of the iris. Because the extremely pigmented back of the eye is seen via the lens, the pupil appears black. On the other hand, because of the blood vessels on the surface of the retina, red light is reflected back while bright light is directed into the pupil. When a flash is aimed squarely at the pupil then subject's eyes seem red and thses behavior called as "red eye". Pupil diameter is controlled by autonomic reflexes in response to light intensity. The parasympathetic fibers of the coulometer (III) nerve induce the sphincter papillae or circular muscles of the iris to contract in response to excessive light enjoyment, which results in a constriction of the pupil. Sympathetic neurons activate the radial muscles or dilator in darkness.[1]

Retina

The third inner layer of the eyeball is the retina which is the beginning of the visual pathway. This layer's anatomy can be viewed with an ophthalmoscope, an instrument that shines light into the eye and allows an observer to peer through the pupil, providing a magnified image of the retina and its blood vessels as well as the optic (II) nerve. The surface of retina is the only location in the body where blood vessels can be directly observe and evaluated for pathological conditions, such as diabetes, hypertension, cataracts, and age macular disease. Many kinds of landmarks may be viewed utilizing an ophthalmoscope. The optic (II) nerve exits the eyeball near the optic disc. The primary retinal vein, a branch out of the ophthalmic artery, and the artery that runs through the retina are bundled in tandem with the optic nerve. The central ocular artery branches out to nourish the anterior surface of the retina; the central retinal vein drains blood from the retina through the optic disc. Also visible are the macula lutea and fovea centralis, which are described shortly. The retina contains a pigmented layer with a neural layer. The pigmented layer is melanin-containing epithelial cell placed in the region between the retina and the choroid. Likewise, in the choroid, the pigmentation layer of the retina's melanin contributes to the absorption of stray light rays. The retina is neural (sensory) multilayer that shows a great deal of visual information before nerve impulsesare sent into the axons. The outer and interior synaptic layers, which are where connections between neurons emerge, split the three distinctive layers of retinal neurons: the retinal photoreceptor cell layer, the network layer, the bipolar column layer, and the ganglion-like cell layer. It should be noted that before reaching the photoreceptor layer, light comes through the ganglion, bipolar cell, and both synaptic layers. Two other types of cells present in the bipolar cell layer of the retina are called horizontal cells and amacrine cells. These cells form laterally directed neural circuits that modify the signals being transmitted along the pathway from photoreceptors to bipolar cells to ganglion cells. Photoreceptors are specialized cells in the layer of photoreceptors that begin the process of turning light particles into nerve impulses. Rods and cones are the two distinct types of photoreceptors. Retina has about 120 million rods and 6 million cones. Humans can see in low light due to rods. In low light, humans can see just black, white, and gray because rods are fail to ensure color vision. Cones are triggered by a brighter light, which results in color vision. There are three numerous types of cones in the retina: greenish cones, blue cones and red cones. From photoreceptors, information flows through the outer synaptic layer to bipolar cells and then from bipolar cells through the inner synaptic layer to ganglion cells. The axons of ganglion cells extend posteriorly to the optic disc and exit the eyeball as the optic (II) nerve. The optic disc is known as a blind spot. Because it shows no presence of the rods.[1]

Lens

The lens lies within the eyeball's cavity, behind the pupil and iris. The refractive media of the lens, which is typically entirely transparent and lack of blood vessels, is composed of proteins called crystalline that are stacked inside the lens's cells like layers on an onion. It stays firmly anchored by encircling zonular fibers that adhere to the ciliary processes, and it is enclosed by a transparent capsule of connective tissue. To enable clear seeing, the lens aids in condensing images on the retina.[1]

Interior eye cavities

The anterior cavity and vitreous chamber are the two interior visual cavities that separate by the lens. Two chambers serve as the anterior cavity. Situated between the iris and the cornea is the anterior region. Located in front of the lens and consular fibers, the posterior chamber resides behind the iris. These watery fluid called as aqueous humor, which nourishes the cornea and lens and covers both chambers located in the anterior cavity. Aqueous humor multiple times enters the posterior chamber of the ciliary body using blood vessel walls in the ciliary processes. After going through the pupil and between the iris and lens, it then joins the anterior chamber. Aqueous humor escapes into the scleral region from the anterior chamber.[1]

Image formation

To understand how the eye forms clear images of objects on the retina, we must examine three processes:

1. The refraction or bending of light by the lens and cornea
2. Accommodation, which is the change in shape of the lens
3. Constriction or narrowing of the pupil.

The refraction or bending of light by the lens and cornea

When light rays traveling through a transparent substance pass into a second transparent substance with a different density, they bend at the junction between the two substances. This bending is called refraction. Light shines are refracted at the anterior and posterior surfaces of the cornea when they enter the eye. The light rays are further scattered by both surfaces of the eye's lens, pulling them directly into focus on the retina. About 75% of the total refraction of light occurs at the cornea. The lens provides the remaining 25% of focusing power and also changes the focus to view near or distant objects. When an object is 6 m (20 ft.) or more away from the viewer, the light rays reflected from the object are nearly parallel to one another.[1]

Accommodation, the change in the shape of the lens

A surface that curves outward, like the surface of a ball, is said to be convex. When the surface of a lens is convex and lens will refract incoming light rays to each other, so they can eventually intersect. If the surface of a lens curves inward, like the inside of a hollow ball, the lens is said to be concave and causes light rays to refract away from each other. The lens of the eye is convex on both its anterior and posterior surfaces, and its focusing power increases as its curvature becomes greater the lens curves more when the eye is focused on a close object, thereby increasing the rate of light that is filtered. Accommodation is the term for this increase in the lens's curvature for adjacent vision. The shortest distance at which an item can be maximally absorbed and still be clearly concentrated is known as the near point of vision. In a young adult, this distance is about 10 cm (4 in.).[1]

Constriction or narrowing of the pupil

The circular muscle fibers of the iris also have a role in the formation of clear retinal images. As you have already learned, constriction of the pupil is a narrowing of the diameter of the hole through which light enters the eye due to the contraction of the circular muscles of the iris. His autonomic reflex inhibits light rays from entering the eye through the lens's periphery at the identical period as accommodation. Blurred vision could result in light rays entering at the periphery having no focus on the retina.[1]

Cataract

Cataracts are cloudy or opaque areas in the lens of the eye (which should usually be completely clear). This results in changes that impair vision. Age-related (or senile) cataract is defined as the cataract occurring in people is <50 years of age in the absence of known mechanical, chemical, or radiation trauma. This review covers treatment for age-related cataract in four different populations: people without ocular comorbidity, people with glaucoma, people with diabetic retinopathy, and people with chronic uveitis. Surgery for cataract in people with glaucoma may affect glaucoma control, and in people with diabetic retinopathy, the usual acuity after surgery for cataract may be lower; the optimal strategy for treating these conditions when they co-exist is not clear.[2-4]

Cataract is the leading cause of blindness worldwide, it refers as the lens degradation that is characterized by clouding with blurry or hazy vision.[5] There is an evidence that cataract account for 10.8 million out of 32.4 million blind individuals, and that 35.1 million out of 191 million people with impaired vision globally have the depilating disease.[6] The prevalence of cataract increases exponentially after 40 years of age, ranging from 3.9% among 55–64 years old to 92.6% among those 80 years and older.[3,7,8] In the US, number of people suffering from cataract is the projected to double from 24.4 to 50 million by the year 2050.[9] Studies have prove that the common risk factor of risk factors includes age smoking UV radiation, female gender, steroid consumption, diabetes mellitus, and high body mass index. As life expectancies improve throughout the globe, the number of people suffering from cataracts is predicted to increase worldwide, especially in low-income nations that lack easy access to cataract surgery, warranting a search for cheap, pharmacology alternatives to the management of this disease.[10-12]

Cataract is complete or partial opacification of sufficient severity on or in the human lens or in the capsule, which impairs vision. It is one of the leading causes of reversible blindness in the world today. The pathophysiology behind that oxidation is very early or initial event in the overall process in the sequence of events that leads to cataract.[17,18]

According to the World Health Organization report, cataract is the leading cause of blindness, responsible for 47.8% of blindness and accounting for 17.7 million blind people. Blindness due to cataract ranges from as low as 5% in the USA, the UK, and Australia to as high as 58.5% in countries such as Peru and to 55% in some parts of Africa.[2] Thus, there is a huge variation

in the prevalence of blindness due to cataracts. The factor explaining these variations in the indicators for monitoring the cataract program can be a good tool to compare differences across these countries. These indicators include the prevalence and incident of blinding the visually impaired cataract, cataract surgical rate, cataract surgical coverage, and usual outcomes.[19]

Cataract is the visual cause of disability and blindness in the aging population presenting enormous financial burden for both government and individuals.[20] Handling a constantly increase in demand for highly successful and cost-effective cataract extraction is great challenge for the public health system.[21] Heredity is the major determinant for the development of cataract.[22] The hereditary component is responsible for up to 70% of cataract cases.[23] The role of genetics has been shown repeatedly through the case observation family studies and studies of twins.[24-27] Heritability is clearly not limited to only congenital cataract, but it is also important in the development of age-related nuclear and cortical opacities.[24,25,28] The term external risk factor for cataract refers to those risk factors that are not hereditary. The non-hereditary age-related cataracts is understood and the effect of many unknown risk factors blunded with old age contributing external risk factor; every hypothesis is an important and quantitative analysis due to various possible risk factors. Sometimes cataract is associated with diseases such as diabetes and its treatment are interviewed, and it can be difficult to determine whether the risk is external or internal. A large number of epidemiological associations were suggested between various health hazards and cataract prevalence. The associated factors can either be merely markers or real causes of disease.[29,30]

Morphology

Nuclear cataract

Nuclear cataract is usually present at birth and is nonprogressive. In cases with dense cataracts where early surgery is mandatory, the cataracts are of the nuclear type. The opacification is located in the embryonic and fetal nuclei between the anterior and posterior Y sutures and is usually very dense in the center. The eyes are almost always smaller than normal eyes. In animal studies, it has also been found that removal of the crystalline lens at an early age reduces eye growth, regardless of whether the animal has a good retinal image or not. The cataract is bilateral in about 80% of cases. For individuals with bilateral congenital nuclear cataract, inheritance can be demonstrated in 30%–50% of cases. The inheritance is mainly autosomal dominant having one of the parents is affected.[31]

Posterior cataract

Infants and children are commonly associated with persistent fetal vasculature, and the affected eye is usually microphthalmic. The retrolental vascular structure in contact with the lens capsule gives blood vessels encompassing the lens, causing hemorrhage, during surgery. The fibrovascular stalk may cause tractional retinal detachment. After early surgery, secondary glaucoma is, unfortunately, a common complication in these eyes.

After the hard period of visual development,the cataract linked with posterior lenticonus or posterior lentiglobus. It generally happens unilaterally and rarely. It generally happens rarely. The lens alteration begins as a tiny defect in the posterior lens, which gradually increase and causing the posterior to bulge, the subcapsular lamellae get unorganized and the lens to become opaque. During surgery, it is necessary to be aware of the posterior capsule's brittleness in these eyes and, if at all possible, prevent hydrodissection. A preexisting posterior capsule defect in cases with congenital cataract is a challenge to the surgeon, and it is important to detect this before surgery.[31]

Lamellar cataract

Lamellar cataract usually develops after the establishment of fixation. The cataract may remain subclinical for many years, but it is usually continuous and surgery, including the implantation of IOLS, is frequently performed before the patient enters school age. The cataract formation, vision and treatment mentioned in Figures 1-6. The lamellae enveloping the fatal nucleus external to the Y sutures are affected by the cataract. The corneas of eyes without lamellar cataracts typically have normal sizes. The illness is always bilateral, and it usually inherits through autosomal dominant pattern.[31]

Other morphological types of cataract

There are some other morphological types of congenital cataracts. Some are the result of lenticular developmental defects present at birth. These may have little influence on vision. Such defects are sutural cataract and anterior polar cataract, which usually do not progress. The main risk factor for amblyopia in congenital anterior lens opacities is an isometropia and, surprisingly, not the diameter of the cataract.[31]

Classification, signs, and symptoms of cataract

Cataracts are classified based on the type of disease and specified location of opacity. Table 1 provides the etiology classification of various forms of cataracts summarized by Gupta *et al*.[13] Congenital and development cataracts occur during fetal growth or growth of children. Age-related cataracts are associated

with old age and are mainly attributed to oxidative stress. Traumatic complicated and metabolic cataracts are attributed to physical trauma, inflammatory and degenerative eye disease, and metabolic disease, respectively. On the contrary, toxic, radiation, and electrical cataracts occur due to exposure to toxicants, electromagnetic waves, and high electric current.[22]

Age-related cataracts can be further classified based on the anatomical location of opacity within the lens into nuclear, cortical, and posterior subcapsular cataracts.[14] Nuclear cataracts affect the center of the lens, with the lens becoming yellow or brown after hardening. Nuclear cataract is common with older age and is associated with myopia. In contracts, cortical cataracts affect the outer fibers of the lens and assume a wedge-shaped appearance. Cortical cataracts can cause alteration of vision as much as nuclear cataracts caused. Posterior subscapular cataracts, which affect the posterior cortex of the lens, are observed in relatively younger patients. This form of cataracts is associated with hypermetropia and progresses faster than nuclear and cortical cataracts patients, patients with posterior subscapular cataracts may experience glare. Posterior subscapular cataracts are also associated with corticosteroid use.[15] Shared symptoms across different types of age-related cataracts include clouded or blurred vision faded colors, glare, a halo around lights, poor night vision, and frequents prescription changes for corrective lenses.[16]

Treatment

Cataract surgery

Cataract surgery is the common single surgical procedure carried out in the developed world. In the developing world, cataract is the common cause of blindness. In 1990, an estimated 37 million people were blind world wild and 40% of them because of cataract. Every year, an extra 1–2 million people go blind. Every 5 s one person in our world goes blind, and the child goes blind every minute. In 75% of these cases, the blindness is treatment or preventable. However, 90% of blind people live in the poorest section of the developing world, and without proper interventions, the number of blind people will increase to 75 million by 2020.[32] The types of cataract is mentioned in Table 1.

Many aspects of the surgery for age-related cataract have changed considerably in the past 5 years, and the quality of result, plus the improved safety of the modern procedure, has in part driven the increase number of procedures performed.[32]

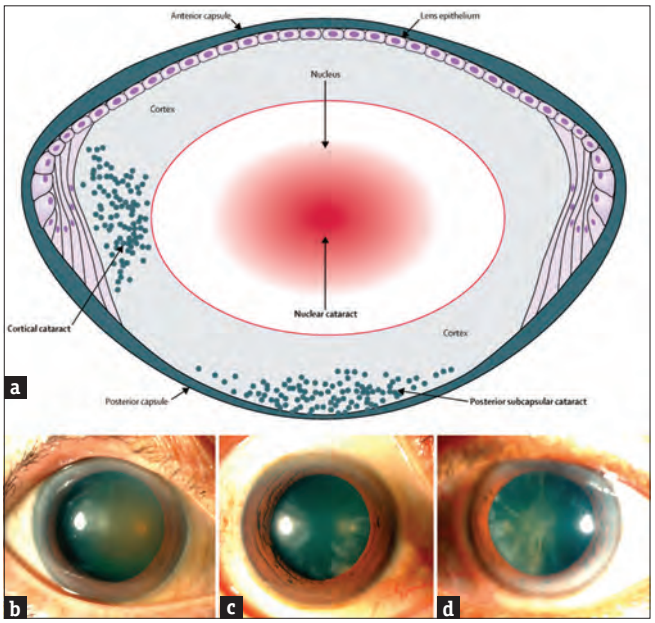

Figure 1: A schematic view of lens structures and corresponding types of cataracts. (a) Schematic illustration of human eye showing common locations , (b) Nuclear cataract, (c) Posterior subcapsular cataract, (d) Cortical cataract

Table 1: Types of cataract[12]

Cataract	Causes	Vulnerable population
Congenital and development	Heredity, gestational mal-development of lens, maternal malnutrition, infection, drugs, radiation, fetal/ infantile factors-anoxia, metabolic disorders, birth trauma, malnutrition, congenital anomalies, idiopathic	It may occur since birth or from infancy to adolescence
Age-related	Senescent changes, dehydration, systemic disease, smoking, oxidative stress and lack of dietary elements	Elderly persons, mostly those over the age of 50 years
Traumatic	Some physical damage to the eye lens capsule, penetration of foreign object	People working in hazardous conditions such as welders and those in glass furnaces
Complicated	Complications of some chronic inflammatory and degenerative eye diseases	Patients of skin diseases, allergy, uveitis, glaucoma, diabetes, emphysema, asthma
Metabolic	Metabolic disorders diabetes mellitus, galactosemia	Persons deficient in certain enzymes and hormones
Toxic	Certain toxicants and drugs - steroids, NSAID's	People on steroid therapy and toxic drugs
Radiation and electrical	Infra-red rays, X-rays, ultra-violet rays, and powerful electric current	Persons who encounter excess sunlight, artificial radiations, high voltage

NSAIDs: Nonsteroidal anti-inflammatory drugs

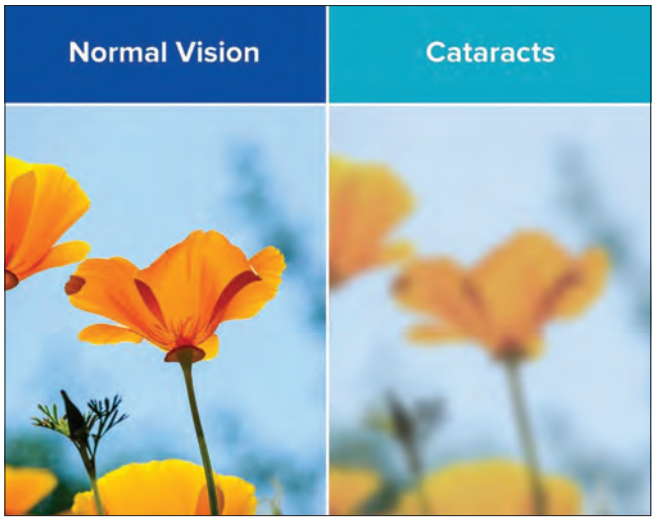

Figure 2: Scene viewed by normal vision and a person with cataracts[16]

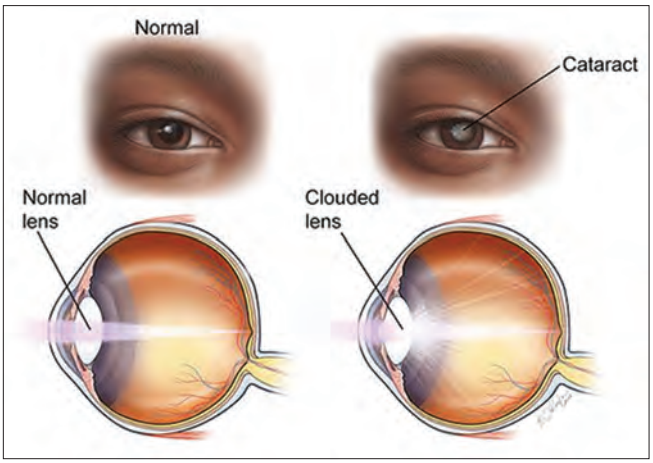

Figure 3: Comparison of normal eye and cataract

What causes cataract

Most cataracts arise because of the aging of the crystalline lens. As a new lens fiber continues to be laid down in the crystalline lens, and existing ones is not replaced, the lens is unusual in being one of the few structures of the body that continues to grow during life. The lens's tiny structure and chemistry belong to a number of interdependent components that maintain its lack of reflection and optical homogeneity. As we age, yellow-brown pigment steadily builds up inside the lens, affecting light transmission. The ordinary morphology and distribution of the lens filaments, which are required to preserve optical purity, are also disrupted by structural alterations to the beams.[32]

Geographic and socioeconomic factors affect the extrinsic factors associated with cataract formation. Several factors seem significant in the developing world, including acute dehydrated disorders at a young age, exposure to too much sunlight, and hunger. Young adults with cataracts are common in many poor countries, and their cases are frequently linked to atopic sickness and their treatment as well as with diabetes. Other causes of cataract involves trauma in a variety of forms, such as direct penetration,radiation, electrical or metabolic disorders. This review deals only with age-related cataract.[32]

Decisions for surgery

Developed world

There is no hard and fast rule about when to operate for cataract. Essentially, surgery is considered when the likely improvement in vision compared with the current problem makes it worth taking the risk of serious life-threatening complications (although it is a now uncommon with modern surgical practice). In the past, a combination of relatively crude surgical techniques and poor visual rehabilitation Afterwords (no lens implants) meant that cataracts were left until they were advanced (ripe) before surgery was undertaken. However, as technique has become more sophisticated and safer and visual results have improved, surgery is undertaken at a much earlier stage. Indeed, the risk of serious complications may now be greater if the cataract has been left at an advanced stage.[32]

Developing world

In the developing world, the problem of cataract blindness is much greater, as most people do not seek the reasons for lack of awareness about cataract treatment, sex bias, low socioeconomic condition and lack of an old age maintenance plan by government. Many countries do not have enough clinicians to meet the demand, and most existing doctors prefer to settle in larger cities because more rural areas have inadequate infrastructure and education and civic amenities. This has resulted in high dissimilarities in the distribution of eye care services.[32]

Free diagnostic and treatment services organized by the National Plan for Control of Blinders, the District Blindness Control Society Program, and nongovernmental organization in rural areas have helped to reduce the burden of blindness to a great extent, but the backlog for cataract surgery remains large. Furthermore, in these mass surgery programs, the quality of the outcome is not always satisfactory VISION 2020: The Right to Sight, a global initiative jointly launched by the World Health Organization and the International Agency for the Prevention of Blindness together with more than 20 international nongovernmental organization involved in eye care and preventing and managing the blindness and aims to eliminate avoidable blindness by year 2020. The World Health Assembly provided more support for the vision 2020 initiative.[32]

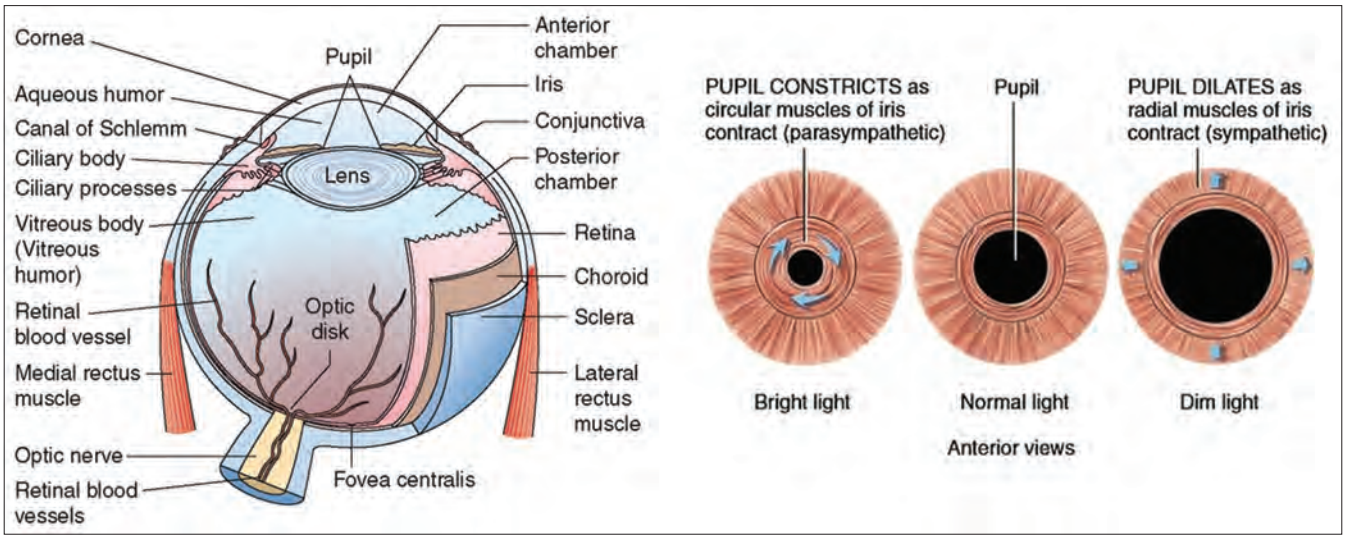

Figure 4: Superior view of transverse section of right eyeball and Responses of the pupil to light of varying brightness

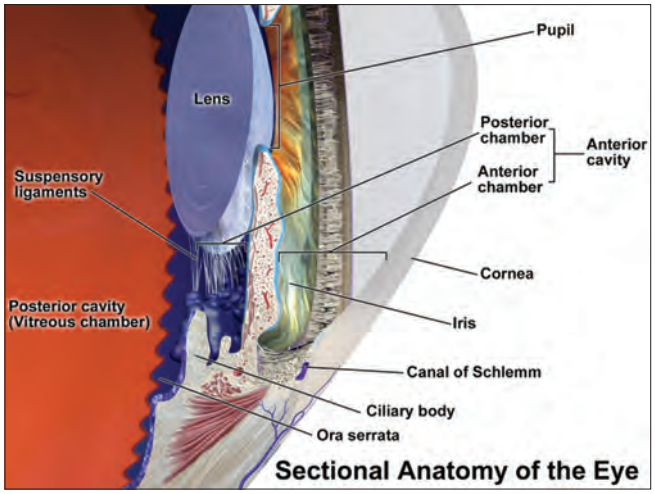

Figure 5: The iris separating the anterior and posterior chambers of the anterior cavity of the eye

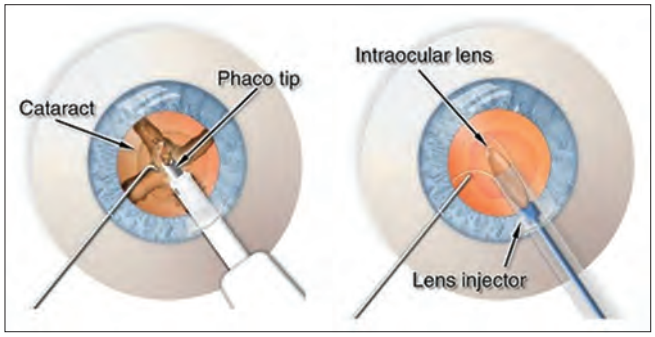

Figure 6: Phacoemulsification

Cataract surgery

There are two generic terms used for cataract extraction, i.e., intracapsular and extracapsular. In intracapsular extraction, the entire lens is extracted while still encased in its intact capsule. This method is largely obsolete in developed countries due to inferior visual outcomes and increased complications. However, it persists in the developing world due to its cost-effectiveness, simplicity, and reduced reliance on advanced equipment and services, making it viable with minimal training.[32]

Extracapsular extraction entails extracting the lens from its capsule, which remains within the eye, serving as a partition between the anterior and posterior segments and serving as the typical location for the implantation of a replacement lens. In manual extracapsular extraction, the lens nucleus is removed as a whole, necessitating a comparatively sizable incision.[32]

Phacoemulsification

Phacoemulsification, a main component of contemporary extracapsular extractions, employs advanced machinery to disintegrate the nucleus into an emulsion and small fragments, facilitating removal through a dual-lumen system. Typically conducted through a 3-mm incision, recent advancements allow extraction through a mere 2 mm incision. The benefits include minimal corneal shape alteration, enhancing unaided vision, and a controlled surgical environment that reduces complications and ensures stable visual recovery. Consensus indicates phacoemulsification's superiority over other techniques, supported by a well-controlled trial comparing it with manual extracapsular extraction. However, this method demands sophisticated equipment, a quality operating microscope, and a reliable power supply. During phacoemulsification, a small incision, usually at the cornea's edge, is made, followed by injecting a viscoelastic substance into the anterior chamber for space maintenance and endothelium protection. A tear in the cataract us lens's anterior capsule grants access for removal using the

phacoemulsification handpiece. After emptying the lens capsule, a foldable replacement lens implant is inserted, and the incision is checked for water tightness. Suturing is rarely necessary, and injecting cefuroxime postsurgery significantly reduces the risk of endophthalmitis.[32]

In regions of the developing world, where trained surgeons and suitable infrastructure are lacking, phacoemulsification may not be feasible. Instead, sutureless manual cataract surgery, also known as small incision cataract surgery, is increasingly employed as an alternative.

In this technique, a self-sealing incision of approximately 6.0 mm is made outside the limbus. A tear in the anterior capsule allows the firmer portion of the cataract (nucleus) to be expressed out of the eye through this incision. Suturing is rarely required, making it suitable for high-volume surgery. While the results are less predictable than with phacoemulsification, this method yields an acceptable outcome and has proven economically viable in the developing world. Extracapsular cataract extraction, coupled with good microsurgical technique, is crucial in high-volume centers due to its affordability, resulting in fewer postoperative complications. In developing countries, rigid IOLs are more common than foldable ones due to the latter's significantly higher cost.[32]

Outcomes

Modern cataract surgery outcomes have significantly improved over the past 20 years, with fewer operative and postoperative complications and substantial enhancements in uncorrected visual acuity. Approximately 85%–90% of patients achieve the best-corrected vision of 6/12 (20/40 or 0.5), rising to about 95% for those without ocular comorbidities such as macular degeneration, diabetic retinopathy, or glaucoma. Selecting the correct optical power for the replacement lens is crucial, as the surgery involves replacing the natural lens with an artificial implant. While most patients prefer good unaided distance vision, some, particularly those already near-sighted, may opt for a degree of myopia to enhance closer vision, such as for reading In the developed world, expectations for postoperative unaided vision quality are high, but refractive outcomes may not always align with predictions, leading to refractive surprises. Procedures such as lens exchange or refractive laser surgery can address this, depending on individual circumstances.

In the developing world, the rapid visual rehabilitation offered by modern cataract surgery compensates for the additional cost of IOLs. This is particularly significant in terms of saving economic costs related to workforce loss from blindness and the socioeconomic support required for blind individuals, making modern cataract surgery economically favorable.[32]

Complication

While small incision extracapsular surgery is safer than earlier techniques, complications can still occur. Rupture of the posterior capsule, occurring in 2%–4% of operations, may result in the loss of part or the entire nucleus into the posterior segment or prolapse of the vitreous body into the anterior segment. Careful removal of prolapsed vitreous material is crucial. Posterior capsule rupture, with or without vitreous loss, is associated with an increased risk of infected endophthalmitis, cystoid macular edema, and retinal detachment.

Patients should be aware that complications, though relatively rare (around 0.1%), can lead to the loss of functional vision in the operated eye. Notably, specific complications such as infected endophthalmitis, choroidal or suprachoroidal hemorrhage, and retinal detachment pose potential risks, particularly if the fellow eye lacks useful vision.

In developing countries, endophthalmitis remains a major concern. The periodic outburst of sporadic or cluster cases in mass cataract surgery "camps" remains a challenge for the organizations involved.[32]

Recent developments

IOL design has witnessed two significant innovations. Conventionally, these lenses featured spherical anterior and posterior surfaces, leading to "spherical aberration" that reduced image quality as light passing through more peripheral parts was bent differently than through central parts. Aspheric IOLs, inspired by fields such as microscopy and astronomy, now exist. Some are designed to maintain a neutral level of spherical aberration, while others aim to counteract positive spherical aberration found in most corneas. Although reducing spherical aberration can enhance contrast in low illumination, evidence suggests that a small degree of spherical aberration may benefit certain aspects of eye function, such as depth of focus.

The second major innovation focuses on providing spectacle-free full vision range, distance, intermediate, and near. Bifocal or multifocal IOLs, in use for two decades, have evolved to offer substantial spectacle independence with fewer side effects compared to early designs.[32]

Cataract surgical problems

- Zonular weakness poses a challenge for cataract surgeons, and while a capsular tension ring can stabilize a loose lens, significant weakness or extensive zonular dialysis may limit its effectiveness. In cases of generalized weakness, even with the ring, the lens

may remain too loose, leading to challenges during surgery and potential issues like late IOL decentration.

The Morcher Co. has introduced modified versions of the capsular tension ring (models 1-L and 2-L), addressing these challenges. Designed to allow suturing to the scleral wall, these versions enhance intraoperative and postoperative stability. Surgeons can choose to suture the ring if needed, providing additional support in cases of persistent zonular weakening.

In scenarios where an original-style capsular tension ring is inadequate, replacing it with a 1-L or 2-L model is a viable option. However, retrieving the original ring without further damage to the zonules or the capsular bag is a delicate task. The surgeon can use viscoelastic material to clear a path to the eyelet, employ a Geuder shooter to engage the eyelet, and then retract the plunger slowly to retrieve the ring. Stabilizing the lens with a second instrument through a side-port incision may be necessary during this process.

If the eyelet of the capsular tension ring is not visible, it may be necessary to use a Sinskey hook or an Osher-style underhook to "fish" it into view, taking care to avoid tearing the peripheral bag or anterior capsular rim. Once in view, the ring can be retrieved using the method described earlier.

After removing the capsular tension ring, the modified version can be placed and sutured. In cases of extensive generalized weakness, such as this patient, the 2-L model with two fixation hooks may be necessary. Placement and suture fixation details for these modified rings can be obtained from the Morcher Co. Once secured, phacoemulsification and IOL placement can proceed in a relatively routine manner.

If the modified ring is unavailable, phacoemulsification is still possible, using "slow-motion" parameters to avoid stressing the zonules. A groove can be created with a Kelman tip, and cohesive viscoelastic material can be used for viscodissection and emulsification. Cortical material can be aspirated manually, ensuring a tangential approach to avoid perpendicular forces on zonular attachments. If the capsular bag is too loose, suturing an IOL to the scleral wall through the capsular bag may be considered.

In cases where the lens is too loose for phacoemulsification, it can be prolapsed into the anterior chamber with a microvitreoretinal blade, followed by phacoemulsification in the anterior chamber with viscoelastic protection. Alternatively, the entire lens, along with the capsule and ring, can be removed through an enlarged incision using a lens loop. Anterior vitrectomy can be performed through the pars plane incision or the anterior cataract incision, with subsequent implantation of an anterior chamber or sutured posterior chamber IOL once extraction is successful.[33,34]

- Performing a capsulorhexis in the presence of loose zonules can be challenging due to the pseudoelasticity of the anterior capsule. Achieving a larger capsulorhexis may be difficult with supracapsular phacoemulsification techniques. Once capsulorhexis is accomplished, the risk of violating the posterior capsule is high through three mechanisms.
  1. Lack of centrifugal zonular tension: The posterior capsule may appear loose or floppy, especially during the removal of adherent epinucleus or cortex. The looser posterior capsule may fold and follow lens material into the phaco or irrigation/aspiration tip, leading to a central tear
  2. Rapid suction or aggressive aspiration: Overly rapid or aggressive suction of the cortex or epinucleus may result in partial aspiration of the anterior capsule edge. Weakened zonules increase the risk of localized zonular dehiscence, particularly during epinuclear or cortical removal
  3. Shearing force during nucleus manipulation: Shearing force transmitted via the nucleus to the zonules, especially during sculpting or rotation, poses a risk. In cases of weakened zonules, the inability to rotate the nucleus can be problematic, especially with sculpting and cracking techniques.

A "nonstop" 100% chopping technique, such as the original Nagahara phaco chop or the Pfeiffer chop technique, is ideal in cases of weakened zonules. These techniques eliminate nuclear sculpting, reducing stress on the zonules and capsule. In chopping techniques, the phaco tip holds and immobilizes the nucleus, directing forces centrally inward, minimizing stress on the zonules and capsule. The initial nuclear wedge can be removed without rotating the nucleus, providing a safer approach for patients with compromised zonular integrity.[35]

- Phacoemulsification of a subluxated lens, especially in eyes with pseudoexfoliation syndrome, requires surgical skill and careful consideration. Achieving an adequate capsulorhexis and implanting a capsular tension ring are crucial steps. It is essential to caution against implanting a tension ring while the nucleus is still in place, as this can be difficult and risky, potentially leading to complications such as tearing of the capsular bag.

Thorough hydrodissection is highlighted as a key factor for success. The divide and conquer technique is recommended during phacoemulsification, ensuring that forces are vectored circularly to minimize strain on the zonule. Maintaining a low infusion bottle position helps reduce pressure on the lens diaphragm.

To protect the zonules, avoiding brisk lens movements during nucleus suction is emphasized. Following successful phacoemulsification, the capsular ring can be implanted in the anterior chamber with viscoelastic assistance. Careful aspiration of the remaining cortex is essential, considering the risk of catching and tearing the loose capsular bag.

In cases with very weak zonules, the surgeon may choose not to implant the IOL in the capsular bag. Instead, a diaphragm stabilized by a tension ring allows for safe IOL implantation in the sulcus. This precaution is particularly relevant in pseudoexfoliation syndrome, where ongoing zonular weakening may lead to dislocation of the lens over time.[36]

Management of general conditions before surgery

Many general health conditions require optimization before surgery for better results.[37]

- Diabetes mellitus
- Hypertension
- Myocardial infarction
- Angina
- Respiratory infection
- Stroke
- Leg ulcer
- Viral hepatitis
- AIDS
- Epilepsy
- Parkinson's disease
- Rheumatoid arthritis.

Medical

The most commonly used ophthalmic steroid is prednisolone acetate 1%, and dexamethasone 0.1% ophthalmic solution is used as alternative for sometimes.

If visual activity is 6/24 or better, then pupillary dilation with 2.5% phenylephrine or refractive glasses is enough to carry on routine activities, and surgery is not required.

Cyclopentolate and atropine are also useful.[37]

Recently, there are also cataract drops under trial, which can dissolve cataract.

Drugs used in cataract treatments are:[37]

- Antioxidants – Ascorbic acid (Vitamin C), Vitamin E, Vitamin E and selenium, alpha-lipoic acid, stobadine, and melatonin
- Minerals and trace elements – Zinc sulfate, ebselen, sodium pyruvate, pyruvate, and L-cysteine
- Ketoacids and amino acid – N-acetylcysteine, N-acetylcysteine amide and GSH ethyl ester, N-acetylcysteine amide, acetyl-L-carnitine, rutin, hesperetin, hesperetin derivatives, and ellagic acid
- Plant-derived compounds and herbal remedies – Green tea, green and black tea extracts, caffeine, lycopene, curcumin, turmeric, hydroalcoholic extract, etc.

Conclusion

Cataract is a significant and increasing global problem. It becomes the leading cause of blindness in the majority of problems. Widespread surgical services can capable of delivering good vision which must be acceptable and accessible to all in need. It needs broad techniques that go much beyond its limited emphasis on surgical techniques to develop and sustain these services. This review gives information about a cataract, which is the leading cause and its treatment.

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Conflicts of interest

There are no conflicts of interest.

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Original Article

Outcomes of OcxyLon Plus (4% Chondroitin Sulfate and 3% Sodium Hyaluronate) on Endothelial Cell Count in Cataract Surgeries with Systemic Comorbidities

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Abstract

Purpose: The purpose of this study was to compare the endothelial protective effect of an ophthalmic viscosurgical device (OVD), which is a combination of 4% chondroitin sulfate and 3% sodium hyaluronate (OcxyLon Plus) with hydroxypropyl methylcellulose (HPMC).

Methods: It was a retrospective comparative study, where micro-incision cataract surgery performed using HPMC (Group 1) and the combination OVD (Group 2) were compared in 50 eyes each. Specular microscopy was done pre- and postoperatively at 1 month, to assess endothelial cell loss. The mean cell loss and percentage of reduction were calculated for variables such as age, diabetes, hypertension (HT) and cataract density.

Results: In the age group of above 60 years, the combination OVD showed a lesser percentage of reduction of endothelial cells (14%) as against 22% reduction by HPMC which was statistically significant. The cell reduction with the usage of the combination OVD in diabetics (12%) and in hypertensives (11%) was lesser than the percentage of reduction with HPMC (18% in both diabetics and hypertensives) but not statistically significant. For cataract Grades 3 and 4, the difference in percentage of reduction was significantly lesser (P = 0.044) than the combination OVD. The mean phaco time was similar in both groups (OcxyLon Plus = 7.27 min and HPMC = 8.07 min). Thus overall, the mean endothelial cell loss in the combination group was 334 cells compared to the HPMC group which was 529 cells and the difference was statistically significant (P = 0.027).

Conclusion: OcxyLon Plus offers superior protection to the endothelium during phacoemulsification. Although it is a well-proven fact, the comparative analysis in terms of age, diabetes, HT, and cataract grading is novel in the present study.

Keywords: *Chondroitin sulfate, endothelial cell reduction, hydroxypropyl methylcellulose, phacoemulsification, sodium hyaluronate*

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Introduction

Ophthalmic viscosurgical devices (OVDs) have become an indispensable tool in cataract surgery and multiple other ophthalmic procedures. With so many different viscoelastics available from the major manufacturers, it is clear that there is no single OVD that is perfect under all circumstances. Its rheological properties such as viscoelasticity, viscosity, pseudoplasticity, and surface tension determine the classification, behavior, and utility of each OVD.[1]

This study aims to compare the endothelial protective effect of an OVD product which is a combination of chondroitin sulfate and sodium hyaluronate (OcxyLon Plus – no financial interest) with hydroxypropyl methylcellulose (HPMC) each in 50 Indian eyes.

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Methods

The study was performed with prior ethical clearance in a private eye hospital with state-of-the-art technologies and an operating microscope. It was a retrospective comparative analytical study. Outcomes of micro-incision cataract surgery performed in 50 eyes using HPMC and another 50 eyes using a combination of chondroitin sulfate and sodium hyaluronate were compared. Convenience sampling was used. Patients with cataracts of nuclear sclerosis 1–3 and posterior subcapsular cataracts 1–4 by the Lens Opacities Classification System III (LOCS III) and specular count >2000 cells/mm^2 were included in the study, after informed consent, whereas those with black, brunescent cataracts, ocular pathology/uveitis/trauma/previous surgeries, small rigid pupil, subluxated cataract, pseudoexfoliation, and glaucoma were excluded from the study, in view of anticipated low preoperative endothelial cell count.

Evaluation for cataract surgery included best-corrected visual acuity using Snellen chart, slit-lamp biomicroscopic examination of anterior and posterior segments, intraocular pressure (IOP) measured by noncontact tonometry, nasolacrimal duct patency, clinical specular microscopy, LipiScan, optical coherence tomography Macula, biometry using intraocular lens (IOL) master, and systemic blood investigations.

The patient was advised to use topical antibiotics 1 day before surgery. On the day of surgery, the eye to be operated was given povidone-iodine 5% drops, antibiotics, topical nonsteroidal anti-inflammatory drug, and lubricant. Topical anesthetic, proparacaine, was usually started from 15 min before surgery, one drop every 5 min. Inside the operating room, the patient's eye was painted with Betadine 10%, draped using a sterile disposable drape, covering the eyelashes, speculum was placed, and fornices were thoroughly washed. All eyes were operated by a single senior operating surgeon. Limbal incision of 2.2 mm was made at the steep axis; two side ports were made on either side of the main port. Intracameral preservative-free 2% xylocaine (Xylocard) and trypan blue mixed in a ratio of 1:1 are used to stain the anterior capsule. Continuous curvilinear capsulorhexis (CCC) of size 5.5 mm approximately was made manually using bent 26G cystotome mostly and microcapsulorhexis forceps, when intralenticular pressure was high and the CCC tended to extend. Either HPMC or OcxyLon Plus which is a combination of chondroitin sulfate and sodium hyaluronate was chosen and used throughout phacoemulsification. Stop and chop was the preferred technique. Bimanual I and A was used for cortex aspiration, and monofocal or multifocal or toric IOL was placed in the bag using irrigation fluid. Visco-elastics were not used for IOL insertion, which reduced the post-IOL insertion, wash time, and efforts. The anterior chamber was formed with a balanced salt solution, intracameral moxifloxacin was injected, and side ports were hydrated and checked for leaks. The eye was patched with lubricant and antibiotic ointment for 1 day and reviewed on postoperative days 1, 3, 7, and 30. At the time of surgery, the effective phaco time was noted.

Postoperative outcome was measured in terms of endothelial cell count using a clinical specular microscope. The mean cell loss at 1 month and percentage of reduction from baseline endothelial cell count were calculated and compared between the two groups for variables such as age, systemic comorbidities (diabetes and hypertension [HT]), and density of the cataract. Statistical analysis was done using IBM SPSS Statistics, Version 24.0. (Armonk, NY: IBM Corp.). Mean and percentage of cell loss were calculated, correlation was done between the groups using Student's *t*-test, and $P < 0.05$ was considered statistically significant.

Results

A total of 100 eyes were included in this study, wherein 50 eyes were operated using HPMC and the remaining 50 eyes using a combination of 4% chondroitin sulfate and 3% sodium hyaluronate. Based on age, the patients were divided into two groups, those below and above 60 years of age. In the HPMC group, 15 people were <60 years and they had a 13% reduction of endothelial cells postoperatively compared to 12 people in the combination group who had a 7% reduction (no statistical significance; $P = 0.106$). In patients above 60 years, the HPMC group ($n = 35$) had a 22% reduction, whereas the combination group ($n = 38$) had a 14% reduction which was statistically significant ($P = 0.047$). The mean endothelial cell loss according to the age in each OVD group is shown in Table 1.

Among those with diabetes mellitus (DM), the mean endothelial cell loss in the HPMC group was 493 cells/mm^2 (18% reduction) and in the chondroitin and hyaluronate group was 337 cells/mm^2 (12% reduction). In patients with HT, the mean endothelial cell loss in the HPMC group was 506 cells/mm^2 (18% reduction) and in the chondroitin and hyaluronate group was 308 cells/mm^2 (11% reduction). Thus, among those with diabetes and HT, the percentage of reduction was less with the usage of chondroitin and hyaluronate, but it was not statistically significant ($P = 0.266$ for DM and $P = 0.116$ for HT).

The cataract grading followed in this study was the LOCSIII System. The highest number in any of the categories was taken as the numerical grade. For example, a cataract with a grading of NO2C2C0P0 was numbered as Grade 2 and a cataract with NO1C1C1P4 was numbered as Grade 4. The mean endothelial cell loss for Grades 1 and 2 was grouped together; similarly, Grades 3 and 4 were grouped together for simplification and analysis [Table 1]. There was a 16% reduction and 12% reduction in the HPMC group and chondroitin group, respectively, for Grades 1 and 2, whereas in higher grades of cataract (Grades 3 and 4), the HPMC group showed a 24% reduction versus only 13% reduction in the combination group and the difference was statistically significant (P = 0.044).

The mean phaco time taken in the HPMC group was 8.07 min and in the combination group was 7.27 min [Table 1]. However, the difference was not statistically significant (P = 0.424). Thus overall, the mean cell loss in the HPMC group was 529 cells/mm^2 (19% reduction) [Figure 1] and in the combination group was 334 cells/mm^2 (12%), and the difference was statistically significant (P = 0.021).

Discussion

Phacoemulsification has become the most commonly used procedure for removing cataracts, owing to the least wound size and nil or lowest induction of postoperative astigmatism and hence fastest rehabilitation with good visual outcome. However, corneal endothelial damage still remains an important complication of phacoemulsification, especially in hard cataracts compared to manual small-incision cataract surgery.[2] There can be multiple pre- and intraoperative parameters that affect the endothelial cell count postphacoemulsification. Longer absolute and effective phaco time, higher mean ultrasound power, and, most importantly, higher cataract density are significantly associated with endothelial cell loss on univariate analysis.[3] Furthermore, eyes with shorter axial length and preexisting endothelial compromise seem to affect the endothelium postsurgery.[4]

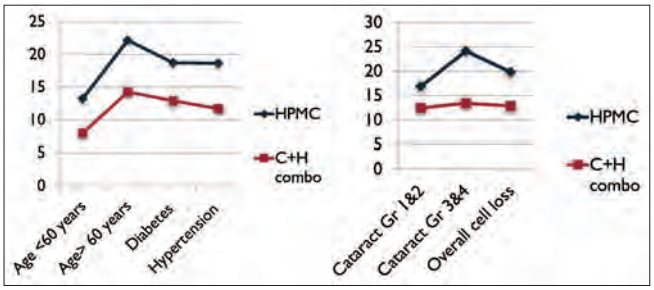

Figure 1: Pictographic representation of comparison of percentage of endothelial cell loss between two groups

The introduction of OVDs has had a profound influence on the evolution of phacoemulsification surgeries and also decreased the incidence of corneal edema postphacoemulsification.[5] An ideal OVD should not only be able to create and maintain space during intraocular surgical manipulation and protect the corneal endothelium but also be biocompatible with ocular tissues. It should also be easily removable from the anterior chamber at the end of surgery and should not cause postoperative IOP rise. Initially, OVDs were classified into two kinds: higher viscosity "cohesive" and lower viscosity "dispersive." High-viscosity cohesive OVDs such as Healon, Provisc, and Amvisc induce and sustain pressure in an eye, despite an incision, and can be easily removed from the eye as a bolus. Lower-viscosity dispersive OVDs such as VisCoat, OcxyLon Plus, and OcuCoat have lower molecular weight and are retained better in the anterior chamber during high levels of fluid turbulence. It takes longer to completely remove dispersive OVDs from the eye,

Table 1: Percentage of endothelial cell loss in both groups

Parameter	Cell loss in the HPMC group		Percentage of cell loss	Cell loss in the chondroitin sulfate-sodium hyaluronate group		Percentage of cell loss	*t*-value	Significance
	n	Mean±SD		*n*	Mean±SD			
Age								
<60 years	15	395.00±347.03	13.24	12	203.75±208.50	7.96	1.678	0.106
≥60 years	35	587.37±531.69	22.12	38	375.21±352.63	14.28	2.024	0.047*
DM	18	493.33±547.77	18.69	18	337.00±209.98	12.88	1.131	0.266
HT	22	506.27±509.00	18.62	25	308.84±325.80	11.69	1.603	0.116
Cataract								
Grade 1 and 2	30	450.63±411.01	16.82	28	327.42±313.20	12.37	1.277	0.207
Grade 3 and 4	20	648.20±576.70	24.04	22	342.50±358.30	13.34	2.084	0.044*
Phaco time	50	8.07±5.16		50	7.27±4.83		0.803	0.424
Overall cell loss	50	529.66±488.36	19.72	50	334.06±330.34	12.79	2.346	0.021*

*P<0.05 is considered significant. DM: Diabetes mellitus, HT: Hypertension, SD: Standard deviation, HPMC: Hydroxypropyl methylcellulose

because when aspirated, it breaks apart and is vacuumed out in smaller pieces, leaving most of the OVD mass behind and thus providing added endothelial protection. OVD classification has recently been modified to accommodate DisCoVisc (Alcon). DisCoVisc (1.6% hyaluronic acid/4.0% chondroitin sulfate) combines the advantage of both a cohesive and a dispersive OVD. It provides a dual function; space maintenance (cohesive) and superior retention (dispersive) as a combination.[1]

Earlier studies compared cohesives versus dispersives (i.e.) Healon versus HPMC as they have different properties and found that HPMC was more protective for endothelium. While new groups of OVDs like DisCoVisc evolved, which combine the properties of both cohesive and dispersive, the present study compares a similar product (OcxyLon Plus, similar to VisCoat) which is a combination of 4% chondroitin sulfate with 3% sodium hyaluronate versus plain 2% HPMC in phacoemulsification surgeries and analyzes the endothelial protective nature in terms of age, systemic illness like diabetes, HT, and density of cataract. This has a better tendency to occupy space as well as to protect the endothelium.[6] Hence, it eliminates the need for using two different types of OVDs as in the soft-shell technique. A few disadvantages occasionally are the entrapment of air bubbles and the lower transparency, thereby reducing visibility and its resistance to removal.

Studies have shown that there is an inverse correlation between endothelial cell density and age. The rate of endothelial cell attrition ranges from 0.3% to 0.5% per year according to various European studies.[7,8] As per the present study, with an increase in age, the damage to endothelial cells is found to be higher in both HPMC and the combination group. The percentage of reduction was significantly higher in the HPMC group above 60 years of age. There is no previous literature on this fact.

Despite good glycemic control, diabetics undergoing phacoemulsification have significantly more endothelial damage compared to nondiabetics in spite of a similar nuclear classification and phacoemulsification energy used.[9] Having said this, the current study clearly shows that among the diabetic population, the reduction in endothelial cell density following phacoemulsification was less in the combination group compared to the HPMC group but was not statistically significant (P = 0.266). Previous studies on the effect of blood pressure on corneal endothelium were few, but they all mention that hypertensives have lower endothelial cell density compared to nonhypertensives.[10] The comparison of endothelial cell loss after phacoemulsification among hypertensives shows that the mean cell loss and percentage of reduction were less in the combination group with a statistical significance of P = 0.116. It suggests the advantage of using the combination OVD of 4% chondroitin sulfate with 3% sodium hyaluronate in those with diabetes and HT undergoing phacoemulsification.

Mahdy *et al*.,[11] Assaf and Roshdy,[12] and several similar studies have undoubtedly stated a significant positive correlation between endothelial cell loss and an increase in nuclear sclerosis grade with phacoemulsification. The present study also reiterates the same. It is also found that the percentage of endothelial cell reduction in the combination group is significantly lesser than in the HPMC group which further adds the advantage of choosing this chondroitin and hyaluronate combination while operating on denser cataracts. For equal-density cataracts, Koch *et al*.[13] from Texas studied the corneal endothelial changes after the use of Healon or VisCoat during phacoemulsification. It was inferred that if phacoemulsification is performed at the iris plane or anterior to it, VisCoat provided greater corneal endothelial protection than Healon. It is consistent with the results of the present study where OcxyLon plus (chondroitin and hyaluronate combination) is superior regarding endothelial protection.

The ultrasound time did not show statistical significance between HPMC and the combination group. This is consistent with a very similar clinical comparative study between DisCoVisc and 2% HPMC in phacoemulsification published in 2012 where there was no significant difference between groups regarding the mean ultrasound time.[14] However, the visco wash-out time was significantly more with 2.0% HPMC than the DisCoVisc, and the amount of viscoelastic material used was greater with 2.0% HPMC than DisCoVisc. This parameter was not measured in the present study.

Thus overall, the combination of 4% chondroitin sulfate with 3% sodium hyaluronate outweighs the advantages of HPMC alone in terms of endothelial protection even with an increase in age, presence of systemic illness like diabetes and HT, and with poor endothelial count and denser cataracts, undoubtedly. Vajpayee *et al*.[15] from AIIMS in 2005 studied the safety and efficacy of VisCoat, Healon GV, and Healon 5 in phaco and derived that the density of endothelial cell loss was lesser in the VisCoat group. The study by Oshika *et al*.[16] also demonstrated better endothelium protection with DisCoVisc than Healon. Two other studies by Praveen *et al*.[17] and Adina[18] also insisted that DisCoVisc was superior to combining viscoelastics as in the soft-shell technique.

Another interesting fact is about the production of free radicals namely – OH during the process of ultrasound phacoemulsification. Sodium hyaluronate is a well-known free radical scavenger that is used even in arthritis.[19] While all three agents, namely, sodium hyaluronate, chondroitin sulfate, and even HPMC, have free radical scavenging properties, it has been proved by experimental studies that at higher concentrations of Hydroxyl ions, sodium hyaluronate acts best as a scavenger compared to other agents.[20]

Limitation

Statistical significance could not be established for a few parameters although there is a numerical difference between the groups, especially in diabetes and HT because of the small sample size, maybe. The study has not compared other parameters such as visual acuity, intraocular pressure, and central corneal thickness between the two viscoelastic materials, which can also have some relevance.

Conclusion

The combination OVD (4% chondroitin sulfate + 3% sodium hyaluronate) is safer for corneal endothelium following phacoemulsification, compared to HPMC, especially for cataracts in elderly age groups, diabetics, hypertensives, and in dense cataracts. The superior endothelial protection of this combination is due to better retaining power in the endothelium and its property to fight free radicals, thereby reducing endothelial cell loss. This study also reiterates on yet another investigative modality that preoperative endothelial cell count using a clinical specular microscope (wherever available) should be made compulsory in all cases to be fully prepared to take care of patients with compromised endothelial count and health, especially in dense cataracts.

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Conflicts of interest

There are no conflicts of interest.

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Original Article

One-to-One Observation: Pilot Study on Practical Aspects of Manual Small Incision Cataract Surgery Training for Residents in Tertiary Eye Care Hospital

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Abstract

Background: Cataract surgery and surgical training has undergone extensive revolution over years. Phacoemulsification is the surgery of choice. However, in developing countries, residents begin surgical training with small incision cataract surgery (SICS). SICS is a stepping stone to acquire good intraocular awareness and eventually perform phacoemulsification surgeries. Through this study we emphasize the need for one-to-one monitoring of surgeries performed by residents. The objective analysis of their surgical performance was based on the International Council of Ophthalmology Ophthalmology Surgical Competency Assessment Rubrics (ICO OSCAR).

Aims and Objectives: Primary objective: To improvise the ophthalmic surgical training of the residents by one to one monitoring of the first 20 surgeries performed by the trainee. Secondary objective: To ensure the best possible outcome with the least number of complications in the resident surgical cases.

Materials and Methods: It was a cross sectional, observational study done in the tertiary care eye hospital in South Bengaluru from May 2023 to August 2023. Six residents, who were to begin their surgical training in our institute, were observed by three senior skilled faculty surgeons. At the end of each surgery, ICO OSCAR structured questionnaire was given to each resident for self evaluation, and the assessment made by the resident was re analysed by the observing faculty on the postoperative day one based on the outcomes of surgery.

Results: The significant observations made by senior skilled faculty surgeons has been summarized as verbatim quotes. We describe the performance of the candidate during surgery as per ICO-OSCAR scoring, 2-novice; 3-beginner; 4-advanced beginner, 5-competent. This structured procedure of candidate observation and assessment was followed for the first twenty surgeries performed by the residents who have enrolled in the study. The data was entered in Microsoft-EXCEL version 10 and analysed.

Conclusion: We conclude that one is to one monitoring by the senior faculty surgeon during the initial few cases plays a pivotal role in the surgical learning curve of the residents and observations of our study can be used for future modifications to improvise the postgraduate training program in ophthalmology.

Keywords: *International Council of Ophthalmology-Ophthalmology Surgical Competency Assessment Rubrics, one-to-one observation, small incision cataract surgery, surgical training*

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Introduction

Cataract surgery has undergone extensive revolution in the past two to three decades.[1] Although

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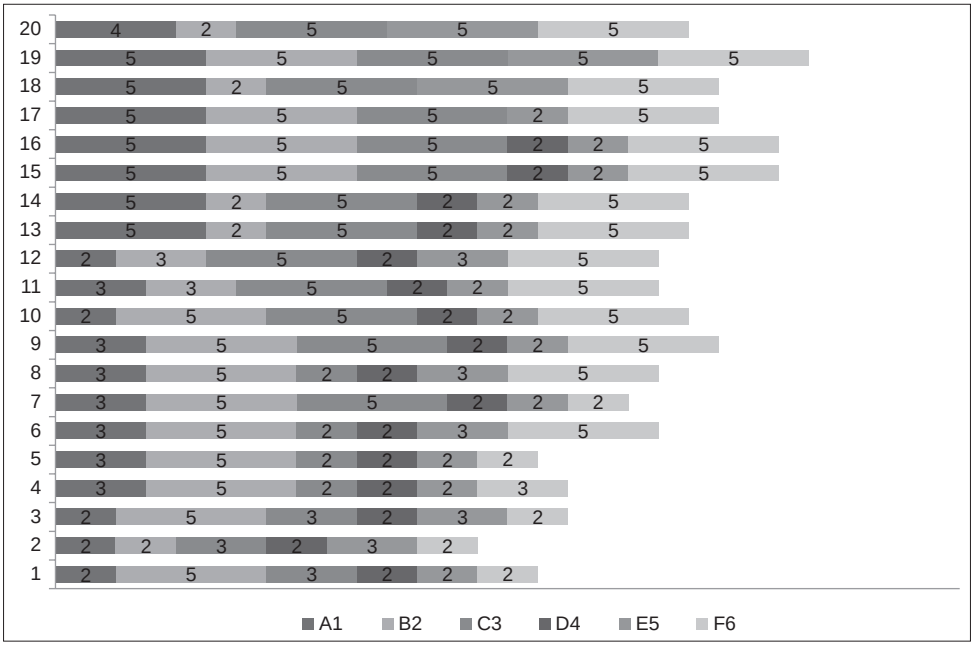
phacoemulsification is the surgery of choice in many developed countries, in most of the ophthalmic training institutes in developing countries, residents begin surgical training with small incision cataract surgery (SICS).[1] As per a survey conducted by a tertiary eye care hospital, ophthalmology residents in the region of Southern India are performing surgeries on a human eye within the 1st year of residency.[1,2] There is a huge responsibility on the training ophthalmologist to make sure the best possible outcome with the least number of complications is ensured in the resident surgical cases. SICS is a stepping stone to acquire good intraocular awareness and eventually perform phacoemulsification surgeries.[3,4] Through this study, we aim to improvise the ophthalmic surgical training of the residents by one-to-one monitoring of the first 20 surgeries performed by the trainee. Conventionally, the ophthalmic institutes emphasize on wet laboratory training of the residents before entry into ophthalmic operation theater to perform SICS. However, the candidates may still encounter difficulties at various steps of the surgery, which is not identified by the novice operating surgeon and may hamper the overall visual outcome of the patient. Hence, we feel that a candidate must be assessed at each step while performing the surgery, and we planned this pilot study of one-to-one monitoring of resident doctor while performing manual SICS by the training surgeon for their first 20 cases. The objective analysis of their surgical performance was based on the International Council of Ophthalmology-Ophthalmology Surgical Competency Assessment Rubrics (ICO-OSCAR).[5] The observations of our study can be used for future modifications to improve the current postgraduate program in ophthalmology.

Methodology

Study design

The study design was a cross-sectional, observational study.

The study was done in the tertiary care eye hospital in South Bengaluru. Six residents, who were to begin their surgical training in our institute, were included in the study. Three senior skilled faculty surgeons were sensitized about the study. The duration of the study was 4 months from May 2023 to August 2023. The surgical cases were allotted from ophthalmic cataract screening camps to the residents, a day before the surgery. Senior skilled faculty conducted one-to-one monitoring of the whole surgery performed by the resident through the side viewing piece of the ophthalmic surgical microscope. At the end of each surgery, ICO-OSCAR structured questionnaire was given to each resident for self-evaluation, and the assessment made by the resident was re-analyzed by the observing faculty on the postoperative day 1 based on the outcomes of surgery. As per ICO-OSCAR scoring, 2 – novice; 3 – beginner; 4 – advanced beginner; and 5 – competent. This structured procedure of candidate observation and assessment was followed for the first 20 surgeries performed by the residents who have enrolled in the



Graph 1: Horizontal stacked bar diagram showing serial performance of the residents during sclerocorneal tunnel construction in the first 20 cases. A1: Candidate 1, B2: Candidate 2, C3: Candidate 3, D4: Candidate 4, E5: Candidate 5, F6: Candidate 6. Novice (score = 2), Beginner (score = 3), Advanced beginner (score = 4), Competent (score = 5)

study. Data were entered in Microsoft Excel version 10 and analyzed.

Discussion

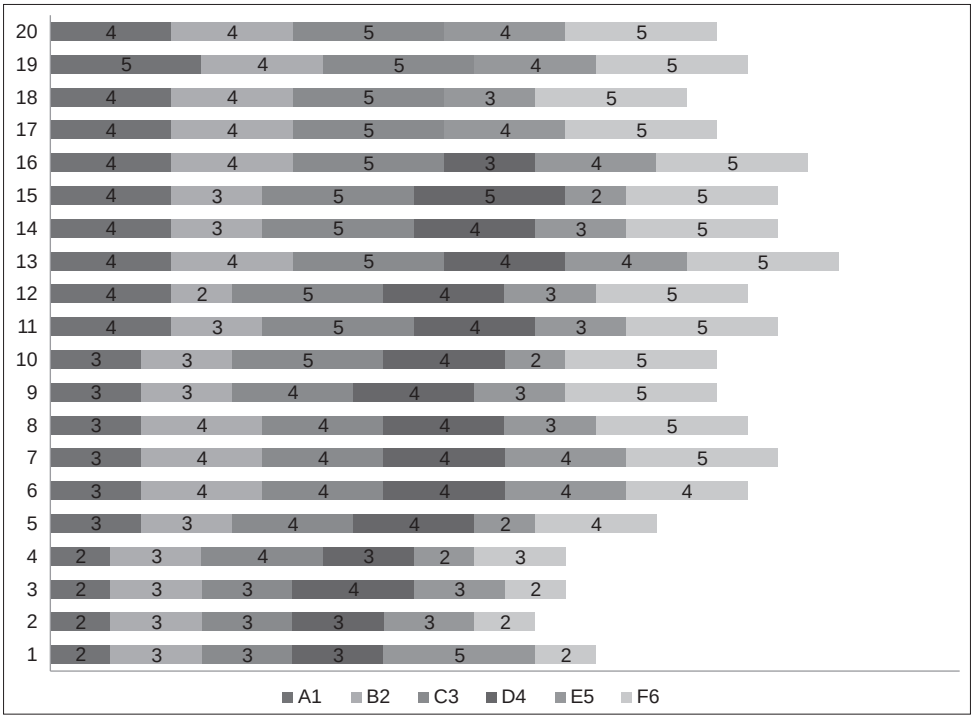
The novice surgeon may have the necessary knowledge to perform the cataract surgery as the ophthalmic literature has a number of studies to explain the different techniques to perform small incision cataract surgeries.[6,7] However, our literature review did not yield studies related to one-to-one observation by the skilled surgeons to observe the practical difficulties faced by novice surgeons. Our residents were made to revise the relevant surgical anatomy and methodology for each step from standard SICS manuals well in advance.[6,8,9] Once the novice resident surgeons started surgeries, though they were well versed with the relevant theoretical aspects and had sufficient wet laboratory training necessary to perform each step, we observed that at various stages during the surgery, they faced practical challenges. Hence, this pilot study was designed to fill that lacuna. We intend to discuss major observations made at the most important steps.

Posture and microscope adjustments

We recommend that, when a student starts the surgery, posture should be proper such that the student does not extend the neck and slouching is also avoided, shoulder and elbow should be in a relaxed position. Interpupillary distance, table height, magnification, and foot switch control, must be adjusted accordingly to avoid diplopia and achieve necessary depth. We recommend that these first few steps must be practiced by the resident periodically so that the resident is aware of microscopic adjustments even before performing surgery in real time.

Sclerocorneal tunnel construction

In our observation, it was noted that two candidates [Graph 1: A1 and D4] out of six candidates had tunnel-related difficulties in the initial 12 and 16 cases, respectively, after multiple attempts of verbal guidance by the senior faculty, significant observation was made, candidate A1 and D4 could not appreciate appropriate depth during the tunnel construction and could not progress further, despite repeated wet laboratory training sessions. With a suspicion of nonstrabismic binocular single vision anomaly, we decided to perform a detailed orthoptic evaluation, candidate D4 was noted to have convergence insufficiency. The candidate performed significantly better after starting therapy for the same. Candidate A1 had a refractive error, was using overcorrected minus lenses, and was in a state of accommodative excess. Appropriate refractive error correction and orthoptic measures to relax accommodation were initiated. Hence, we recommend that for every candidate before enrolling themselves into surgical training, cycloplegic refraction



Graph 2: Horizontal stacked bar diagram showing serial performance of the residents during capsulorhexis in the first 20 cases. A1: Candidate 1, B2: Candidate 2, C3: Candidate 3, D4: Candidate 4, E5: Candidate 5, F6: Candidate 6. Novice (score = 2), Beginner (score = 3), Advanced beginner (score = 4), Competent (score = 5)

and a detailed orthoptic evaluation must be performed to diagnose treatable orthoptic issues. We also noted that students need help initially in recognizing blunt instruments, guidance appropriately will help prevent complications such as buttonholing of the cornea, Descemet membrane detachment, deep tunnel, and premature entry, which are otherwise common with the usage of blunt instruments. Adequate extension of the tunnel until the edge to facilitate nucleus delivery was emphasized.

Continuous curvilinear capsulorhexis

We noted that the residents had difficulty in perceiving anterior lens capsule (ALC) depth. Hence, residents were instructed to focus on the level of the iris, use trypan blue for better demarcation of the capsule, to wash the dye off completely before starting the rhexis. Appropriate bending of cystotome was supervised. Stabilizing the globe through nondominant hand by holding at the limbus (the junction of the tenons and conjunctiva), where there is a firm grip so that coaxial illumination is maintained throughout the step, was emphasized. At the same time, too much pressure on the globe must be avoided as it may lead to the escape of the viscoelastic from the anterior chamber (AC). Specifically, candidate A1 [Graph 2] had difficulty with depth perception due to convergence insufficiency.

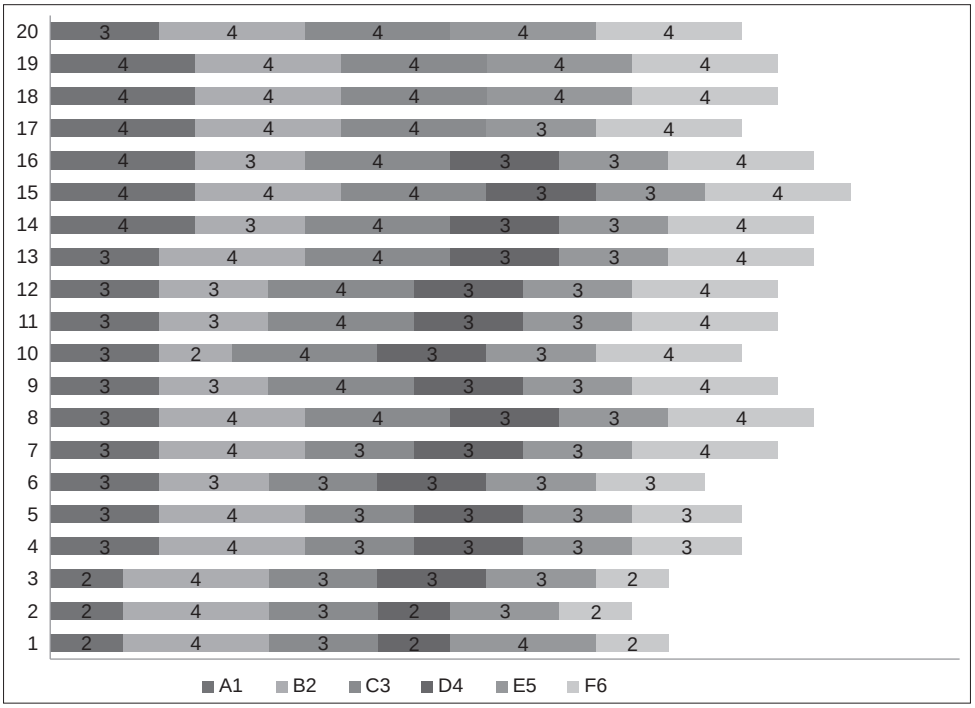
Extension of continuous curvilinear capsulorhexis

The most common mistake was that residents initially started with a long capsular vertical nick. The capsule flap tends to get lifted 2 mm beyond the edge of the nick.[10] The tendency to extend is maximum if the initial nick is very lengthy at the very beginning of the step. Hence, care must be taken to initiate the rhexis with a slight curvilinear movement rather than a straight long vertical nick. Dislodgment of the capsular flap from the rest of the capsule, after the completion of rhexis, must be confirmed by adequate use of viscoelastic and free floating of the capsular flap in AC.

Perception of the size of continuous curvilinear capsulorhexis

Most often to achieve a complete round rhexis, the size of continuous curvilinear capsulorhexis (CCC) was compromised, and residents made a very small round CCC. Small CCC is known to be detrimental in SICS.[10] Since a minimum of 6–7 mm CCC is preferred in SICS,[11] residents should ensure the adequacy of CCC based on the grade of the nucleus.

In our observation, Candidate B2 [Graph 2] had mild difficulty in performing CCC in the initial few cases due to exaggerated physiological tremors. Tremors may be anxiety associated. However, to a certain extent exaggerated tremors can be controlled by the antitremor exercises.[12] The resident was also recommended to maintain composure and periodically practice antitremor exercises on the simulator to improve hand stability.



Graph 3: Horizontal stacked bar diagram showing serial performance of the residents during nucleus management in the first 20 cases. A1: Candidate 1, B2: Candidate 2, C3: Candidate 3, D4: Candidate 4, E5: Candidate 5, F6: Candidate 6. Novice (score = 2), Beginner (score = 3), Advanced beginner (score = 4), Competent (score = 5)

Nucleus management

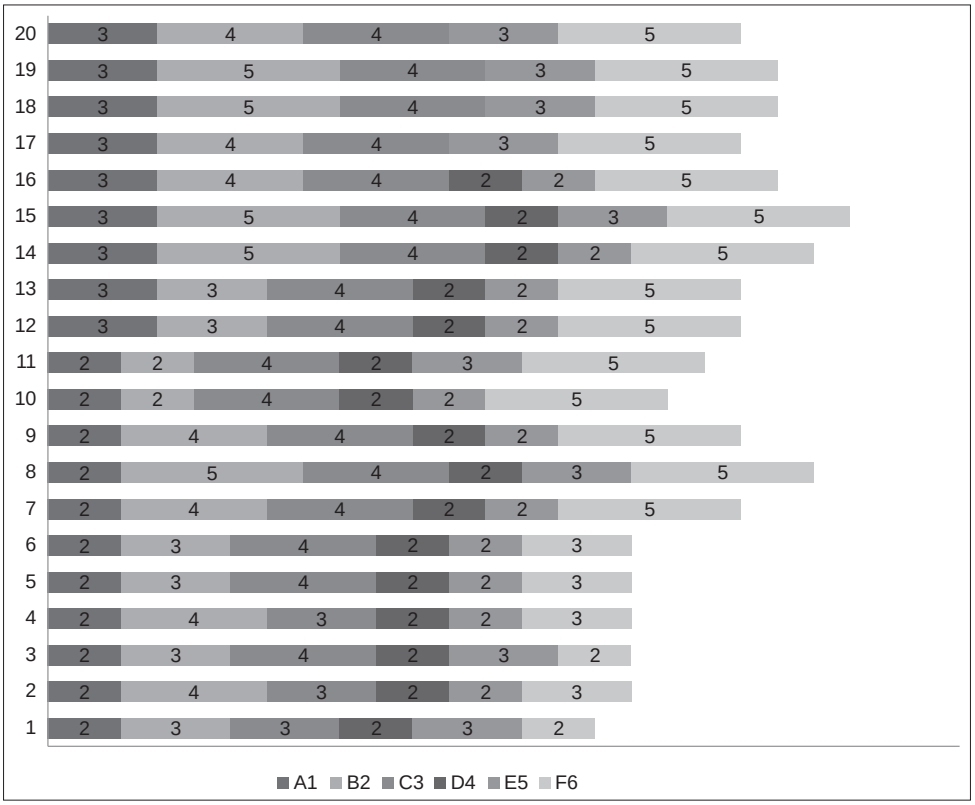
Most often, hydrodissection was done in the wrong plane by the novice, which may cause inadvertent pupillary constriction making the rest of the steps difficult. Resident should be aware that the plane of hydrodissection should be appropriate, and the rhexis margin must be identified and slightly lifted. We recommend that hydrodissection should be done with small jets of fluid in four clock hours (2, 4, 7, and 11 clock hours) initially. Inappropriate hydrodissection leads to difficulty in maneuvering the nucleus out of the capsular bag.[13] Multiple attempts for hydrodissection may lead to the displacement of the anterior cortical matter, eventually causing pupillary constriction, the ALC rim may be obscured, and when the novice tries to prolapse the nucleus out of the capsular bag, they may inadvertently place the Sinskey hook over the ALC, and the chances of capsular bag dialysis are higher. Adequate viscoelastic must be injected to maintain AC during maneuvering the nucleus. If required, displaced anterior cortical matter must be aspirated before reattempting the nucleus delivery, to facilitate prolapse of the nucleus.

The technique followed in our institute for the nucleus delivery is the sandwich technique. In our observation, Candidate E5 [Graph 3] had iris prolapsing through the main wound after the nucleus delivery in most of the cases. We have observed that inadequate perception of the position of the Wire Vectis at the time of the nucleus delivery is responsible for this.

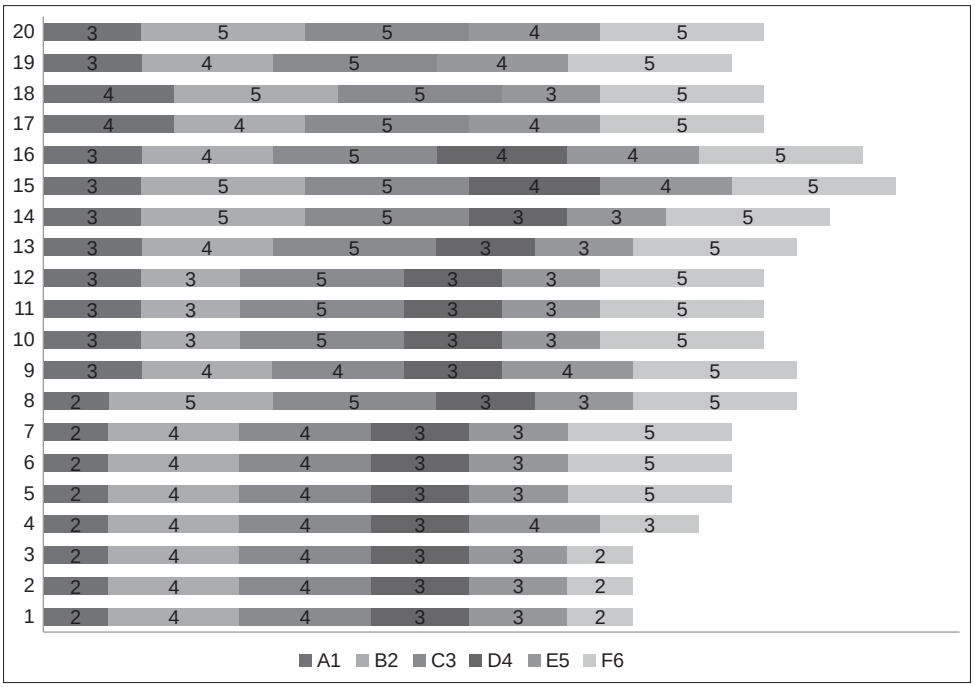
Inferior pupillary margin, if held along with the nucleus at the time of delivery, inferior iridodialysis is expected. Similarly, if the AC is shallow and the superior pupillary margin is dragged during the introduction of the vectis, superior iridodialysis can occur. Hence, residents were recommended to introduce the vectis slowly, and the direction should be downward, forward, and upward along the contour of the nucleus and the tip of the Vectis should be visualized after engaging the nucleus. Deep or multiplanar tunnels can lead to prolapse of the iris, and during nucleus extraction, superior iridodialysis can occur.

Irrigation and aspiration of cortical matter

The technique followed in our institute is continuous irrigation with Simcoe cannula and manual aspiration. This technique has a steep learning curve.[14] Candidate A1, D4, and E5 [Graph 4] had difficulties in performing the step. In the first few cases, it was observed that the residents performed hydrodelineation instead of hydrodissection which resulted in a thick epinuclear



Graph 4: Horizontal stacked bar diagram showing serial performance of the residents during irrigation and aspiration in the first twenty cases. A1: Candidate 1, B2: Candidate 2, C3: Candidate 3, D4: Candidate 4, E5: Candidate 5, F6: Candidate 6. Novice (score = 2), Beginner (score = 3), Advanced beginner (score = 4), Competent (score = 5)



Graph 5: Horizontal stacked bar diagram showing serial performance of the residents during intraocular lens management in the first twenty cases. A1: Candidate 1, B2: Candidate 2, C3: Candidate 3, D4: Candidate 4, E5: Candidate 5, F6: Candidate 6. Novice (score = 2), Beginner (score = 3), Advanced beginner (score = 4), Competent (score = 5)

Table 1: The case at which resident has achieved the stage of Grade 4–5 in ophthalmology surgical competency assessment rubric scorings

	Ophthalmology surgical competency assessment rubrics scoring Grade 4–5				
Residents	**Sclerocorneal tunnel**	**Capsulorhexis**	**Nucleus management**	**Irrigation and aspiration**	**IOL management**
A1	13	11	14	-	17
B2	7	6	1	2	1
C3	9	4	8	3	1
D4	-	3	-	-	15
E5	3	6	1	-	4
F6	4	5	7	7	5

A1: Candidate 1, B2: Candidate 2, C3: Candidate 3, D4: Candidate 4, E5: Candidate 5, F6: Candidate 6

Table 2: The major observations made by the senior observing surgeons summarized as verbatim quotes

Verbatim quotes
1. One-to-one monitoring reduces the surgical learning curve
2. All residents must undergo proper refractive error assessment and orthoptic evaluation before enrolling in surgical training
3.Verbal guidance by a senior observing surgeon – can prevent or salvage complications
4. One-to-one monitoring will have a psychological impact – will improve the confidence of trainee
5. Wet laboratory practice – key to improve initial few steps of SICS
6. Antitremor exercises – improves hand stability
7. Continue to observe and assist senior surgeons

SICS: Small incision cataract surgery

sheath being retained in the bag, in which case, a secondary hydrodissection is recommended.[14] For most of the cases, residents needed verbal guidance for performing the step. Despite verbal guidance, if the candidate could not complete the step, the senior surgeon had to complete the step.

Intraocular lens insertion

Candidates were given rigid intraocular lens (IOLs). It was noted that Candidate A1 [Graph 5] was applying undue pressure while maneuvering IOL in AC which caused posterior capsular rent. Inappropriate dialing of IOL was also observed, and verbal guidance at that stage and timely help from a senior observing surgeon could salvage the step and prevent undue complications. It was also noted that residents tended to place the IOL in the sulcus, due to which IOL stability was compromised, mild decentration or tilting of IOL[15] was observed, and dialing of IOL into the bag was done by the senior surgeon.

Table 1 highlights the case at which the operating resident has achieved the stage of Grades 4–5 in OSCAR scorings. It was noted that the difficult steps for each candidate varied. Special guidance was given for those steps accordingly. Candidate F6 [Table 1] has achieved the competence of Grades 4–5 (OSCAR scoring) as early 5th–6th case in most of the steps. Candidate F6 had regular wet laboratory practice and would keenly observe the steps even while assisting the senior surgeon. This candidate also had minimal prior surgical exposure of 20–25 cases in another institute before enrolling in our institute. Candidates A1 and E5 did not achieve the stage of Grades 4–5 on OSCAR scoring during the step irrigation and aspiration in their first 20 cases. The learning curve for irrigation and aspiration (using Simcoe cannula) is steep, and some candidates may need additional practice for better understanding of handling the instrument. However, Candidate E5 has significantly performed well in other steps. Candidate D4 could not attain the OSCAR Grade of 4–5 in most of the major steps even after 20 cases, this candidate had orthoptic issues, and therapy was initiated for the same we also emphasize the fact that the surgical learning curve is variable, and some candidates need additional guidance to improvise surgical skill. We summarize certain important observations made by the senior observing surgeons in our study in Table 2 as verbatim quotes.

Our study has certain limitations, it is a small-scale study. However, it was planned as a pilot study, and through the observations of this study, we intend to plan in-depth larger studies in future to improvise resident surgical training. One-to-one observation could not be completed for the first 20 cases for Candidate D4; however, it was done for the first 16 cases, and results of which have been included in the study.

Conclusion

We conclude that one is to one monitoring by the senior faculty surgeon during the initial twenty cases plays a pivotal role in the surgical learning curve of the residents as it is the critical period during which the resident gains awareness of intraocular structures and it enables best possible surgical outcomes with least number of complications in resident surgical cases. We believe that the observations of our study may be used for modifications in future to improvise postgraduate surgical training program in ophthalmology.

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Conflicts of interest

There are no conflicts of interest.

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Original Article

A Case Series: Refractive Outcome of Implantable Phakic Copolymer Lens with Central Hole among Adults with High Myopia and Compound Myopic Astigmatism

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Abstract

Purpose: To assess the effectiveness and safety profile of implantable phakic copolymer lenses (IPCLs) with central and peripheral optic holes in adults with moderate-to-high myopia and myopia with astigmatism.

Materials and Methods: Twelve eyes of seven adults who underwent IPCL implantation were followed up for 6 months after surgery, and data were analyzed. Preoperative parameters, such as subjective refraction, anterior chamber depth, and white-to-white diameter, were measured. A custom-made IPCL was then implanted in the posterior chamber through verion-guided temporal incision to correct moderate-to-high myopia/myopia with astigmatism.

Results: Clinical outcome data were analyzed. The mean age was 24.08 years (standard deviation [SD] 1.72 years), and 75% of the patients were female. The mean preoperative best-corrected visual acuity was 0.3 logMAR unit (SD: 0.154 range 0.176–0.447, median 0.176). The post-IPCL implantation mean uncorrected visual acuity was 0.329 logMAR units (SD: 0.456 range 0.176–1.77, median 0.176); complications were seen in 2 (16.6%) cases. Spectacle independence was achieved in 91.3% of cases.

Conclusion: Implantation of the IPCL with central and peripheral holes in the intraocular posterior chamber resulted in a clinically significant improvement in unaided visual acuity and quality of vision among the most in the study group, which makes it a suitable surgery for such cases though serious complications like retinal detachment also should be kept in mind.

Keywords: *Anterior chamber depth, anterior segment optical coherence tomography, central optical hole, gonioscopy, implantable contact lens, implantable phakic copolymer lens, pathological myopia, vault height*

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Introduction

Posterior chamber phakic lenses (located behind the iris and in front of the crystalline lens) are a safe and effective option for correcting refractive errors, especially when corneal procedures are counter indicated.[1-3]

The implantable phakic copolymer lens (IPCL V2.0; Caregroup, Gujarat, India) is a new posterior chamber phakic intraocular lens that can be used to correct refractive problems.[4] It was created as a cost-effective alternative to traditional refractive correction instead of an implantable collamer lens (ICL). The advantage of this new IPCL is that maximal myopic correction attainable with ICL is restricted to −18.0D, while the IPCL is freely available and can correct a wide range of ametropia up to −30.0D.[5]

This new IPCL (IPCL V2.0) with a 380 μm central artificial hole is commercially available. This can eliminate the necessity for a peripheral iridectomy and reduce the risk of cataracts and pupillary block glaucoma.[6] We aimed to evaluate the efficacy of this

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lens as well as the safety profile among our study group.

Materials and Methods

This prospective study was conducted at the Retina Institute of Bengal after obtaining approval from the Institutional Review Board. Written informed consent was obtained from all the patients in tenets with the declaration of Helsinki. Twelve eyes of seven adults who had undergone an IPCL implantation operation from November 11, 2022, to June 18, 2023, were followed up for 6 months, and finally, all data were analyzed.

Inclusion criteria

Patients aged 19–35 years with stable refraction for the past 1 year with myopia ranging from −7D to −25D were included in the study. In addition to high myopia, patients with high astigmatism (above 1.5 D) were also included.

Exclusion criteria

Exclusion criteria were irregular corneal topography, corneal scar, higher keratometry value above 47 D, narrow anterior chamber angle, any anterior segment anomaly, any serious retinal pathology, and an anterior chamber depth (ACD) of <3 mm. Eyes with prior ocular surgery, comorbidities, including cataracts, glaucoma, or uveitis, were excluded from the study.

Ophthalmic examination with slit-lamp biomicroscopy and gonioscopy was performed by an anterior segment surgeon to evaluate the anterior chamber, angle, lens status, and corneal status taking particular attention to ruling out the presence of guttae and epithelial irregularities. Posterior segment evaluation was done by a vitreoretinal (VR) surgeon with indirect ophthalmoscopy. Visual acuity assessment was performed using Snellen charts, and cycloplegic refraction was carried out in all cases, followed by postmydriatic test. All values were recorded. The anatomy of the corneal endothelium was assessed using a slit lamp, and its functionality was determined through optical pachymetry (Zeiss intraocular lens [IOL] master 700). The intraocular pressure (IOP) was measured using Goldman applanation tonometry, whereas the macular thickness and posterior pole status were evaluated through optical coherence tomography (Stratus OCT, Topcon). Gonioscopy was performed in all the patients to assess angle anatomy, followed by anterior segment OCT (AS OCT) angle photography. After counseling about the IPCL surgery, patients were sent for biometry to record ACD, lens thickness, white to white, and central corneal thickness. Later, verion-guided planning was done for individual cases so that a precise temporal main incision site could be made under verion guidance during surgery. The refraction results, along with biometric data were sent for making the customized IPCL.

The IPCL is made of a hybrid acrylic hydrophilic material and has a 380 μ hole in the center of the optic for proper aqueous flow, which, though at the center, does not induce significant visual disturbances. Its six haptic pads ensure better stability in the ciliary sulcus. It is a rectangular lens with seven holes; one at the center, two in each haptic, and two along the periphery of the optic, which determines the orientation of the lens inside the eye. The peripheral optical holes are meant for directional orientation and have to be directed upward inside the eye. IPCL V2.0 has a special patterned hole in the upper left corner to ensure the proper direction of the lens.

Under strict aseptic preparations, the IPCL was loaded in a butterfly cartridge with the help of dispersive viscoelastic. The IPCL was placed in the inner groove of the cartridge, making sure that the convexity of the lens would be facing upward in the anterior chamber after release. The orientation of the IPCL is determined by observing two peripheral optic holes, which should be towards the upper lid. For right-eye implantations, the peripheral optical holes were placed on the left of the cartridge, and for left-eye implantations, the peripheral optical holes were on the right of the cartridge. Next, the haptics of the IPCL were pushed downward and gently, the wings were folded and introduced into the groove of the handle. The plunger was pushed to check the smooth forward movement of the lens, making sure the IPCL moves freely.

After completing the loading of the lens, a 2.8-mm temporal clear corneal incision as the primary implantation site was made under verion guidance and two side ports at 2'o clock and 11'o clock were made for manipulation of the IPCL once it was inside the anterior chamber. Through the main incision, dispersive viscoelastic was put inside the anterior chamber, and it was deepened. The cartridge was introduced gently through the temporal incision and the IPCL was slowly pushed inside, which was then unfolded inside the anterior chamber (AC). While unfolding, the convexity was made to face upward and the optic holes were followed so that the two peripheral holes were located superiorly. Now, first, the leading haptic was tucked underneath the peripheral iris, and later, the trailing haptic was also tucked temporally beneath the iris, using dialing hooks in both hands. Once no part of the haptic periphery was visible outside the papillary margin, the viscoelastic was washed off thoroughly. Finally, carpinol was used for miosis and making sure the haptics were

placed in the sulcus. The toric variant of IPCL was also kept in a similar manner, making sure that the toric marking on the lens is aligned with the verion-guided temporal incision. No rotation of toric IPCL was needed as the toricity is incorporated in the lens at an alignment of 0°–180°.

Postoperative assessment

During postoperative evaluation, visual acuity was noted, and patients were sent to the diagnostic room for evaluating vault height, ACD, and angle OCT, and all parameters were recorded. Anterior chamber evaluation and IPCL position noted in dilated pupil under slit lamp bimicroscopy. ASOCT for ACD, vault height, and angle were repeated at 1st week, 4th week, 3rd month, and 6th month postoperatively during each scheduled visit. Furthermore, any evidence of complication was examined for and taken care of during postoperative period. Data were entered, and visual acuity was converted to logMAR unit for statistical analysis.

Results

Table 1 is showing the demographic distribution and ocular parameters along with the values. In total, 12 eyes of 7 patients were included in the study. The mean age of the patients at the time of surgery was 24.08 years (standard deviation 1.72, minimum: 23 years and maximum: 26 years). There were 9 (75%) female patients and rest 3 were male patients (25%).

Visual acuity

The mean preoperative best-corrected visual acuity (BCVA) was 0.30 logMAR units (SD: 0.154 minimum: 0.477 and maximum: 0.176). The average refractive error corrected was −15 D (SD 6.7048) (minimum: −7D and maximum: −24.4D). The mean cylindrical error corrected was −4.0D (SD 1.457) (minimum: −2.5D and maximum: −6D). Approximately 58.33% of the recipients (7 eyes) received a spherical IPCL, whereas the remaining received a toric IPCL. Figure 1 is showing the image of an IPCL lens and Figure 2 is showing IPCL after placement inside the eye of one of the subjects.

The mean uncorrected visual acuity in the postoperative day (POD) 6 months of follow-up was 0.329 with SD 0.456 [Figures 3 and 4]. In this study series, 83% of the patients attained either the same or better visual acuity in comparison to preoperative BCVA. Thirty-three percentage eyes achieved greater than (Mean 0.26 logMAR unit, range 0.17–0.30) improvement compared to their preoperative BCVA. Two eyes (16.6%) had comparatively less visual outcome (mean 0.71 logMAR unit). One patient required minor Glass correction (8.3%) as that case could not afford suitable IPCL power due to financial restraint.

Figure 1: Computer generated picture of IPCL (implantable phakic copolymer lens)

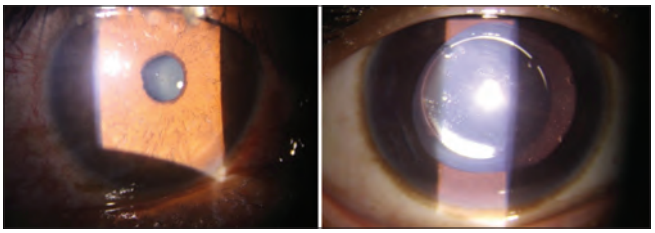

Figure 2: IPCL (implantable phakic copolymer lens) in undilated and dilated pupil

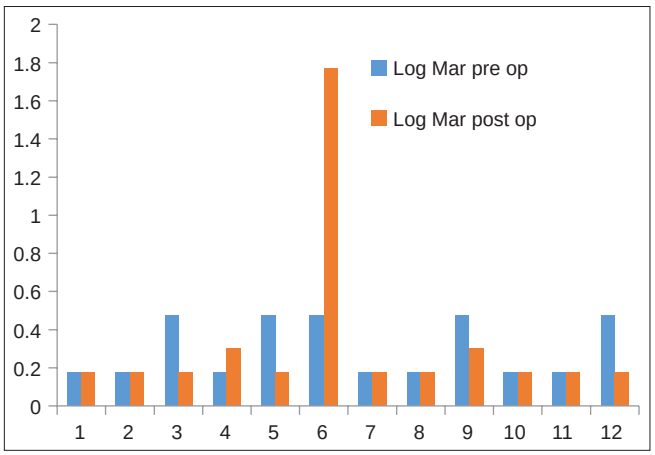

Figure 3: Bar diagram of comparison of visual out come

In this bar diagram, a comparison of visual outcomes in LogMAR unit, pre- and post-operatively at 6 months is showing gain in V/A in 4 cases and deterioration in 2 cases while among the rest V/A remained the same. The tall spike of reduction in V/A in 1 case is due to the development of rhegmatogenous retinal detachment in that case. In 6 (50%) cases, there was no change in Visual acuity before or after surgery.

The median log mar preoperative and postoperative was 0.176 (interquartile range 0.3), showing that there was no change in the median value.

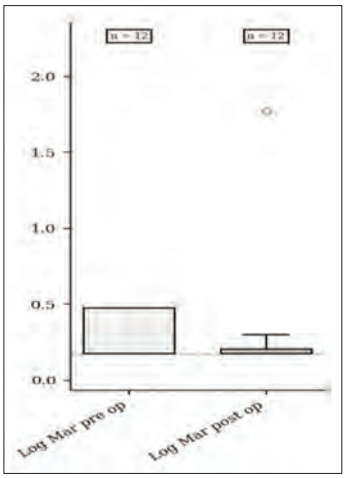

Figure 4: Comparison of visual outcome in LogMAR unit pre- and postoperatively at 6 months by Wilcoxon signed-rank comparison

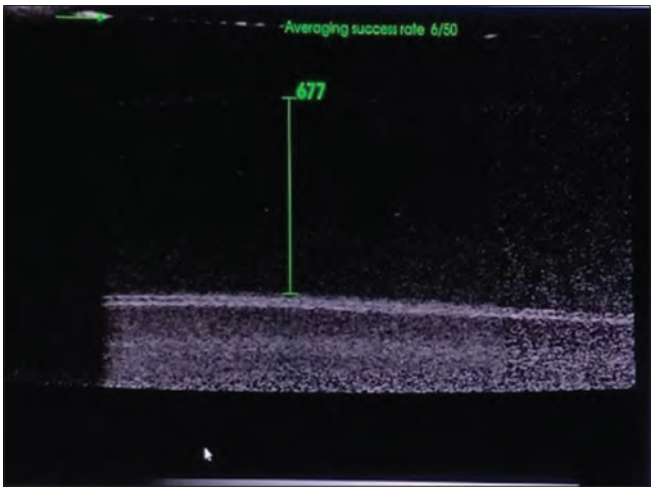

Figure 5: Anterior segment optical coherence tomography showing vault height 677 µm in one patient

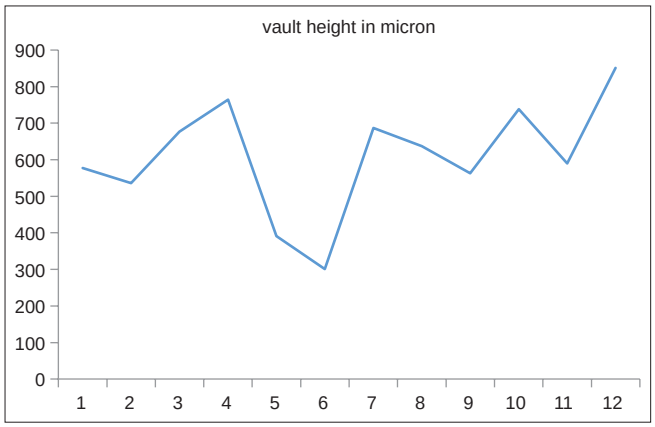

Figure 6: Distribution of vault height among IPCL patients

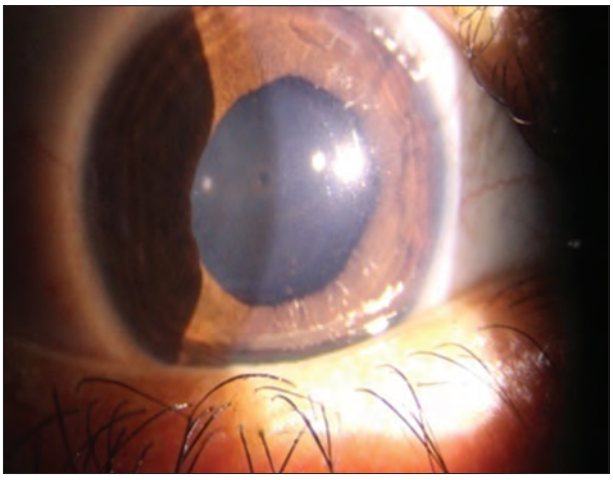

Figure 7: Mid-dilated pupil in a case of Urrets–Zavalia syndrome

Vault height

Postoperative mean vault height was 609.33 µm with SD 154.31 in the study group. The vault height in postoperative follow-up was satisfactory among all patients and did not change over time during 6 months follow-up. Figure 5, showing the vault height in one subject and Figure 6 showing the distribution of post operative vault height among the study group.

Postoperative complications

Table 2 is showing frequency and distribution of complications after surgery. One patient (8.3%) developed a high IOP above 30 due to retained viscoelastic. That case also had severe AC reactions. Antiglaucoma medication (AGM) was prescribed along with topical steroids frequently. AGM was continued for 1 month, and later, IOP subsided, but the patient developed mid-dilated pupil with complaints of glare during 1-month follow-up visit. A tentative diagnosis of Urrets–Zavalia syndrome was made, and the patient was kept on observation [Figure 7]. Another patient developed rhegmatogenous retinal detachment at the end of 6 months, for which surgical management was planned.

Anterior chamber angle evaluation

All cases had gonioscopic angle open with visible scleral spur; ASOCT of the anterior chamber angle was also done to confirm the angle status. Postoperatively, no shallowing of angle was noted gonioscopically or with AS OCT-angle view. Figure 8 is showing an open angle in one of the subjects.

Discussion

Cataracts and elevated IOP are the most frequently recorded complications associated with phakic posterior chamber IOL implantation,[7] and in our study, the safety profile of IPCL was found to be good considering the fact that none of the patients developed cataracts or persistent glaucoma during follow-up period of 6 months.

After this surgery, the low risk of cataract formation may be due to the central hole, which is unique in this

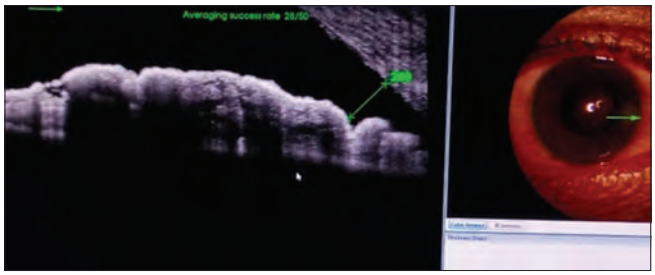

Figure 8: Angle optical coherence tomography showing open angle in a postoperative case

IPCL. The central hole in IPCL may decrease the risk of cataract formation due to possible circulation of the aqueous humor through the hole, reducing the risk of lens malnutrition.[8]

In 6 months follow-up apart from one, none of our patients developed chronic raised IOP because the central hole in the optic of the V2 IPCL permits near-normal aqueous humor circulation, and so in such patients Nd:YAG iridotomies are not also required.[9] In our study, the angle was open preoperatively in all cases where sclera spur was visible in gonioscopy among the study group, and postoperatively also, there was no narrowing in gonioscopy or in ASOCT evaluation of the angle.

One patient (8.3%) had raised IOP since the 1st POD and was controlled with topical AGMs, while the patient again developed high IOP after 1 month; that patient later was found to have persistent papillary dilatation suggestive of Urrets–Zavalia syndrome though her IOP was controlled after 2 months. The risk of secondary glaucoma otherwise is minimal in IPCL cases, as has been shown also in a similar study by Vasavada *et al*., where 6.6% of cases had developed a transient rise in IOP.[10] In another similar study done in India by Sachdev and Ramamurthy among 134 adults, IOP rise was seen in 2.9% of cases, which also highlights the low risk of developing glaucoma in IPCL patients. The same study reported a low incidence of cataracts (2.2%). Both studies are similar to our findings of low incidence of glaucoma and cataracts in IPCL patients.[5]

An appropriate vault size for avoiding IPCL and crystalline lens contact should be >250 to <750 μ or. 5–1.5 the thickness of the cornea.[11] Patients with a low vault height are at an increased risk of postoperative cataract progression and toric ICL rotation.[12,13] In our study, vault height was high, where the mean height was 609.33 μ, with no case below 250 or above 750. There was no significant change noticed in 6 months follow-up in vault size among the study group.

The significant improvement in visual acuity was noticeable in our study and apart from one case (8.3%), all were spectacle independent, which accounts for

Table 1: Demography and ocular details

Ocular parameters and demography	Value
Age (years)	
Mean with SD	24.08 (1.72)
Median (range)	25 (23–26)
Anterior chamber depth (mm)	
Mean with SD	3.66 (0.235)
Median (range)	3.66 (3.32–4.11)
Preoperative V/A	LogMAR unit
Mean with SD	0.3 (.154)
Median (range)	0.176 (0.176–0.447)
Postoperative V/A	LogMAR unit
Mean with SD	0.329 (0.456)
Median (range)	0.176 (0.176–1.77)
Vault height (μm)	
Mean with SD	609.33 (154.31)
Median (range)	613 (391–851)
Pachymetry value (μm)	
Mean with SD	533 (36.65)
Median (range)	521 (490–623)
IPCL number/type	
Total	12
Toric	5 (41.66)
Nontoric	7 (58.33)

SD: Standard deviation, IPCL: Implantable phakic copolymer lens

Table 2: Frequency of complications

Complication	*n* (%)
High IOP	1 (8.3)
Urrets–Zavalia syndrome	1 (8.3)
Cataract	0
IPCL dislocation	0
Angle closure	0
Iris atrophy	0
Corneal edema	0
Retinal detachment	1 (8.3)

IOP: Increased intraocular pressure, IPCL: Implantable phakic copolymer lens

91.7%. There was no incident of toric IPCL rotation or regression of toricity among the study group.

Myopia was moderate to high in our study, ranging from −7 to −20D. Also, the quality of vision preoperatively among the study group was unsatisfactory and all of them wanted to get rid of glasses. As spectacle correction of high myopia results in unsatisfactory vision correction because of higher-order aberrations,[14] an intraocular lens at the focal point of the eye not only reduces the higher-order aberrations but also increases the field of vision.[15] After surgery in our study, the LogMAR value changed from 0.3 logMAR unit preoperatively to 329 logMAR unit post-IPCL. This deterioration is because one case developed retinal detachment, and so the mean log mar unit value of

post-IPCL Visual acuity was lower than preoperative value. However, if we consider the median value, it is the same (0.176 logMAR) in both the groups. Furthermore, definite improvement in the mean logMAR unit value was noted among 91.3% of cases if we exclude the case of retinal detachment, which certainly had reduced the mean value of the postoperative group as a whole.

The study effectively has shown the efficacy of IPCL in reducing spectacle dependence which was seen in 91.3% of cases who did not require glasses anymore after surgery. The study could highlight the efficacy and safety profile of IPCL as well as complication status, though this study has certain limitations like a short duration of follow-up of only up to 6 months. Furthermore, if the study population was larger, this study could have emphasized complications and outcomes with more variables and outcome results.

Conclusion

Implantation of the IPCL with central and peripheral holes in the intraocular posterior chamber resulted in a clinically significant improvement in unaided visual acuity and quality of vision among the most in the study group, though serious complications like retinal detachment also should be kept in mind. With an increasing number of patients planned to be added to this study in the future, this study will have a better scope to highlight more on the complications and safety profile. As a whole, this IPCL implantation surgery can be a good option for high myopia and compound myopic astigmatism, and it can offer spectacle independence in such cases.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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Original Article

Energy-efficient Chop: A Novel Technique of Nucleus Chopping

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Abstract

We describe a novel technique of nucleotomy in phacoemulsification called "energy-efficient chop." The technique aims at reducing the phaco energy inside the eye when emulsifying the nucleus of any grade. After hydrodissection, the phaco tip is embedded into the nucleus using ultrasound energy and stabilized using vacuum and divided into two halves using either horizontal or vertical chop. After rotating the nucleus by 180°, the balanced tip is embedded horizontally in the center of the heminucleus using phaco power and stabilized using vacuum and each heminucleus is further divided into 3 or 4 pieces depending on the grade of cataract and emulsified. The balanced tip when embedded horizontally allows a larger area of the heminucleus to be held and thus makes chopping easier without having to bury the tip at multiple places in the heminucleus. This technique decreases the total phaco energy dissipated in the anterior chamber during phacoemulsification.

Keywords: *Cumulative dissipated energy, horizontal chop, nucleotomy, phaco energy, phacoemulsification, vertical chop*

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Phacoemulsification is the worldwide standard for cataract surgery. Although phacoemulsification is a relatively safe procedure for cataract removal, the current technology has certain drawbacks. According to Wong *et al*.,[1] ultrasound energy used during nuclear emulsification is associated with endothelial cell loss. In ultrasonic phacoemulsification, piezoelectric crystals convert electrical energy into mechanical energy, which emulsifies the lens material by vibration of the tip. Ultrasonic tips create both heat and cavitational energy. The heat and cavitational energy that is dissipated in the eye can cause corneal burns and endothelial cell loss. A reduction in average phaco power and effective phaco time will cause less heat energy to be dissipated in the eye, thereby decreasing the endothelial cell loss. Several techniques to reduce the amount of US energy to the eye have been developed such as stop and chop and direct chop.[2,3] We describe a novel technique of nucleotomy in phacoemulsification called "energy-efficient chop." The technique aims at reducing the phaco energy inside the eye when emulsifying hard nuclei.

Surgical Technique

The surgeries are performed under topical anesthesia using the Centurion Vision System.

1. Two Verion-guided side port incisions of 1.3 mm are made
2. Viscoat is injected through one side port, followed by Provisc, after which the main incision (2.3 mm) is made
3. Verion-guided capsulorrhexis is performed using 26G cystitome/capsulorrhexis forceps. Hydrodissection was performed with a hydrodissection cannula until a complete wave is observed (Steps 1-3 can be changed as per surgeon's preference)
4. Phacoemulsification settings which we use are an intraoperative Intraoperative intraocular pressure (IOP) of 26 mmHg, 459 mmHg vacuum (max.), aspiration flow rate of 26 cm^3/min, and 60% torsional phacoemulsification with Intelligent Phaco (IP) setting at 90% occlusion
5. The energy-efficient chop is performed as follows: after a good hydrodissection, anterior cortex and epinucleus within the rhexis rim is aspirated to expose the nucleus [Figure 1]. The balanced phaco tip

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is embedded into the nucleus (oriented horizontally such that the bevel of the tip is facing the side of the chopper, thereby making multiple chops possible) using ultrasound energy and stabilized using vacuum and divided into two halves using modified vertical chop [Figure 2]. If the bevel is not facing the chopper, multiple chops are not possible as it is the tip which is acting as the fulcrum. In vertical chopping, the forces act against each other as the phaco tip holds the nucleus up and the chopper depresses downward into the nucleus to cleave it. After stabilizing the nucleus with vacuum, the nucleus is chopped vertically using the chopper and then laterally separated and divided into two halves. This is the modified vertical chop. With the same hold on one heminucleus, the heminucleus is further chopped into 3–4 pieces [Figure 3]. After rotating the residual nucleus, the same procedure is repeated. The balanced tip when embedded horizontally allows a larger area of the heminucleus to be held and thus makes chopping easier without having to bury the tip at multiple places in the heminucleus.

This technique allows chopping the nucleus with only two holds, thus decreasing the total phaco energy dissipated in the anterior chamber during phacoemulsification.

Advantages

Energy-efficient chop causes lesser energy dissipation in the eye, thereby proving to be less traumatic and providing faster visual rehabilitation and better patient comfort in the postoperative period.

Discussion

It is well known that direct chop technique of nucleotomy decreases the amount of energy dissipated in the eye and causes less corneal endothelial damage compared to other techniques of nucleotomy.[4] The "energy-efficient chop" not only decreases the phaco energy used in the eye and the endothelial damage but also creates comparatively less zonular stress as rotation of the nucleus is minimized, thereby minimizing complications like zonular dialysis. It can be safely attempted in patients with weak zonules, pseudoexfoliation, subluxated cataracts with adequate support. The technique also proves to be effective in patients with small pupils as the chances of iris getting stuck into the phaco tip are less. Furthermore, time taken for nucleotomy decreases with this technique, thereby decreasing the total surgical time. However, the technique is not suitable for very soft cataracts as the high vacuum settings can cause excavation of the nucleus, and chopping is not a very suitable method for nucleotomy.

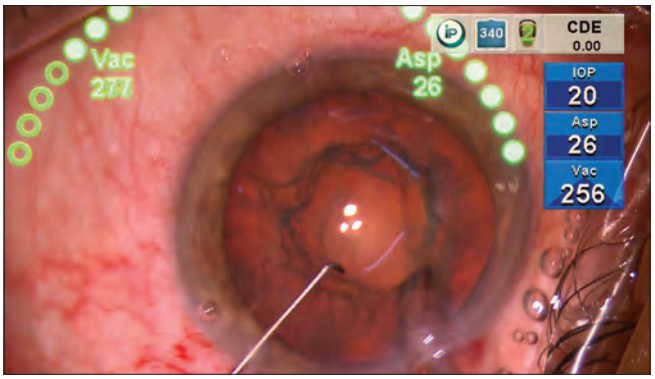

Figure 1: Aspiration of cortex and epinucleus to expose the nucleus

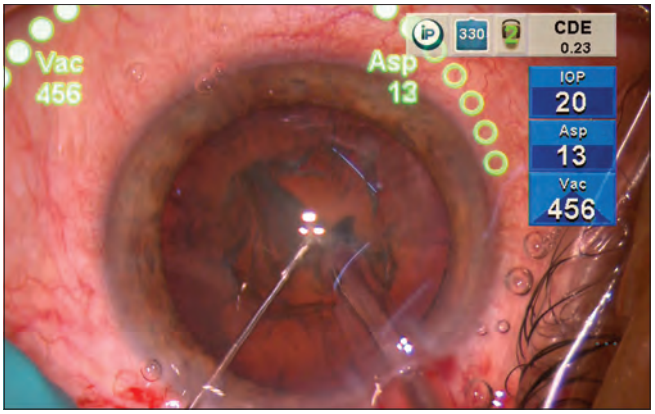

Figure 2: Modified vertical chop

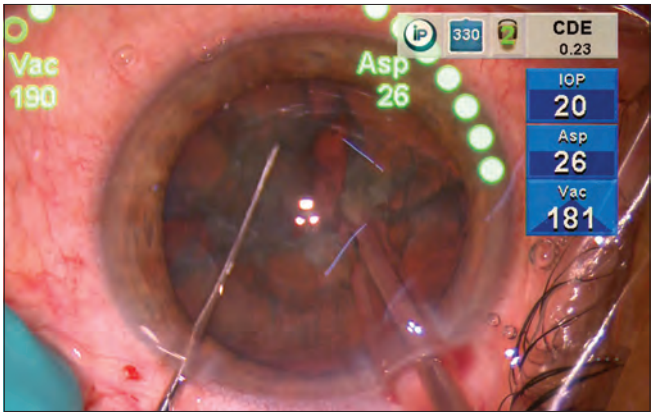

Figure 3: Multiple chops in one hold- energy efficient chop

Value Statement

What was known?

Postoperative corneal endothelial cell loss is related to increased intraoperative phaco energy dissipated in the eye.

Direct chop technique of nucleotomy reduces the phaco energy dissipated, thereby proving to be a safe technique.

What this paper adds?

The novel "energy-efficient chop" makes safe techniques like direct chop safer by further reducing the energy dissipated in the eye and additionally reducing stress on the zonules when performing nucleotomy in hard cataracts.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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Original Article

Revolutionizing Cataract Surgery with Advanced Techniques

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Abstract

Background: Cataract is the predominant reversible factor leading to blindness globally, affecting approximately 95 million individuals. The surgical procedure to replace a cloudy lens with an artificial lens is typically performed using local anaesthesia. Ultrasonic phacoemulsification is the conventional method used to fragment the nucleus of the lens. Thus far, randomized controlled trials (RCTs) have not demonstrated the superiority of the femtosecond laser compared to phacoemulsification for this specific purpose. In addition to the traditional single-focus type, the range of artificial intraocular lenses includes lenses with multiple foci, extended-depth-of-focus (EDOF) lenses, and astigmatism-correcting lenses.

Aims and Objectives: This article presents three distinct chop techniques that vary depending on the severity of the cataract. The goal is to minimize damage to the endothelial cells and maximize visual improvement after surgery.

Materials and Methods: patients were classified according to the grade of nuclear sclerosis. The patients with soft grade 1 cataract underwent 'Hydropop" technique. Patients with grade 2 nuclear sclerosis underwent phcoemulsifictaion using "Half Stop-Chop' technique. Patients with Grade 3 and grade 4 nuclear sclerosis underwent phacoemulsification using "Petal by Petal' technique.

Results: All patients who underwent phacoemulsification had a good visual outcome and full segmental nuclear fragment management was done without causing any endothelial and posterior capsular complication.

Conclusion: In order to improve patient outcomes, safety, and efficiency, phacoemulsification is a crucial part of modern cataract surgery. Newer innovations in different techniques of nuclear management only enable good visual outcome while reducing the learning curve.

Keywords: *Cataract, hydro-pop, Lens Opacities Classification System III, phaco-chop, phacoemulsification*

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Introduction

Cataract is a term used to describe the clouding or opacification of the lens of the eye [Figure 1]. This gradual clouding of vision progressively diminishes visual acuity, potentially resulting in complete loss of sight. Additional symptoms, contingent upon whether clouding impacts the nucleus or the cortex of the lens, may encompass diminished visual contrast, heightened sensitivity to glare, compromised color perception, and alterations in the refractive power of the lens. Specifically, the process of the nucleus of the lens becoming harder (nuclear sclerosis) is linked to the gradual development of myopia (near-sightedness). Cataracts develop gradually, without causing pain, and are considered the leading reversible cause of blindness globally, impacting around 95 million individuals.[1,2] The most prevalent form of cataract is age-related (senile) cataracts. Other types include congenital, conatal, and secondary cataracts.[3] The occurrence of lens clouding in children is estimated to be 1 in 200, and it does not always affect their visual acuity.[4] The prevalence of cataracts in children is 4.2 cases per 100,000, with

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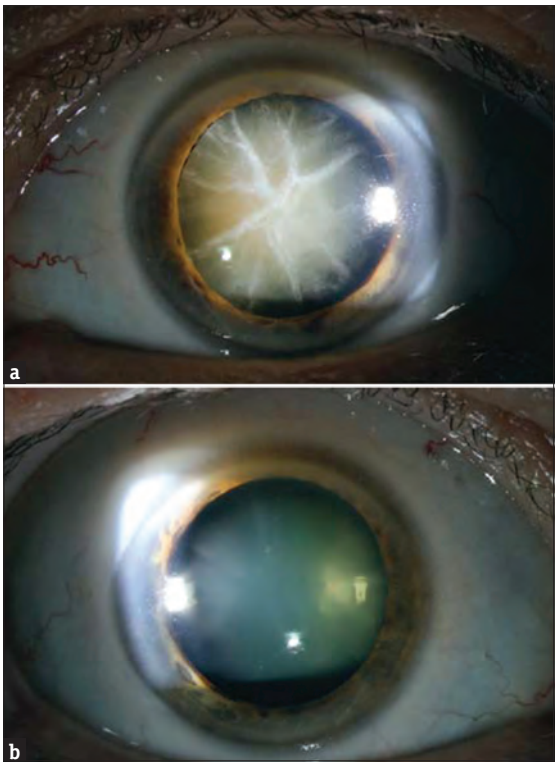

Figure 1: Lens findings on slit-lamp examination. (a) Advanced opacification of the left lens, (b) Incipient opacification of the right lens

significant differences depending on the geographic location. The highest prevalence is found in Asia, with a rate of 7.4 cases per 100,000.[5] The occurrence of cataracts increases as people get older. Its frequency goes up from 3.9% among individuals aged 55–64 to 92.6% among those aged 80 and above.[6-8] However, the seriousness and symptoms of cataracts may differ depending on how it is defined. In addition to old age, the risk factors for cataracts include smoking (with an odds ratio of 1.41 in cohort studies and 1.57 in case–control studies), myopia, intraocular infection/inflammation, and less commonly, metabolic diseases, certain drugs, ionizing radiation, and a genetic predisposition that is not yet fully understood.[9-11]

Indications for cataract surgery

The only effective treatment for cataracts is the surgical extraction of the clouded lens, followed by the insertion of an artificial lens. Animal experiments utilizing lanosterol eye drops for the purpose of dissolving opaque lenses[12] have not yet been applicable to humans. The primary indication for cataract surgery is a significant deterioration in vision and/or heightened sensitivity to glare. Surgical intervention may be necessary to address the issue of lens thickening due to aging, which can result in the flattening of the anterior chamber and narrowing of the chamber angle. This, in turn, leads to an increase in intraocular pressure. This condition is primarily observed in farsighted (hyperopic) individuals with a small eyeball size, short bulb length, and/or a shallow anterior chamber.[13] Cataract surgery is also necessary when there is lens injury resulting in lens swelling (known as traumatic cataract), or when an opacified lens obstructs visibility of the retina during retinal surgery.

Grades of cataract

For the evaluation of cataracts, the Lens Opacities Classification System III (LOCS III) is a prevalent grading system. Published in 1993,[14] it was developed by a group of researchers. The LOCS III system offers a standardized approach to delineating the attributes and severity of lens opacities within the ocular region. Cortical and posterior subcapsular cataracts, nuclear opalescence (NO), and nuclear color (NC) are the three major components of the system.

Grading of nuclear opalescence

NO is quantified on a six-point scale, where zero denotes the absence of opacity and six signifies the development of a mature cataract.

Grading of nuclear color

The grading system for NC varies from 1 to 6, where a clear lens is denoted by 1 and a mature cataract with a distinct yellow or brown hue is designated by 6.

Posterior subcapsular (P) and cortical (C) grading

Each grade for posterior subcapsular and axial opacities is assigned a numerical value between 0 and 5 [Figure 2].

Materials and Methods

The couching technique, which involved displacing the opacified lens from the optical axis by either pushing it back into the interior of the eye or attempting to remove it through a hollow needle, was already being used over a 1000 years ago. During the 1950s and 60s, techniques were developed to remove the lens and the entire capsular bag from the eye using a cryoprobe through a large incision in the cornea. This procedure is known as intracapsular cataract extraction. In a subsequent advancement known as extracapsular cataract extraction, the complete nucleus of the lens was removed from the eye by making a large incision in the cornea, while keeping the capsular bag undisturbed. This enabled the insertion of an artificial lens either inside or in front of the capsular bag. Two additional advancements have paved the way for the current surgical techniques used to treat uncomplicated forms of cataracts with significantly reduced complications. These advancements are phacoemulsification, a procedure that uses ultrasound to break up the cataract, and foldable intraocular lenses that can be inserted into the eye

Figure 2: Lens Opacities Classification System III classification system

through a small incision. These procedures can now be performed on an outpatient basis.[15] The utilization of ultrasound in cataract surgery was only established once piezoelectric elements were introduced, along with the development of suction pumps that could be integrated into a handpiece. Kelman (1930–2004) was a prominent figure in the advancement of phacoemulsification techniques used for the removal of lenses.[16,17] These advancements have made it possible to perform cataract surgeries using increasingly smaller surgical techniques while preserving the capsular bag, where the flexible artificial lens can be inserted.[18] The current standard is ultrasound phacoemulsification.

Having positive postoperative outcomes has become easier with the introduction of phacoemulsification and subsequent advancements in nucleus emulsification management. Various methods of nuclear management in phacoemulsification such as direct chop and stop and chop help in reducing ultrasound energy, thereby decreasing surrounding tissue damage and early postoperative recovery. Among the both, many surgeons have dissimilar opinions regarding the same, hence a sneak peek into comparison among both techniques is necessary.

Surgical technique for management of soft cataracts (hydropop technique) [Figure 3]

This method is especially beneficial for the treatment of soft cataracts. Following meticulous and sufficient capsulorhexis, hydrodissection is performed suboptimal

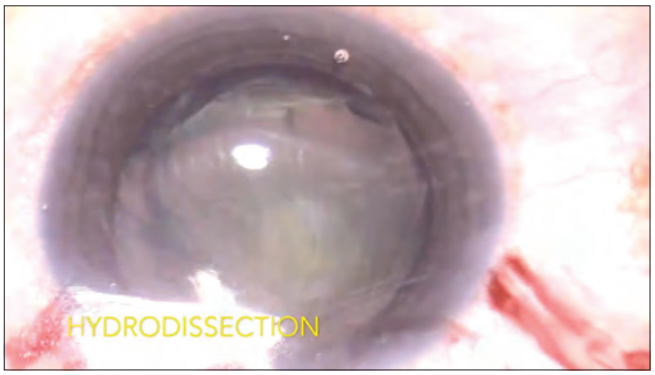

Figure 3: Hydropop technique

to the capsulorhexis margin to isolate the nucleus and epinucleus from the cortex.

In the anterior chamber, dispersive viscoelastic is employed to create space, while a combination of cohesive and dispersive viscoelastic is utilized to coat the endothelium in a "soft-shell" fashion, which serves to safeguard against endothelium loss.

After the cortex and soft nucleus have been separated, hydrodissection can be utilized to "pop" the nucleus from the bag and into the pupillary plane. This facilitates the nucleus's separation from the bag, allowing for additional phacoemulsification. The phacoemulsification probe is subsequently inserted through the main port and can be directly emulsified without the need for sculpting or trenching, using low power and high vacuum.

By utilizing a low-energy approach and a soft shell designed to protect the endothelium, this method facilitates the management of soft cataracts more rapidly while reducing endothelial cell loss.

Subsequently, the epinucleus can be extracted utilizing moderate vacuum settings and minimal power, and the cortex can be routinely aspirated employing bimanual or coaxial techniques.

Surgical technique for management of grade NO_2 NC_2– NO_3 NC_3 (half stop–chop technique) [Figure 4]

Moderately hard cataracts are amenable to this technique. To separate the nucleus from its encompassing attachment while preventing any force on the zonules, a gentle hydrodissection is performed subsequent to a meticulous capsulorrhexis.

Placing the probe in the center and commencing the trench from that point, analogous to how one would draw the radius of a circle, produces a narrow, eccentric, vertical trench. By requiring one-third and one-third, respectively, of the nucleus, this radius is eccentric. The nucleus is subsequently rotated 180° without cracking, and an attempt is made to coerce the smaller half in "chop" mode using the trench's starting point as the "chop wall." The trench located behind this smaller half facilitates easy cracking, which subsequently enables emulsification without excessive strain on the zonules. The larger half can now move much more freely in the bag without disrupting the zonules or posterior capsules, once the smaller half has been emulsified. A "stop-and-chop" or "direct chop" method may subsequently be employed to emulsify the larger portion.

Surgical technique for management of hard cataract Grade NO_4 NC_4–NO_6 NC_6 (petal by petal deflowering of cataract nucleus) [Figure 5]

A complete peribulbar block is administered to induce akinesia and anesthesia. Following a superior snip peritomy, a 2.8 mm scleral tunnel is created. To guide the capsulorhexis, the anterior capsule is stained with trypan blue under air and a 5.5 mm rhexis marker is applied to the cornea. During hydodissection for cytoplasmic cleavage, the large nucleus is rotated freely with constant burping. Endothelium is safeguarded by viscodispersive viscoelastic. The "petal-by-petal" method of phacoemulsification is done, in which a groove is initially formed in the nucleus through the process of sculpting using a venturi machine set to 80% power and 40 mmHg suction. The nucleus is then rotated 180 degrees, and a chop is executed once a firm grip is achieved on the half-sculpted ledge. Power is set to 80% linear and vacuum pressure is set to 150 mmHg during this time. The two halves are formed through the union of the posterior lens fibers.

Then, each half is sculpted or chopped into the shape of a flower, with multiple nuclear petals joined in the center, the hard nucleus core in the center resembles the capitulum of the flower. Phacoemulsification then breaks down each petal as if "plucking the petals," leaving the posterior plate's central core intact. This is subsequently prolapsed and emulsified. Thus, the cataract is "deflowered" and emulsified petal by petal. Viscoelastic is utilized extensively throughout the entire procedure to coat the endothelium.

Results

With the availability of three different techniques of cataract surgeries, all the patients were categorised into different stages according LOCS.

All patients who underwent the cataract surgeries according to the respective techniques based on classification, had good visual outcomes.

Discussion

Phacoemulsification has become the prevailing method

Figure 4: Half stop–chop technique

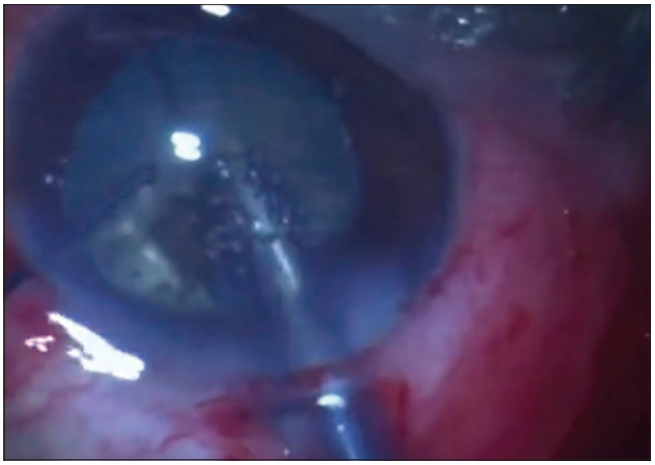

Figure 5: Petal-by-petal removal of hard cataract

of treatment ever since Charles Kelman first proposed it. Phacoemulsification has become standard practice in the majority of developed nations. The surgeons' inclination from manual small incisional cataract surgery to phacoemulsification has also intensified considerably in India.

Since the advent of capsulorhexis, phacoemulsification has needed a technique to extract 8–10 mm of the nucleus through a 5–6 mm opening in the capsule. Over time, an assortment of methodologies for penetrating the nucleus emerged. Disassembling the nucleus and subsequently transferring the nuclear fractions to a safe zone for emulsification has become the cornerstone of all modern techniques.

Various authors in the due course of time have developed their own techniques, of which the basis remains the same. That is, to safely fragment the cataract and safely remove it without causing harm to the posterior capsule and avoiding endothelial cell loss. This in turn ensures maximal visual outcomes.

In 2001, Vanathi *et al*.[19] proposed the crater-and-chop technique, which was the initial method utilized to address these extremely rigid cataracts. By sculpting up to 90% of the nuclear thickness while leaving the outer rim intact, a 6-mm crater was created. This was followed by the formation of numerous small wedges under high vacuum, which were subsequently emulsified in the bag's crater. An additional crater technique modification was documented by Aslan *et al*.[20] After generating a small 3-mm crater using this method, a nucleus splitter is introduced into the crater in conjunction with the phaco tip. In order to divide the nucleus, the splitter is simultaneously moved from the nucleus perimeter toward the phaco tip horizontally. At no time does the phaco tip or nucleus splitter come into contact with vacuum; they are pushed away instead. Until the nucleus is split into fragments small enough to be readily emulsified, the splitting process is repeated while the nucleus is rotated. In contrast to the initial methodology, the formation of a diminutive crater facilitates a more profound and effective grasp, potentially leading to a fruitful division.

An alternative method for performing nuclear disassembly on a hard cataract is known as the drill-and-crack technique.[21] A deep incision is made in the central nucleus utilizing a phaco tip, and the nucleus is subsequently divided or cracked using a prechopper. This is comparable to the placement of dynamite in a hole. It requires the Akahoshi prechopper, a specialized instrument that functions similarly to a pair of tongs and aids in the separation of the nucleus. The authors assert that this method possesses the advantage of requiring minimal effort to master, is applicable to small pupils, and can even be utilized in the event that the phaco-cop technique fails in a hard nucleus due to the reusability of the phaco-tip drilled hole in the drill-and-crack technique. Vasavada and Raj[22] delineated a method for performing multilevel chop in dense leathery cataracts, in which, subsequent to inserting the phaco tip into the nucleus, a vertical component of the chop is depressed posteriorly within the lens fibers, thereby maintaining its proximity to the tip. This causes a partial crack to form. Once more, the phaco tip is inserted, and the procedure is iterated at an even greater depth. To accomplish this, the chopper must be positioned and obstructed at two or more levels to completely divide black cataracts.

Another surgical technique that has been documented is tilt and crack, which involves impaling the lens with the phacotip while tilting the distal pole upwards out of the capsular bag.[23] This facilitates access to the posterior leathery plate, enabling it to be chopped with ease. Variations in the size of the capsulorrhexis (e.g. 6 or 7 mm in diameter) can reduce zonular stress.

Despite the existence of numerous descriptions of different techniques, comparative studies examining the superiority of one technique over the other are scarce. A prospective randomized trial was conducted to compare the outcomes of cataract surgery utilizing the phaco-chop, divide-and-conquer, and stop-and-chop techniques.[24] The results indicated that the phaco-chop technique may offer superior lens removal efficacy and endothelial damage reduction in eyes with hard cataracts compared to the other two techniques. The clinical outcomes of endonucleation chop and conventional crater techniques in the treatment of hard cataracts were compared in a study by Upadhyay *et al*.[25] By performing multiple peripheral chops, this modification to the conventional crater technique separates the central core of the nucleus from the epinuclear shell. The implementation of the novel methodology resulted in a notable reduction in endothelial cell loss, effective phaco time, and the quantity of balanced salt solution required.

An additional emerging method is known as "terminal chop."[26] This process employs a specialized chopper known as the "terminator" to generate a mechanical force that fractures the equator at its thinnest and weakest point. This extends from the equator on the opposite side of the center. In contrast to the traditional crater chop method, the endonucleation chop technique effectively manages phacoemulsification energy, reduces intraocular irrigating solution exposure, significantly mitigates corneal endothelial damage, and expedites

visual rehabilitation when applied to hard nuclear cataracts.

An ongoing progression in surgical techniques involves the development of simple-to-learn methods that protect the posterior capsule while causing minimal endothelial damage. Femtosecond laser-assisted cataract surgery is one such method. One significant benefit is the ability to reduce intraocular phaco energy times, preserve endothelium, alleviate zonular stress, and address astigmatism through precise incisions.[27] The sole constraint pertains to the laser's optical throughput through exceptionally rigid, leathery cataracts.

Rao *et al*.[28] described a "Scoop and Chop" technique for phacoemulsification. Direct vertical or horizontal chop technique was used in all cases with parameters set as required for quadrant removal with high vacuum after the initial cleanup of cortex under the capsulorhexis. To allow better visualization of the hardness of the nucleus core, the sides of the lens were scooped out a central well with vacuum with maximum chopping done centrally within the rhexis as the first step to enable better assessment of the depth of burying the chopper for direct chop.

Conclusion

Phacoemulsification poses a significant challenge when applied to hard cataracts. Insufficient proficiency in phaco may present the surgeon with a more formidable learning curve and undermine their confidence. The benefit of petal-by-petal removal of small pieces is that it does not generate elevated pressure in contrast to the repeated chopping that occurs during the direct chop/stop and chop method. Thus, pressure is not applied to zonules that are already fragile.

Due to the intact posterior plate, the likelihood of Posterior capsule (PC) rent and nucleus drop is significantly diminished, resulting in an improved outcome even for novice hands.

Phacoemulsification is an essential component of contemporary cataract surgery, providing enhanced patient outcomes, safety, and efficiency. Consistent technological progress and ongoing research serve to enhance this methodology, thereby guaranteeing its sustained triumph within the discipline.

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Conflicts of interest

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Original Article

Topography: A Mandatory Screening Tool for Ocular Allergies

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Abstract

Purpose: Assess the need of corneal topography as a diagnostic tool for corneal ectasia in patients with allergic conjunctivitis.

Subjects and Methods: Cross-sectional, descriptive study in which 90 children who are clinically diagnosed with allergic keratoconjunctivitis of age 6–18 years of both gender coming to ophthalmology outpatient department at a tertiary care eye hospital underwent detailed ophthalmic examination and corneal topography on Pentacam (Oculus, Wetzlar, Germany).

Results: The maximum number of patients was in the age group of 6–10 years (48.88%) with a mean age of 11.28. The M:F ratio was 2.6:1 highlighting male preponderance. The most common history given by patients was diminution of vision and seasonal variation. 99.88% patients presented with congestion but 0.03% had positive Munson. 8.89% eyes presented with astigmatism of ≥−3. 3.88% had K-Max ≥49 D and 16.12% participants had K-Max between 46 and 48.9 on topography, suggestive of steep corneas. In our study, the most common axial curvature pattern found was symmetrical Bowtie (35.56%). Patterns suspicious of keratoconus like asymmetrical bowtie (23.89%), superior steepening (21.67%), inferior steepening (12.77%), symmetrical and asymmetrical bowtie with skewed radial axis (1.67%) was also noted. 15.56% patients had B-A outside normal limits which classifies them as keratoconus suspects. 27.23% eyes showed pachymetry between 499 and 450 μm and 7.78% showed pachymetry <450 μm, all these parameters indicate the paramount need to do an early corneal topography in all patients with allergic conjunctivitis. These patients also warrant regular follow-up with corneal topography to look for progression in thinning to confirm the diagnosis of keratoconus.

Conclusion: The study highlights the importance of doing corneal topography in diagnosed cases of allergic keratoconjunctivitis for the early diagnosis and treatment of keratoconus. More aggressive management of allergic conjunctivitis can prevent their progression to established keratoconus.

Keywords: *Allergic conjunctivitis, corneal ectasia, keratoconus, ocular surface allergies, topography*

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Introduction

Allergic conjunctivitis is defined as an inflammation of conjunctiva and it manifests with hyperaemia and increased secretion.

It is quite challenging to assess the prevalence of this disorder because it is typically a very underrated condition and the majority of individuals do not go to hospitals for treatment.[1] According to one study, the prevalence of allergic keratoconjunctivitis in India ranged from 3.9% in the age group of 6–7 years to 10.9% in that of 13–14 years.[2]

Allergens interact with immunoglobulin E that is attached to mast cells that have been sensitized to generate allergic conjunctivitis, which then manifests clinically as ocular allergies. Histamine, tryptase,

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prostaglandins, and leukotriene levels are increased in the tears when mast cells are activated. The symptoms of allergic conjunctivitis include redness, lacrimation, itching, and photophobia.

Keratoconus is a noninflammatory corneal ectasia which mostly has bilateral involvement which presents at the age of 6–18 years. It causes progressive corneal thinning and apical protrusion.

The prevalence of keratoconus is 4.4 and 7.5 times greater for Asian compared with white Caucasians.[3] The prevalence in studies ranges from 2300/100,000 in Central India.[2]

It is frequently due to congenital weakness of the cornea, although it manifests only after puberty. It can secondarily follow trauma, patients with vernal keratoconjunctivitis or Down's syndrome due to repeated rubbing of eyes.[1]

Chronic ocular trauma and rubbing of eyes due to pruritis could be the environmental factor associated with keratoconus.[1] It is characterized by conical steeping of cornea, Munson's sign, Vogt's striae, Fleischer's ring, and acute hydrops. Children with allergic keratoconjunctivitis are especially at risk because uncorrected astigmatism can develop amblyopia and contribute to the onset of keratoconus, a major visual impairment.

Corneal topography is a noninvasive technique used to measure the severe irregularities in cornea and for anterior corneal surface evaluation in dioptric values at each point. It is used to diagnose corneal ectatic condition like keratoconus.

Topography is useful to confirm the diagnosis of keratoconus and in some cases even to make the diagnosis of subtle cases without clinical manifestations.

The purpose of our study is to see if corneal topography can be used as an early diagnostic tool to diagnose the early signs of keratoconus in children with allergic conjunctivitis to prevent visual impairment which could possibly result from the same.

Subjects and Methods

Source of data

Children who are clinically diagnosed as allergic keratoconjunctivitis between age of 6 and 18 years coming to ophthalmology outpatient department (OPD) are included in this study.

Study design

Cross-sectional and descriptive study.

Sample Size: 101

n = ([[Z1]] ^2 {P(1-P))/d^2

P – Your Guess of any population P (any value <1).

Z - Z value associated with confidence d - Absolute precision (value less than P).

n – Minimum sample size

Inclusion and exclusion criteria

- Inclusion criteria:
  a. Children who are clinically diagnosed with allergic keratoconjunctivitis of age 6–18 years of both gender coming to ophthalmology OPD at a tertiary care eye hospital are included in study
  b. Patients willing to participate in the study.
- Exclusion criteria:
  a. Patients with corneal opacities and shield ulcers
  b. Patients who do not cooperative for evaluation.

Time period of study: November 2020–November 2022.

Results

Ninety children coming to ophthalmology OPD were included in this study.

In our study, the maximum number of patients was in the age group of 6–10 years (48.88%) [Table 1]. The mean age is 11.28.

Out of 90 children included in our study, the total number of males was 72.23% and females were 27.77% [Graph 1].

In our study, the most common symptoms were itching (100%), lacrimation (100%), and conjunctival hyperemia (100%) followed by photophobia (96.66). Almost half of the patients presented with foreign-body sensation (48.88%) [Table 2].

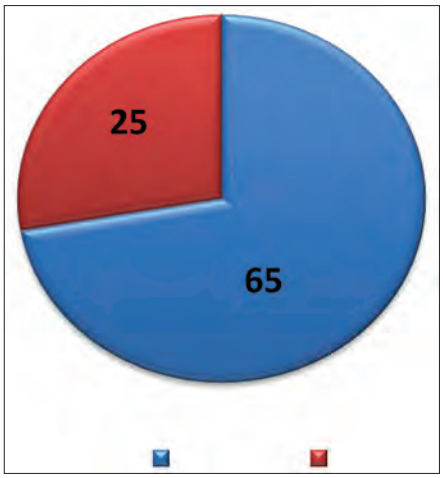
Out of 90 children examined in our study, the most common history given is diminution of vision (56.67%), recurrence (50%), and seasonal variation (51.11%) [Table 3].

Table 1: Distribution according to the age

Age (years)	Number of patients (%)
6–10	44 (48.88)
11–14	31 (34.45)
15–18	15 (16.67)
Total	90 (100)

Table 2: Distribution according to the symptoms of allergic conjunctivitis

Symptoms present	Number of eyes (n=180) (%)
Itching	180 (100)
Photophobia	174 (96.66)
Lacrimation	180 (100)
Conjunctival hyperemia	180 (100)
Foreign-body sensation	88 (48.88)



Graph 1: Distribution according to gender

In our study, 55.61% of children had a vision in the range of 0.00–0.20 (*P*) while there were 1.13% children in the range of 0.08–1.00 and 1.13% children had visual acuity >1.00. Vision of 1 patient could not be assessed due to intellectual disability [Graph 2].

In our study, the most frequent noticed clinical sign was congestion (98.88%). Almost three fourth of children had papillae (78.88%). Other significant finding was limbal gelatinization (57.77%) and conjunctival melanosis (35.55%). Out of 90 children, 3 (0.03%) had positive Munson sign [Table 4].

In our study, all the patients had normal *Q* value, i.e., in the range of − 1–0.

Out of 180 eyes, maximum eyes had astigmatism power <−1 D (53.88%). However, a significant number of children had astigmatism power ≥−3 D (8.89%) which favors toward suspicion of keratoconus [Graph 3].

58.33% of participants in our study had K-Max in the normal range of 43–45.9 but 3.88% had K-Max ≥49 D and 16.12% participants had K-Max between 46 and 48.9 [Graph 4].

In our study, the most common axial curvature pattern found was symmetrical bowtie (35.56%). Suspicious patterns such as asymmetrical bowtie (23.89%), superior steepening (SS) (21.67%), inferior steepening (IS) (12.77%), symmetrical and asymmetrical bowtie with skewed radial axis (1.67%) was noted [Table 5].

In our study, 44.44% had pachymetry in the range on 550–500, but a significant number of participants had pachymetry <450 (7.78%), which suggest a thin cornea which might progress into keratoconus. 27.23% participants were in the range of 499–500 [Graph 5].

Table 3: Distribution according to history

History of	Yes	No	Percentage with positive history
Recurrence	45	45	50
Seasonal variation	46	44	51.11
Diminution of vision	51	39	56.67
Frequent change of glasses	1	89	0.011

Table 4: Distribution according to clinical signs

Clinical signs	Present	Absent	Percentage with positive signs
Munson sign	3	87	0.03
Congestion	89	1	98.88
Conjunctival melanosis	32	58	35.55
Papillae	71	19	78.88
Limbal gelatinization	52	38	57.77
Horner trantas spots	20	70	22.22
SPKs	52	38	57.77

SPKs: Superficial punctate keratitis

Table 5: Distribution according to the axial curvature pattern on corneal topography

	Number of eyes (%)
Symmetrical bowtie	64 (35.56)
Asymmetrical bowtie	43 (23.89)
Symmetrical bowtie with skewed radial axis	3 (01.67)
Asymmetrical bowtie with skewed radial axis	3 (01.67)
Superior steepening	39 (21.67)
Inferior steepening	23 (12.77)
Any other	5 (02.77)
Total	180 (100)

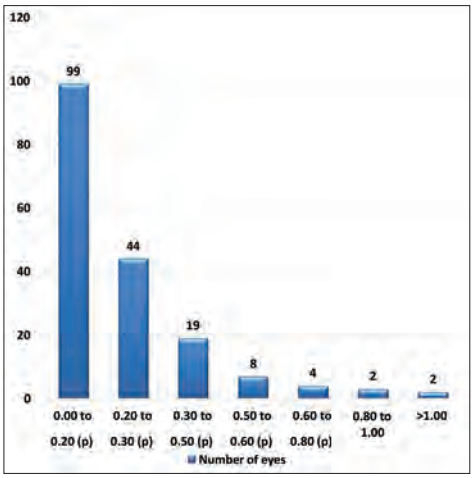
Table 6: Distribution according to patterns seen on anterior elevation maps

Pattern seen	Number of eyes (%)
Symmetrical watch glass	30 (16.66)
Skewed watch glass	8 (04.44)
Tongue-like extension	85 (47.23)
Isolated island	57 (31.67)
Total	180 (100)

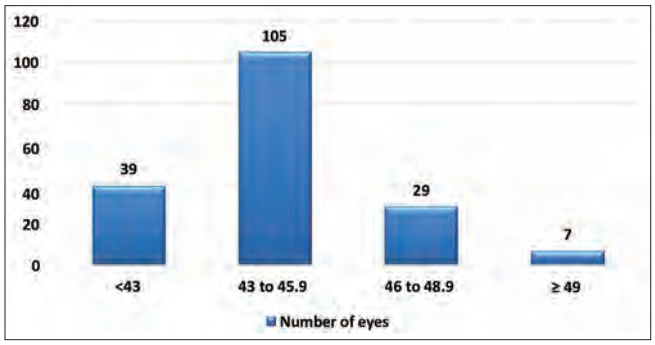
The most frequent pattern noted on Anterior Elevation Maps was Tongue like extension (47.23%). Other patterns seen were isolated island (31.67%) and symmetrical watch glass (16.66%). Only 4.44% showed skewed watch glass pattern [Table 6 and Graph 6].

In our study, all participants had posterior curvature of <12 μm (100%).

84.44% patients had B-A within the normal limits but 15.56% had B-A outside the normal limits which classifies them as keratoconus suspects [Graph 7].



Graph 2: Distribution according to uncorrected visual acuity



Graph 4: Distribution according to K-max

Maximum participants in our study had normal value of <5 μm (61.12%). Five participants i.e., 2.77% had suspicious finding of >7 μm [Graph 8].

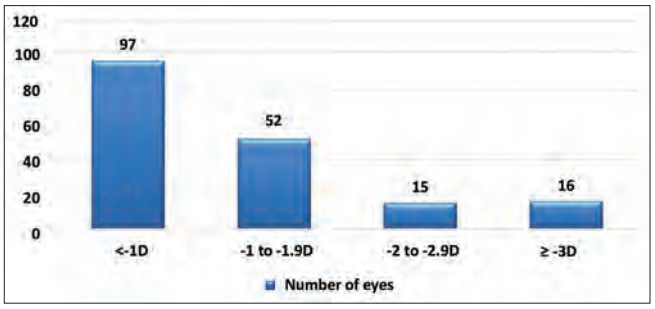
Discussion

Demographics

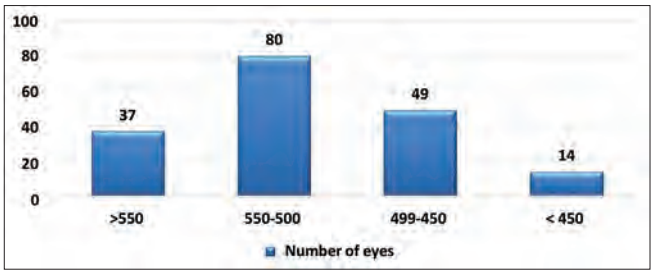
Ninety children coming to ophthalmology OPD were included in this study.

In our study, the mean age group is 11.28 which was similar to a study by Mohan *et al*.[4] with a mean age of 11.7. Various other studies such as Saboo *et al*.,[5] Alemayehu *et al*.,[6] Shoja and Besharati,[7] and Gautam *et al*.[8] showed age group between 10 and 15 years. The onset of allergic keratoconjunctivitis is usually after 5 years, resolves around puberty and rarely persists after 25 years.[9]

Our study showed M:F ratio of 2.6:1 which was similar to studies done by Gautam *et al*.[8] (2.9:1) and Marey *et al*.[10] (2.3:1). Other studies also had a male preponderance. Vernal keratoconjunctivitis especially affects young boys. Sex hormones play a relevant role in the pathophysiology of allergic diseases by reciprocal interactions between the immune and the endocrine system.



Graph 3: Distribution according to astigmatism power on topography



Graph 5: Distribution according to pachymetry at the thinnest location on corneal topography

Estrogens and progesterone have active role in the ocular immune system. Estrogen and progesterone receptors are overexpressed on the conjunctiva by eosinophils and other inflammatory cells. These hormones bind to conjunctival receptors and exert a proinflammatory effect through the recruitment of eosinophils to the conjunctival tissue.[10]

In our study, the most common symptoms were itching (100%), lacrimation (100%), and conjunctival hyperemia (100%).

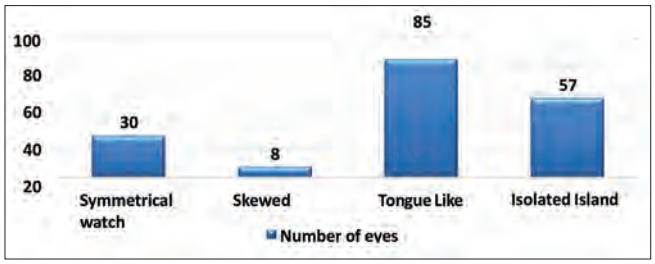
The most common history given by patients was diminution of vision (56.67%) and seasonal variation (51.11%).

India is a subtropical country with distinct cold and hot seasons. From November to May, the weather is cold, dry, and dusty, while the rainy season is from June to October.

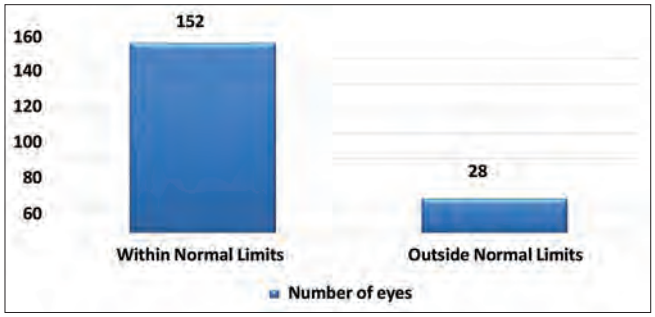
Wade *et al*.[11] also showed similar observation of seasonal variation. The majority of patients 60.7% with allergic conjunctivitis were seen during the dry season, while 39.3% were seen during the rainy season in their study. This can be attributed to the presence of dust and pollen in the air during the dry seasons.[11]

In our study, 55.61% of children had uncorrected visual acuity in the range of 0.00–0.20 (*P*) while there were 1.13% children in the range of 0.08–1.00 and 1.13% children had visual acuity >1.00. Vision of 1 patient could not be assessed due to intellectual disability.

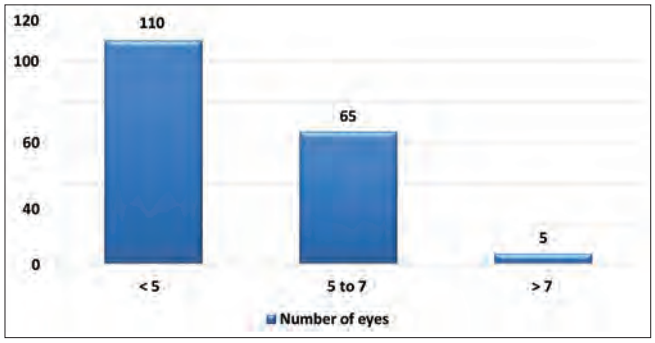
Mimura *et al*.[12] in their study on the relationship between refractive errors and allergic conjunctivitis noted a



Graph 6: Distribution according to the patterns seen on the anterior elevation map



Graph 7: Distribution according to Belin Ambrosio



Graph 8: Distribution according to anterior curvature elevation maps

significant number of allergic conjunctivitis patients with refractive errors (22.1%) and concluded that refractive error may be a risk factor for allergic conjunctivitis.[12]

The abnormal ocular surface deteriorates the capacity of the fluid reservoir over the ocular surface. Tear film anomalies capture allergens in the conjunctival SAC and cause the conjunctival immune-based inflammation by inducing T-cell activation. Thus, refractive error may be a possible risk factor for the direct progression of allergic conjunctivitis.[12]

In our study, the most frequent noticed clinical sign was congestion (98.88%). Almost three fourth of them had papillae (78.88%). Other significant finding was limbal gelatinization (57.77%) and conjunctival melanosis (35.55%). Out of 90 children, 3 (0.03%) had positive Munson sign.

In a study done by Mohan *et al*.,[4] 22.7% patients had positive Munson sign which was significantly higher than our study. Yang *et al*.[13] study out of 307 diagnosed KC patients Munson sign was present in 47.49%.

None of the participants in our study showed any corneal signs of keratoconus.

In contrary to studies such as Mohan *et al*.[4] showed 13.6% patients with Fleischer ring, 11.4% with Vogt's Striae, 6.8% with Rizutti's sign, and 2.2% with acute hydrops.

Naderan *et al*.[14] showed corneal protrusion in 71.7%, scissoring reflex in 64.2%, corneal thinning in 56.6%, Fleischer's ring in 55.5%, and prominent nerve fibers in 54.7% were the most prevalent findings in the keratoconic corneas. These KC patients with these clinical findings had significantly higher mean K, AE, and PE, while having significantly lower central corneal thickness, Thinnest corneal thickness (TCT), and Visual acuity (VA) compared to those who did not present these signs.

In our study, all the patients had normal *Q*-value, i.e., in the range of − 1–0.

Q-value denotes the normal asphericity of cornea. Our study included very young and patients with only allergic conjunctivitis and not diagnosed keratoconus thus none of them had any corneal asphericity.

A study by Dantas *et al*.[15] showed mean *Q*-value as −1.01 ± 1.49. Thirteen patients with steeper central cornea had $Q > -1.27$. 2 patients with paracentral keratoconus presented more oblate corneas ($Q = 1.99$). Only one patient with VKC and keratoconus presented normal cornea asphericity ($Q = -0.14$).

All the above-mentioned studies had included diagnosed keratoconus patients thus corneal signs where easily noticed in these patients. It was different from our study because we included patients with allergic conjunctivitis in whom we looked for any signs of keratoconus.

In our study, out of 180 eyes, maximum eyes had astigmatism power <−1 D (53.88%). However, a significant number of children had astigmatism power ≥−3 D (8.89%) which should arouse the suspicion of keratoconus and warrant further investigations.

58.33% of participants in our study had K-Max in the normal range of 43–45.9 but 3.88% had K-Max ≥49 D and 16.12% participants had K-Max between 46 and 48.9. The normal K-max value is <48 D.[17] These patients need close follow-up with corneal topography to watch for the development and/or progression of KC.

In our study, the most common axial curvature pattern found was symmetrical bowtie (35.56%), which is suggestive of with the rule astigmatism. Patterns suspicious of keratoconus such as asymmetrical bowtie

(23.89%), SS (21.67%), IS (12.77%), symmetrical, and asymmetrical bowtie with skewed radial axis (1.67%) were also noted in our study.

A study done by Mohan *et al*.[5] showed most common axial curvature pattern as asymmetrical bow tie with IS (36.4%). Other patterns found were IS in 34.1%, central cone in 9.1%, symmetrical and asymmetrical bowtie with skewed radial axis each in 4.5%, symmetrical bow tie in 4.5%, SS in 2.3%, and two eyes (4.5%) did not show any topographical changes but showed tomographical changes on pentacam.

Umale *et al*.[16] showed round (R) in 17.11%, oval (O) in 7.24%, SS in 1.97%, asymmetric bowtie with inferior steepening (AS-IS) in 17.11%, asymmetric with superior steepening (AS-SS) in 11.18%, symmetric bowtie (SB) in 38.16%, and irregular pattern (I) in 5.92%. This was comparable to our study as the most common axial curvature pattern was symmetrical bow tie as their study was also intended to diagnose early keratoconus in allergic conjunctivitis patients.

All the patients with suspicious pattern will have to be kept under close observation for progression of KC.

In our study, 44.44% had pachymetry in the range on 550–500, but a significant number of participants had pachymetry <450 (7.78%) which suggest a thin cornea which might progress into keratoconus. 27.23% participants were in the range of 499–500.

The mean pachymetry values in all studies differ from our study as all the patients included in those studies were diagnosed KC patients. All patients with pachymetry <500 µ will need closed observation for progression and thinning.

In our study, the most frequent pattern noted on anterior elevation maps was tongue-like extension (47.23%) which was suggestive of KC thus they will need close follow-up to watch for the development of KC. Other patterns seen were isolated island (31.67%) and symmetrical watch glass (16.66%). Only 4.44% showed skewed watch glass pattern.

Maximum participants in our study had the normal value of <5 µm (61.12%). Five participants, i.e., 2.77% had suspicious finding of >7 µm.

In our study, all participants had posterior curvature of <12 µm (100%) on posterior elevation maps which is considered normal.[17]

In our study, 84.44% patients had B-A within the normal limits but 15.56% had B-A outside normal limits which classifies them as keratoconus suspects. All these patients will need close observation with topography 6 monthly to rule out progression into KC.

In Mohan *et al*.'s[4] study, Pentacam analysis of Belin Ambrosio enhanced Ectatic display map showed abnormal deviation of front elevation difference map (Df) in 11 eyes (25%), abnormal deviation of back elevation difference map (Db) in 6 eyes (13.7%), and abnormality in both parameters (Df and Db) in 27 eyes (61.3%).

In Yang *et al*.'s study,[13] mean Belin Ambrosio display is 10.82 ± 6.05.

Conclusion

Ocular allergy is a wide spread disease in young population worldwide. Generally, it does not affect the vision but hampers day-to-day quality of living. The prevalence of AKC in world is about 6%–30% of the general population and 30% of it is seen in children alone.[18]

The most common age group affected is 10–15 years. Chronic ocular trauma and rubbing of eye due to pruritus are the environmental trigger which is associated with keratoconus development in genetically predisposed individuals. The corneal thinning induces irregular astigmatism, myopia, and protrusion, leading to mild to marked impairment in the quality of vision. The presence of signs of early keratoconus on corneal topography in the absence of any clinical signs was seen in patients suffering from allergic keratoconjunctivitis in our study. Topography patterns suggestive of early KC such as SB, IS, SS, AS-SRAX, etc., were also observed in our study participants. As KC generally progresses in the age group of 15–30 years, our study participants who showed suspicious signs of KC on topography should be followed up closely with regular refraction and corneal topography to look for the signs of progression. This highlights the importance of doing corneal topography in diagnosed cases of AKC for the timely diagnosis and treatment of keratoconus.

The limitations of our study are our small sample size and the fact that we included patients with only allergic conjunctivitis and not diagnosed keratoconus patients.

Future studies with a larger sample size and a control group of diagnosed KC patients and AKC patients are warranted.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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Case Report

A Case of Electric Cataract in High-voltage Electric Current

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Abstract

Electric cataract is a rare type of cataract caused by exposure to high-power electric currents, resulting in cloudiness in the eye's lens or capsule, impairing vision and potentially leading to blindness. It can cause various ophthalmic injuries such as cataract, retinal edema, papilledema, chorioretinal necrosis/atrophy, retinal detachment, and optic atrophy. Most patients develop no early symptoms and become aware of the injury months later. Proper surgical management can result in stable visual acuity. A 40-year-old electrician man was referred to the ophthalmology department after experiencing low vision in his left eye after an electrical shock. After multiple injuries, he was referred to the plastic surgeon for burn treatment. An anterior segment examination revealed a mature cataract, and ophthalmoscopic examination revealed a dull red reflex in the left eye due to cataract. The patient was advised for left eye cataract surgery, which was successful. After 2 months, the patient's vision was stable and no further ocular complications were observed.

Keywords: *Chorioretinal necrosis, electric cataract, electrical shock, visual acuity*

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Introduction

Electric cataract is a rare type of cataract caused by exposure to high-power electric currents. This type of cataract results in cloudiness in the eye's lens or capsule, impairing vision and potentially leading to blindness. Electric injuries may cause different ophthalmic injuries, such as conjunctival hyperemia, uveitis, miosis, spasm of accommodation, cataract, retinal edema, papilledema, chorioretinal necrosis/atrophy, retinal detachment, and optic atrophy.[1] The incidence of electrical cataract ranges from 0.7% to 8.0%.[2] Intraocular inflammatory reactions rarely precede the development of electric cataract, but acute iritis can occur within 10 days to 2 months after the injury.[3,4] Most patients develop no early symptoms and become aware of the injury months later. Proper surgical management can result in stable visual acuity, but final visual acuity depends on other ocular damage due to electrical current. Electric cataracts are rare, and awareness of this complication and testing of all electrical injury cases is important.

Case Report

A 40-year-old male was referred to the department of ophthalmology by a plastic surgeon, with the history of low vision in his left eye after electrical shock. He is an electrician by occupation. Two months ago, he suffered from the injury while working when his head accidentally touched an exposed electric wire. He was unconscious after electric shock. There were multiple injuries occurred near the lip and nose area and hard palate [Figures 1 and 2]. During treatment in government medical hospital, he was referred to the plastic surgeon for burn treatment. One month ago, the patient had noticed a low vision in his left eye; his treating doctor referred him to the ophthalmology department for ocular examination. Informed consent was obtained from patient, on anterior segment examination, mature cataract was seen [Figure 3]. Vision was perception of light in all quadrants.

The right eye anterior segment eyelids, conjunctiva, cornea, anterior chamber, iris, and pupil were normal. Ocular movements were normal. Intraocular pressure was 18 mmHg. Examination of the right eye showed normal visual acuity (6/6). The left eye eyelids,

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conjunctiva, cornea, anterior chamber, iris, pupil, lens, and ocular movements were normal. Intraocular pressure was 20 mmHg. B-scan ultrasonography revealed normal posterior segment in both the eyes.

Ophthalmoscopic examination after dilating the pupils with 1% tropicamide eye drops showed that right eye fundoscopy was normal and a dull red reflex in the left eye due to cataract. Slit-lamp biomicroscopy showed anterior subcapsular diffuse opacity with opacification of the nucleus and cortex in the left eye. The patient was counseled for the left eye cataract surgery. Patient was posted for phacoemulsification surgery with foldable posterior chamber intraocular lens implantation (PCIOL) in the capsular bag under topical anesthesia [Figure 4].

Postoperative recovery was uneventful and the patient regained best-corrected visual acuity of 6/6. On indirect ophthalmoscopy examination red glow was seen, media was clear, optic disc size shape margin was normal, NRR was healthy, CD ratio was 0.3 with A:V ratio 2:3, midperiphery was normal, macula was normal, FR seen. At the end of 2 months, his vision was stable and there were no further ocular complications.

Discussion

The increasing dependency on generated electricity has also resulted in a rise in injuries due to contact with electrical current. The reported power range for electrical current causing cataract formation is 220–80,000 volts.[5] The cataract may develop immediately after injury, or be delayed by a few days; the average latency varies from 1 to 18 months. In the present case, cataract was developed after 1 month.[3,6]

Vacuoles disappear within a day to weeks and are replaced by fine irregular linear or mossy anterior subcapsular opacities. There is some variation in the pattern and sequence of vacuole replacement with anterior opacities.[7,8]

Figure 1: Preoperative picture showing deformative lip and nose

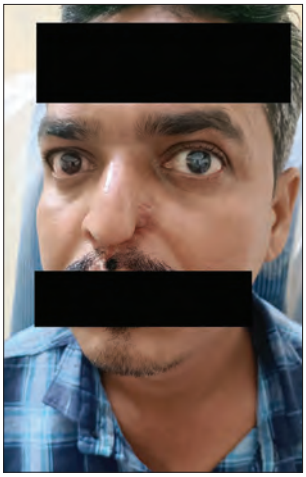

Figure 2: Preoperative picture showing deformative nose

Figure 3: Preoperative picture showing mature cataract in the left eye

Figure 4: Postoperative picture showing posterior chamber intraocular lens implantation in the left eye

A study by Saffle *et al*.[2] reported an incidence of 40% in posterior subcapsular cataracts. Clinically, cataracts generally progress, but they can remain stationary for up to 2 years.[3] In 77% to 82% of cases, cataracts progress to maturity, necessitating surgery, and rarely secondary glaucoma may complicate the condition in the intumescent stage.[9]

The progression of cataract varies, either remaining stationary or slowly progressing over 6 months to become mature or hypermature, and rarely causing phacomorphic glaucoma.[10]

Treatment of the electric cataract is similar to any other cataract, i.e., extracapsular extraction with PCIOL implantation. In the present case, final visual acuity was 6/6 and posterior segment within normal limits rest ocular structures were normal.

Conclusion

Whenever a case of electrical injury or burn is referred for ophthalmic examination, a complete ocular examination must be made to check for any ocular complications. Close follow-up of these patients is mandatory because they may develop cataract changes after injury. Thus, proper surgical management of electric cataract will result in a good visual recovery if the eye has no additional damage, as in this case.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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Case Report

A Droplet in the Eye – A Case of Silicon Oil in Anterior Chamber

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Abstract

We present a case of 12 year old child with defective vision in right eye since 1 month. She had underwent RD surgery 1 year back following which cataract surgery and later developed posterior capsular opacification (PCO). Here we discuss the most common post-operative complication in post-vitrectomized eye in our case.

Keywords: *Silicon oil, PCO, retinal detachment*

A 12-year-old female child presented with defective vision in RE for the past 1 month. She had underwent RD surgery a year back after which cataract surgery was done 6 months back. On examination, OD showed silicon oil bubble in the anterior chamber (AC), irregular pupil, posterior chamber intraocular lens *in situ* with fibrous posterior capsular opacification (PCO) [Figure 1], OS was normal. She underwent OD Nd YAG capsulotomy under TA.

PCO and secondary glaucoma are the most postoperative complications in postvitrectomized eyes. Silicon oil can penetrate into the AC causing corneal decompensation by blocking the nutrition by aqueous humor and removing the silicon oil from AC can prevent the corneal decompensation.[1] PCO formation is due to elevated cytokines due to inflammation after Pars plana vitrectomy (PPV) which accelerates lens epithelial cell (LEC) proliferation and migration leading to PCO and loss of vitreous support may affect the attachment between intraocular lens edge and capsular bag promoting rapid LEC proliferation and contributing to PCO.[2]

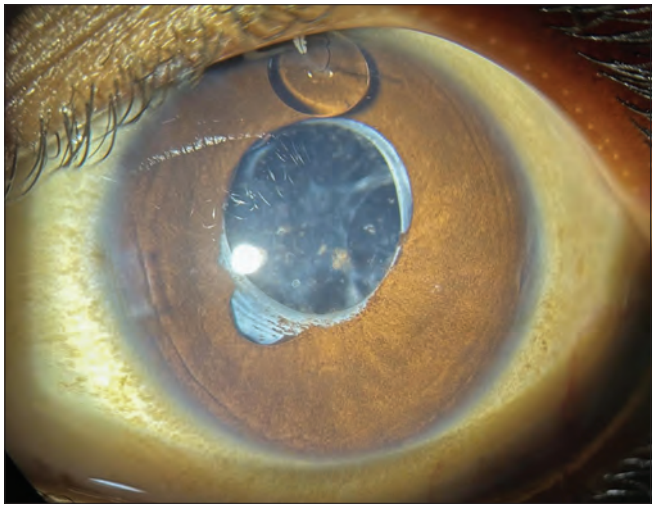

Figure 1: Slit-lamp photodiffuse illumination shows clear cornea with silicon oil bubble at 12 O clock in anterior chamber, irregular 4 mm pupil, posterior chamber intraocular lens *in situ* with dense posterior capsular opacification

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Declaration of patient consent

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Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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Case Report

First Case Report of Mortality Post Manual Small Incision Cataract Surgery in a Known Case of Immune Thrombocytopenic Purpura

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Abstract

We present the first case of death due to profuse bleeding from the wound margin following manual small incision cataract surgery (SICS) in a known case of immune thrombocytopenic purpura (ITP), a rare outcome in a common case. A 62-year-old male patient presented with profuse bleeding from the surgical wound of the left eye for 2 days following manual SICS. He was a known case of ITP with a history of gastrointestinal bleeding for which he was admitted few years back but had discontinued prescribed medications and did not mention this medical history to the concerned ophthalmic surgeon before surgery. His platelet count was 5000/mm3 on admission. The patient was admitted to the general medicine ward and was infused with 8 units of random donor platelets and started on injectable high-dose corticosteroids. Despite prompt interventions, the patient succumbed to profound bleeding and multiorgan failure. This case report underscores the importance of comprehensive preoperative evaluation, especially in patients with known bleeding disorders or a history of bleeding complications. While routine cataract surgeries may not typically require extensive preoperative testing as commonly used techniques these days are bloodless and sutureless, certain high-risk patients, such as those with ITP or other bleeding disorders, warrant thorough screening to assess the patient's hemostatic status accurately to identify and mitigate any adverse outcomes.

Keywords: *Immune thrombocytopenic purpura, manual small incision cataract surgery, mortality, thrombocytopenia*

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Introduction

Immune thrombocytopenic purpura (ITP) is generally considered a benign disease. However, patients with ITP, advancing age, and a history of bleeding episodes with platelet count of 10–20 × 10^3/μl are at a risk of suffering life-threatening bleeding complications.[1,2] Although there have been a few studies proving that thrombocytopenia poses a significant perioperative risk of bleeding,[3] fatal cases of ITP are rarely mentioned in published reports. There have been multiple case reports of cataract extraction by clear corneal incision and phacoemulsification in uncomplicated eyes done safely without prophylactic treatment in patients with severe bleeding disorders;[4] however, there have been no reports of death following manual small incision cataract surgery (SICS) in a case of ITP.

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Case Report

A 62-year-old male patient from Kalahandi, Odisha, of lower-middle class socioeconomic status was referred to the emergency room (ER) of our institute with profuse bleeding from his left eye (LE) [Figure 1]. He underwent an uneventful manual SICS with posterior chamber intraocular lens implantation at a private hospital 2 days before reporting to us. During the postoperative observation period, 2 h after the surgery, the patient complained of sudden onset of vomiting and head reeling and started bleeding from his LE. At the time of examination in the ER, the patient was conscious, cooperative, and

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hemodynamically stable without any signs of neurological deficit. There was no history of trauma following surgery. Vomiting most likely triggered the episode as the bleeding began shortly (within an hour).

On detailed history taking, it was revealed that the patient was a known case of ITP diagnosed at a government hospital elsewhere 1 year back due to generalized weakness and a history of gastrointestinal bleeding. He was hospitalized and treated with injectable steroids, intravenous immunoglobulin, and 3 units of random donor platelets (RPD). His complete blood count (CBC) was completely deranged with hemoglobin (Hb) – 7.0 g/dl and platelet count as low as 5000/mm^3. The patient was advised to continue tablet prednisolone and to follow-up in the hematology outpatient department after 2 weeks of discharge but was eventually lost to follow-up and was noncompliant to the prescribed treatment due to financial constraints and inability to travel due to old age.

Unaware of the far-reaching consequences of the underlying condition, the patient did not mention this history to the concerned ophthalmic surgeon before surgery.

The patient was initially treated at the primary center with injection mannitol 20% 300 ml IV stat, injection tranexamic acid IV stat, and local adrenaline patches, but the bleeding continued. A pressure bandage was given, and the patient was referred to our institute for further evaluation and management.

Complete general and systemic examination of the patient was inconspicuous with stable vitals at the time of admission. The patient did not mention any other history of hospitalization, drug intake, or any similar family history.

Ocular examination revealed a massive clot in the eye pad [Figure 2], with vision of hand movement in the operated eye with grade 3 hyphema, and the active bleeding site was found to be the surgical (conjunctival) wound.

The patient was shifted to the general medicine ward for further management. Routine blood investigations showed Hb – 7.5 g/dl, Total platelet count (TPC) – 10,000/mm^3, with a prolonged bleeding time (BT) and clotting time (CT). He was managed with injection tranexamic acid IV Thrice daily (TDS), injection methylprednisolone, and 6 units of RDP followed by 2 units of RDP the next day. Daily dressing was done and huge blood clots evacuated with continuous bleeding [Figure 2]. The patient was under constant monitoring to prevent further complications; hence, we could not perform any imaging apart from an ultrasound B-scan [Figure 3].

The wound was not sutured by the operating surgeon due to the continuous ooze from the wound margin and due to chances of localized hematoma resulting in excessive rise of IOP leading to further complications.

Hemodynamic instability began with initial signs of shock. Two whole blood units were transfused. The patient had reduced urine output and gradual abdominal swelling with generalized edema signs of multiorgan dysfunction.

Eventually, the patient succumbed to profuse bleeding and hemodynamic shock with multiorgan failure 2 days after hospitalization that is 4 days after manual SICS.

The autopsy performed 3 h after death revealed several areas of petechial hemorrhages macroscopically in the heart, liver, and spleen. Microscopically, numerous areas of hemorrhage, platelet microthrombi, and fibrosis with infiltration of neutrophils and histiocytes are found in the atria and ventricles of the heart, spleen, and periportal areas of the liver. The cause of death was suggested to be cardiac arrhythmias induced by multiple infarctions and myocardial damage due to hemorrhages.

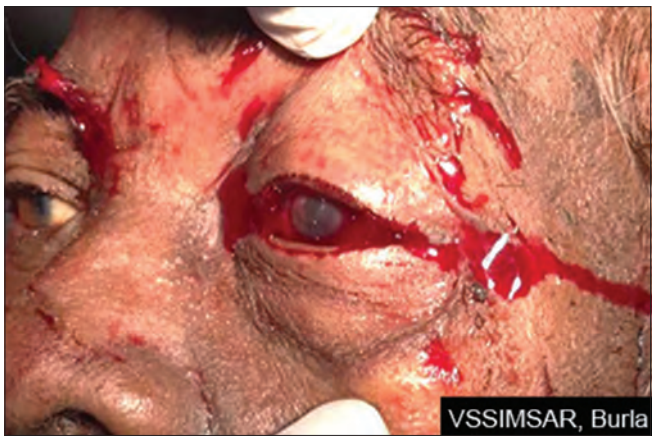

Figure 1: Patient presenting with active bleeding from the conjunctival wound site

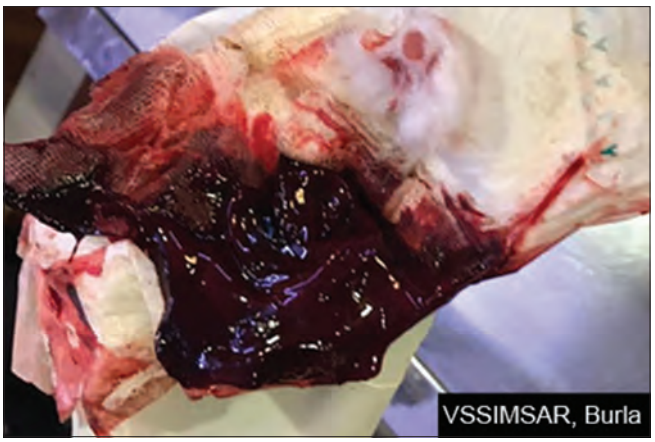

Figure 2: Clot representing the amount of bleeding

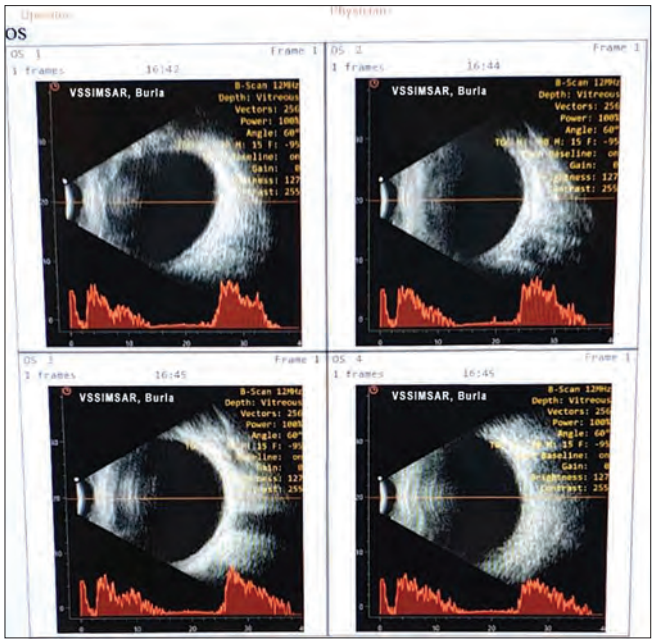

Figure 3: Ultrasonography B-scan done for the left eye showing normal posterior segment findings

Discussion

This first case report underscores the importance of basic preoperative evaluation like CBC. Many cases of leukemia have been accidentally diagnosed by routine hemogram. While routine cataract surgeries may not typically require extensive preoperative testing as commonly used techniques these days are bloodless and sutureless, certain high-risk patients, such as those with ITP or other bleeding disorders, warrant thorough screening. In such cases, both BT and CT should be considered alongside CBC and other relevant screening tests to assess the patient's hemostatic status accurately. Although the incidence is a meager 3.3 cases per 100,000 adults, CBC, BT, and CT are simple, inexpensive investigations that can be done quickly to rule out any possible chances of preexisting bleeding disorders.[5] One such peculiar case report of spontaneous iris bleeding during cataract surgery in a thrombocytopenic patient highlights the fact that patients with platelet counts as high as 75,000/µl should also be considered for platelet transfusion before clear corneal phacoemulsification and IOL implantation to prevent intraocular bleeding.[6] Another study shows bleeding risk in thrombocytopenic patients as an unpredictable factor in determining surgical outcomes in such patients. The platelet counts at which a given surgical procedure carries an acceptable risk of bleeding are unique to every patient and thus cannot be generalized.[7]

Declaration of patient consent

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Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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Case Report

Compensatory Corneal Epithelial Hyperplasia after Photorefractive Keratectomy Enhancement

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Abstract

This case report documents the clinical course of a 27-year-old female patient who underwent surface ablation (transepithelial photorefractive keratectomy [PRK]) refractive surgery for myopia correction, followed by transPRK enhancement for myopic regression 3 years postprimary refractive procedure. Postenhancement, the patient presented with blurred vision attributed to compensatory corneal epithelial hyperplasia. Epithelial thickness map (anterior segment optical coherence tomography) revealed the condition prompting conservative management and periodic monitoring. Over a 6-month follow-up period, the patient's visual acuity improved significantly alongside a reduction in epithelial thickness. This case highlights the challenges and management strategies associated with epithelial responses following refractive surgeries along with the role of meticulous monitoring in optimizing outcomes. Hence, corneal epithelial hyperplasia must be a differential diagnosis in refractive surgery complications, guiding clinicians in decision-making and enhancing patient care.

Keywords: *Anterior segment optical coherence tomography, corneal epithelial hyperplasia, epithelial thickness mapping, refractive surgery, refractive surprise*

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Introduction

Refractive surgeries such as laser-assisted *in situ* keratomileusis (LASIK) and photorefractive keratectomy (PRK) have revolutionized the management of myopia, offering nondependency on glasses/contact lenses. Despite advancements in surgical techniques, cases of postoperative complications such as myopic regression necessitating enhancements are common.[1] Among other challenges, compensatory corneal epithelial hyperplasia following surface ablation enhancement represents a significant clinical challenge.[2]

This case of a 27-year-old female patient, who underwent initial surface ablation (transepithelial PRK) refractive surgery for myopia correction, subsequently experienced myopic regression 3 years postsurgery. Following surface ablation enhancement procedure, aimed to provide maximum visual benefits, the patient developed a diminution of vision postoperatively. As evidenced by clinical examination and investigations, a diagnosis of compensatory corneal epithelial hyperplasia post-PRK enhancement was made. Through meticulous monitoring and a conservative management approach involving medications and close observation, the patient achieved substantial improvement in visual acuity and reduction in epithelial thickness (ET) over a 6-month follow-up period.

This case explores the dynamics of epithelial changes postsurface ablation enhancement, supported by insights from relevant literature on corneal epithelial remodeling and advanced imaging modalities such as anterior segment optical coherence tomography (ASOCT).[3,4] The findings from this emphasize the significance of considering corneal epithelial hyperplasia as a differential diagnosis in cases of refractive surprises postenhancement procedures. This report serves as a valuable reference for refractive surgeons, offering insights into nonsurgical options and the importance of detailed postoperative monitoring in managing

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challenges associated with epithelial responses to refractive surgeries.

Case Report

We present the case of a 27-year-old female patient who underwent surface ablation (transepithelial PRK) refractive surgery for myopia correction 3 years prior, presenting to our tertiary care eye center with complaints of blurred vision in both eyes. Her initial unaided vision was 6/60 in both eyes, with a refractive error of −2.50/−0.50 × 10 in the right eye and −2.50/−0.50 × 180 in the left eye; transPRK was planned with a uniform ablation depth of 39 µm in both eyes leading to 6/6 vision in each eye postoperatively.

For 3 years following surgery, the patient had stable vision. However, after 3 years, she returned with a decline in visual acuity to 6/12 in both eyes, accompanied by a refraction indicating −1.25 DS in both eyes. Detailed topographic evaluation using Pentacam (Oculus Pentacam REF 70700) [Figures 1 and 2] and ASOCT (Cirrus HD-OCT Model 5000) [Figure 3] revealed myopic regression, prompting a surface ablation enhancement procedure. Initially, the patient achieved a visual acuity of 6/9 in both eyes postenhancement.

Two months later, the patient experienced blurred vision, measuring 6/12P in both eyes, with a myopic shift (−0.50 DS RE, −0.75 DS LE) improving to 6/6 vision bilaterally. Epithelial maps on ASOCT indicated an increase in ET compared to preoperative measurements,

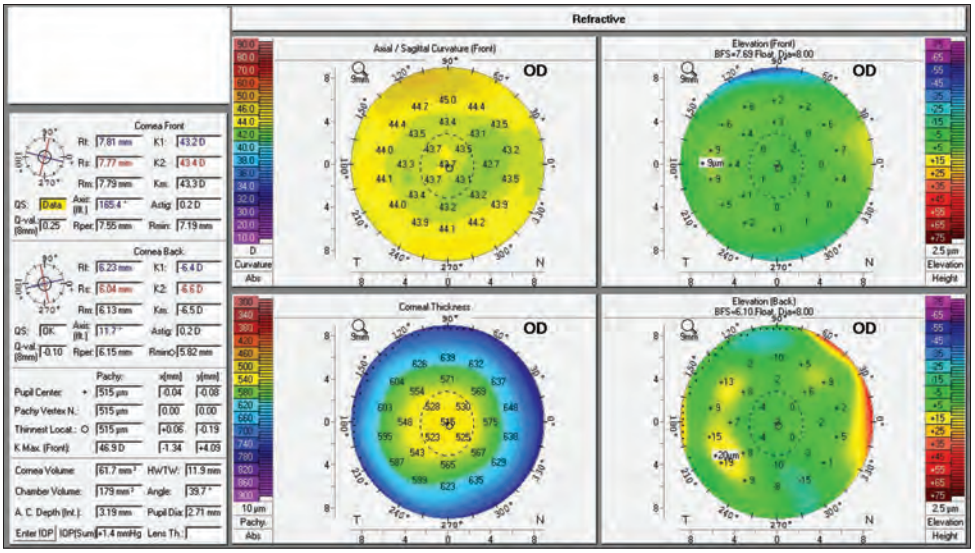


Figure 1: Preenhancement Pentacam tomography view for the right eye

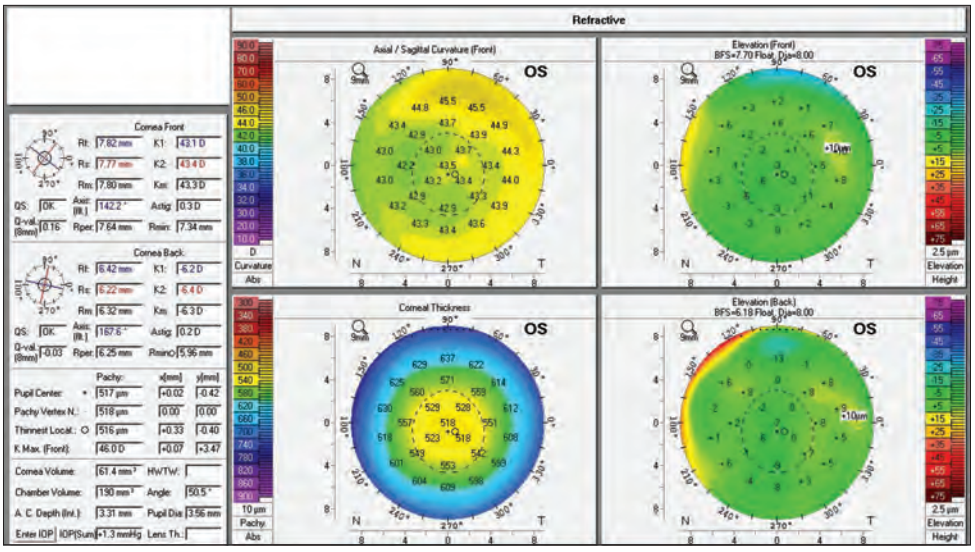


Figure 2: Preenhancement Pentacam tomography view for the left eye

while intraocular pressure remained within normal limits. A diagnosis of compensatory epithelial hyperplasia was made, likely in response to surgical trauma. The patient was counseled and was managed conservatively with low-dose steroids (loteprednol etabonate 0.3%), lubricating eye drops (sodium hyaluronate 0.1%), and antiglaucoma eye drops (timolol maleate 0.5%). Over a 6-month follow-up period, her visual acuity improved to 6/6 in both eyes, accompanied by a reduction in ET as documented by Pentacam and ASOCT scans [Figures 4-7]. Graph 1 and Table 1 show subsequent changes in the central corneal thickness and ET.

Discussion

Compensatory corneal epithelial hyperplasia following PRK enhancement is a recognized phenomenon characterized by thickening of the corneal epithelium in response to surgical intervention. After refractive surgical correction which involves stromal ablation to correct myopia, residual refractive errors or regression may necessitate further treatment.[1] This often involves additional laser ablation to refine the corneal shape.

Table 1: Anterior segment optical coherence tomography central corneal thickness and epithelial thickness postenhancement at 1, 3, and 6 months after photorefractive keratectomy

	Parameters			
	CCT		ET	
	OD (µm)	OS (µm)	OD (µm)	OS (µm)
1 month	504	501	51	55
3 months	512	506	60	63
6 months	506	508	55	56

CCT: Central corneal thickness, ET: Epithelial thickness

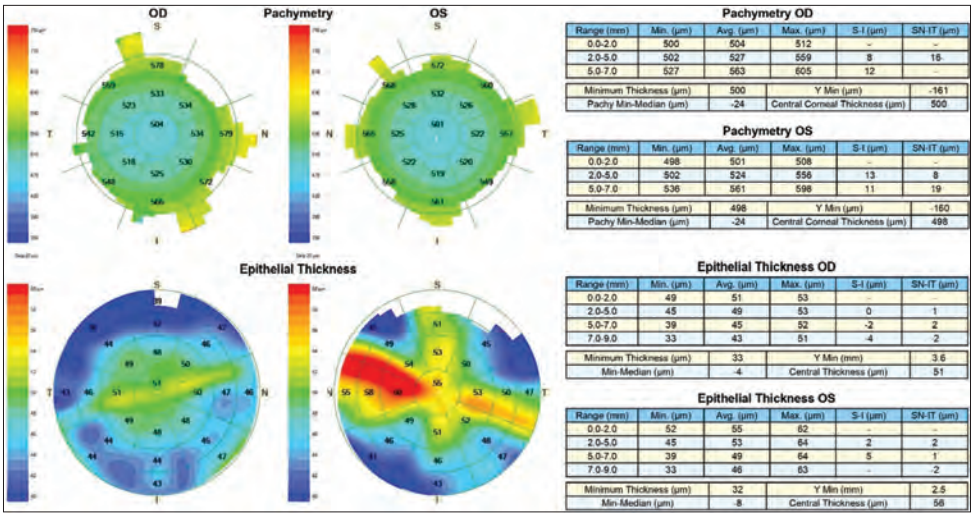


Figure 3: Postenhancement Pentacam tomography view for the right eye

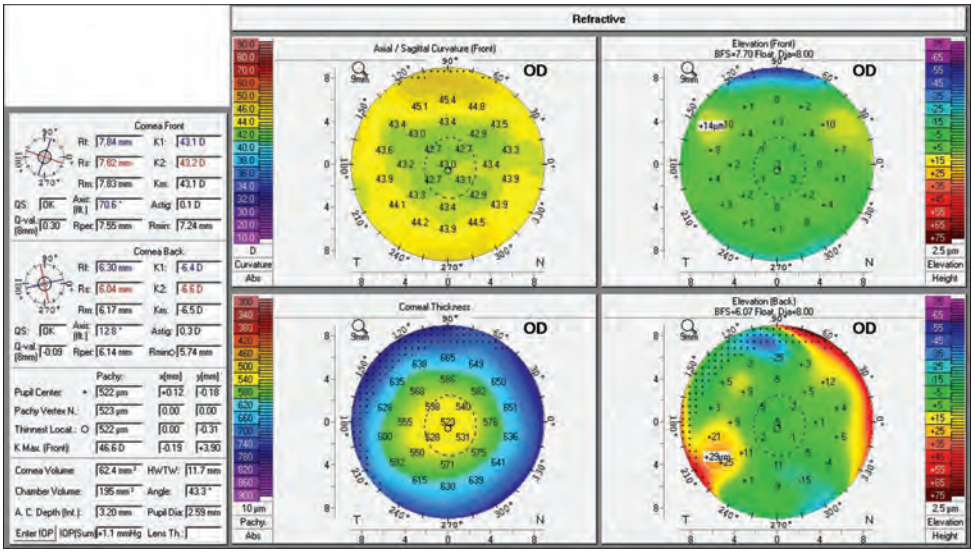


Figure 4: Postenhancement Pentacam tomography view for the left eye

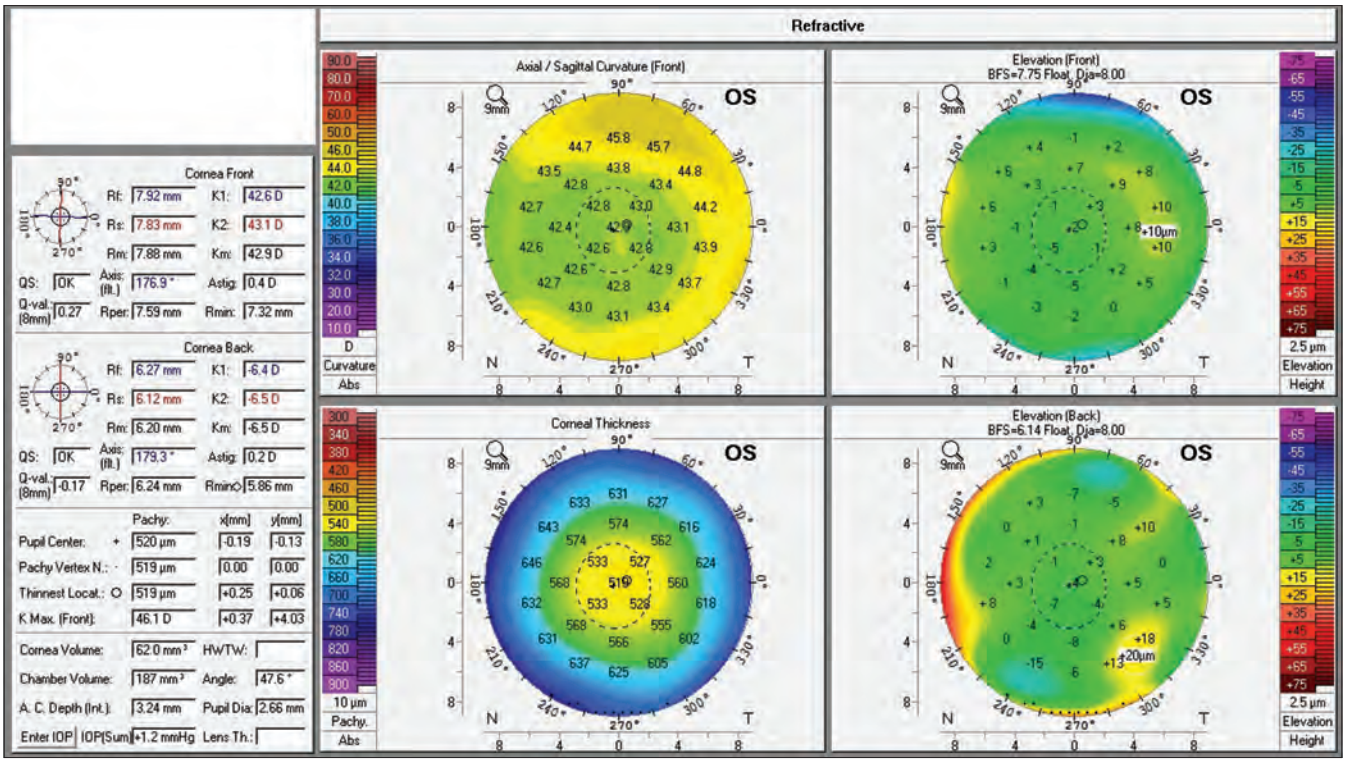
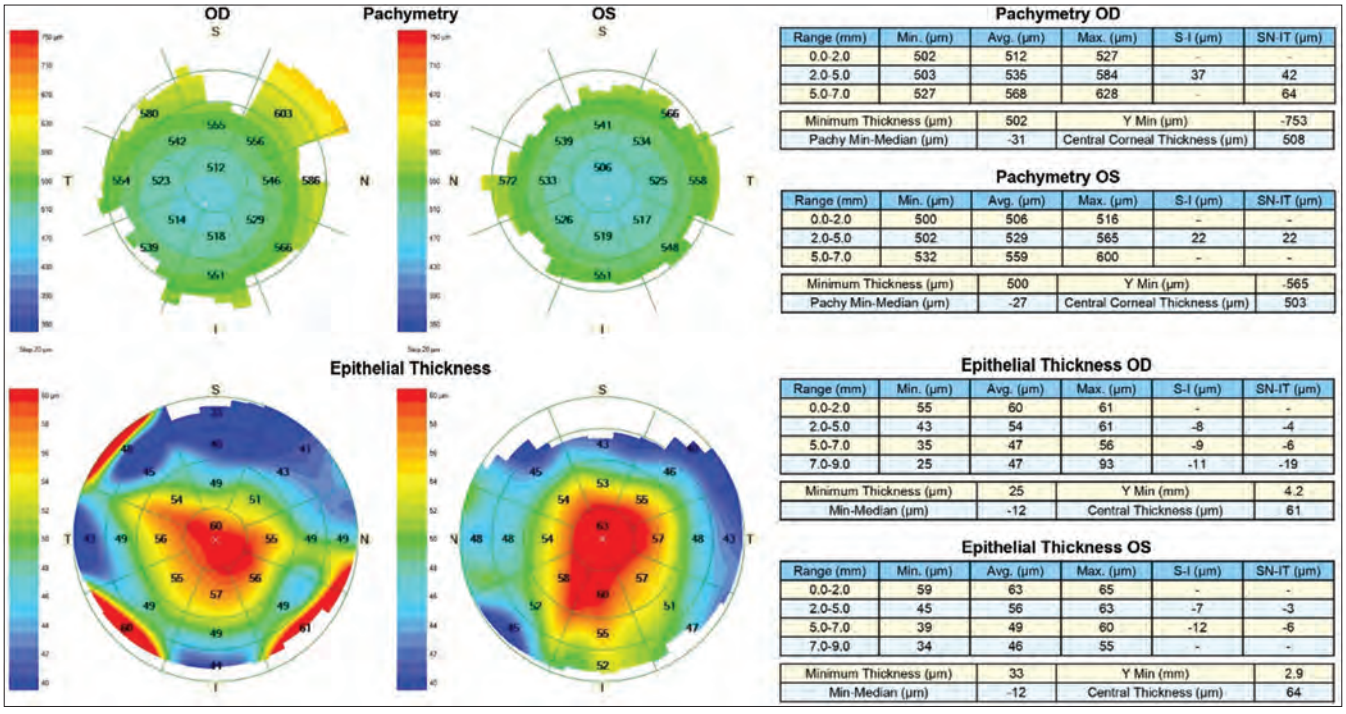


Figure 5: Anterior segment optical coherence tomography image of preenhancement epithelial thickness maps for both eyes



Pachymetry OD

Range (mm)	Min. (µm)	Avg. (µm)	Max. (µm)	S-I (µm)	SN-IT (µm)
0.0-2.0	502	512	527	-	-
2.0-5.0	503	535	584	37	42
5.0-7.0	527	568	628	-	64

Minimum Thickness (µm)	502	Y Min (µm)	-753
Pachy Min-Median (µm)	-31	Central Corneal Thickness (µm)	508

Pachymetry OS

Range (mm)	Min. (µm)	Avg. (µm)	Max. (µm)	S-I (µm)	SN-IT (µm)
0.0-2.0	500	506	516	-	-
2.0-5.0	502	529	565	22	22
5.0-7.0	532	559	600	-	-

Minimum Thickness (µm)	500	Y Min (µm)	-565
Pachy Min-Median (µm)	-27	Central Corneal Thickness (µm)	503

Epithelial Thickness OD

Range (mm)	Min. (µm)	Avg. (µm)	Max. (µm)	S-I (µm)	SN-IT (µm)
0.0-2.0	55	60	61	-	-
2.0-5.0	43	54	61	-8	-4
5.0-7.0	35	47	56	-9	-6
7.0-9.0	25	47	93	-11	-19

Minimum Thickness (µm)	25	Y Min (mm)	4.2
Min-Median (µm)	-12	Central Thickness (µm)	61

Epithelial Thickness OS

Range (mm)	Min. (µm)	Avg. (µm)	Max. (µm)	S-I (µm)	SN-IT (µm)
0.0-2.0	59	63	65	-	-
2.0-5.0	45	56	63	-7	-3
5.0-7.0	39	49	60	-12	-6
7.0-9.0	34	46	55	-	-

Minimum Thickness (µm)	33	Y Min (mm)	2.9
Min-Median (µm)	-12	Central Thickness (µm)	64

Figure 6: Anterior segment optical coherence tomography image of 1-month postenhancement epithelial thickness maps for both eyes

The corneal epithelium responds to these interventions by undergoing hyperplasia, to compensate for changes in stromal architecture. This discussion will explore the implications of this condition, supported by insights from relevant literature.

Research by Wang *et al*.,[2] Reinstein and Archer[5] (2006), and Sedaghat *et al*.[10] has elucidated the dynamics of epithelial changes post-PRK, highlighting that such procedures can disrupt corneal homeostasis, triggering epithelial thickening as a reparative mechanism.

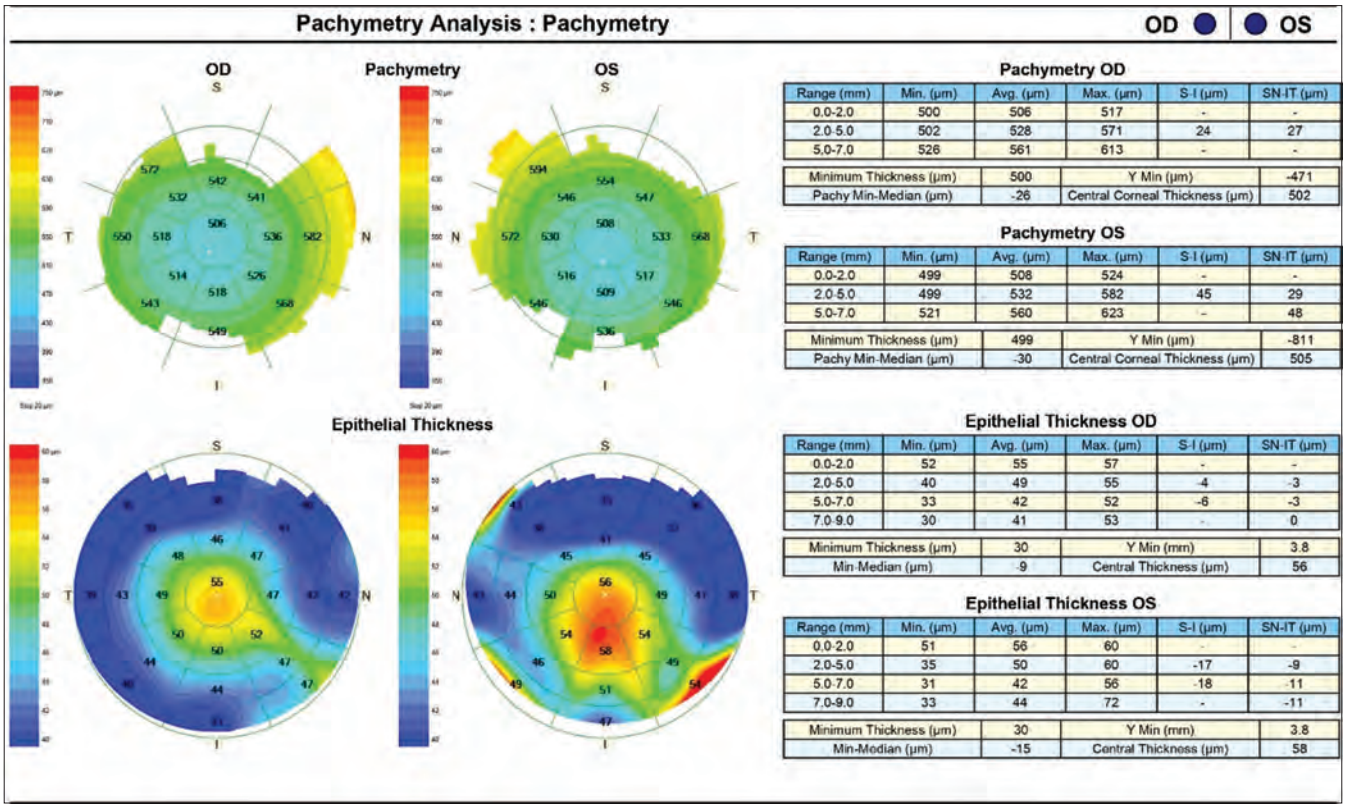
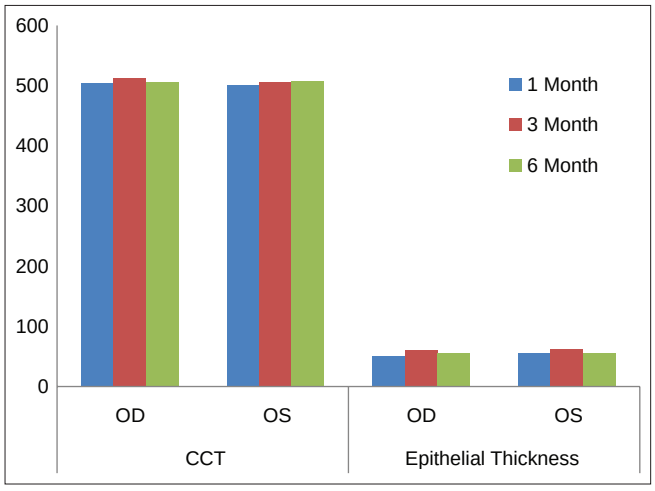


Figure 7: Anterior segment optical coherence tomography image of 6-month postenhancement epithelial thickness maps for both eyes



Graph 1: Anterior segment optical coherence tomography central corneal thickness and epithelial thickness postenhancement at 1, 3, and 6 months after photorefractive keratectomy. OCT: Optical coherence tomography

Reinstein and Archer[5] (2006) specifically discuss the use of advanced imaging techniques such as very high-frequency digital ultrasound-assisted transepithelial PRK, emphasizing the importance of monitoring epithelial responses to surgical interventions. Studies have shown that this hyperplasia can lead to fluctuations in ET, impacting long-term refractive stability and clarity. Lohmann *et al*.[1] and Moller-Pedersen *et al*.[6] studied the biological mechanisms underlying epithelial remodeling post-PRK, emphasizing the role of epithelial cells in maintaining corneal integrity.

In a study done by Reinstein *et al*.[7] (2012) it was observed that post Mypoic LASIK, between 1 and 3 months, the epithelium continued to thicken in the central 7-mm zone by approximately 1 µm ($P<.05$). No change in epithelial thickness occurred after 3 months ($P>.05$).

A study done by Alió *et al*.[8] (2008) and Rajan *et al*.[9] (2006) reported long-term efficacy of photorefractive keratectomy (PRK) for high myopia, with long follow-up showing stable refractive results and good visual outcomes.

Advances in imaging technology, as discussed by Kaluzny *et al*.[3] (2014) and Wu and Wang,[4] facilitate a detailed assessment of ET, aiding in optimizing treatment outcomes and minimizing complications associated with hyperplasia.

Thus, compensatory corneal epithelial hyperplasia following surface ablation enhancement represents a significant challenge in refractive surgery management. It highlights the need for thorough preoperative evaluation, meticulous surgical technique, and vigilant postoperative monitoring using advanced imaging modalities. Integrating findings from relevant studies

allows clinicians to optimize treatment strategies and enhance outcomes for patients undergoing refractive surgery procedures.

Conclusion

In managing refractive surprises post-LASIK, prioritizing nonsurgical approaches and meticulous monitoring is crucial. By utilizing advanced imaging for precise preoperative assessment and closely monitoring ET, ophthalmologists can detect and address corneal changes early, particularly in surface ablation enhancements. Prioritizing ET monitoring enhances the understanding of corneal dynamics postoperatively, ensuring precise adjustments and minimizing unnecessary surgical risks, ultimately leading to improved patient satisfaction and safety in refractive surgery practice.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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Case Report

From Obscurity to Clarity

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Abstract

A 3-year-old male presented with gradual, painless, and progressive vision loss in both eyes over several months. He followed the torchlight. Examination revealed normal pupillary reflexes, nystagmus, and inability to fixate. Slit-lamp examination showed a persistent pupillary membrane, aphakia, and an intact posterior capsule, with unremarkable fundus. There was no history of ocular surgery, infection, trauma, or birth complications. TORCH titers were negative. The mother denied seeing any white reflex in the eye. A diagnosis of spontaneous absorption of the lens was made. Temporary spectacles were prescribed following retinoscopy. The child subsequently underwent bilateral intraocular lens implantation with posterior capsulotomy and anterior vitrectomy, resulting in improved vision and increased playful behavior. Spontaneous absorption of the lens is a rare phenomenon and is a critical diagnosis to consider in pediatric ophthalmology. Comprehensive evaluation and early intervention can lead to excellent visual and developmental outcomes, improving the quality of life as demonstrated in this case.

Keywords: *Aphakia, intraocular lens implantation, lens, nystagmus, pediatric ophthalmology, spontaneous, vision loss*

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Introduction

"Spontaneous" as per Webster's dictionary is defined as "Proceeding from or acting by internal impulse, energy or natural law without external force; self acting." J.C Saunders first mentioned the possibility of absorption of congenital cataract while Warnatz first reported such a case.[1] Pyle's review of literature classified the absorption of lens into the following categories:[2]

1. Cases in which there was absorption after spontaneous rupture of the anterior or posterior capsule.
2. Cases in which there was spontaneous dislocation of the cataractous lens.
3. Cases in which there was intracapsular resorption of the opaque cortex and sinking of nucleus below the axis of vision, after degenerative changes of morgagnian cataract without rupture of capsule or dislocation of the lens.
4. Cases in which there was complete spontaneous resorptioin of both nucleus and cortex without reported history of ruptured capsule, dislocation or degenerative changes of morgagnian type.
5. Cases of spontaneous disappearance of incipient cataract without degenerative changes or marked difference in refraction.

Amongst the previously reported cases, absorption of lens has mostly been associated with Maternal rubella, leptospirosis, morgagnian cataract, uveitis, Persistent hyperplastic primary vitreous, Hallerman-Strief-francois syndrome, Down's syndrome etc.[3-7,10-11]

Case Report

A 3-year-old male was brought by parents with gradual, painless, and progressive vision loss in both eyes over several months. The child followed torch light and his extraocular movements were free full and painless. Clinical examination revealed normal pupillary reflexes, nystagmus, and inability to fixate. Slit-lamp examination showed a persistent pupillary membrane, aphakia, and intact posterior capsule, with quiet anterior chamber. Fundus examination was unremarkable [Figure 1]. The child's medical history was negative for any past surgery,

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infection, trauma, or complications at birth. TORCH titers were negative, ruling out intrauterine infections. The child's medical history shows no previous surgeries, infections, trauma, or birth complications. TORCH titers are negative, excluding intrauterine infections.

Notably, the mother had bilateral subluxation of cataractous lenses for which she underwent corrective surgery 10 years back. She had been vigilant in monitoring for any similar symptoms in her child, such as a white pupillary reflex, which she did not observe, thereby ruling out cataract.

A diagnosis of spontaneous absorption of the lens was made. Retinoscopy values in both eyes were +12.5 Dsph/+1 Dcyl at 90°. Temporary spectacles were prescribed. The child was comfortable with spectacles and was able to perform daily activities cheerfully. On further follow-ups, the child was planned for corrective surgery. The intraocular lens (IOL) power of +28.00D was initially calculated based on keratometry and A-scan values. However, considering the necessity for undercorrection in pediatric patients, we opted for a 10% undercorrection. As a result, a +25.00D IOL was implanted.

The child subsequently underwent bilateral sequential IOL implantation in the sulcus with posterior capsulotomy and anterior vitrectomy [Figure 2]. The surgery was uneventful with a well-centered IOL resulting in improved vision and increased playful behavior. Postoperatively, retinoscopy revealed a prescription of −2.50 cyl at 180° for the right eye and −2.50 sphere at 90° for the left eye. Spectacles were prescribed to correct the refractive error, and the patient was scheduled for routine follow-ups to monitor postoperative complications if any.

Discussion

The pathophysiology behind the spontaneous absorption of a lens is not fully understood. It is hypothesized that enzymatic activity within the eye may play a role in breaking down the lens proteins, leading to gradual resorption.[2] However, this process can result in complications such as aphakia and posterior capsule opacification, as observed in this case. Vancea and Duke Edler proposed unrecognized injury to lens capsule as one of the reasons.[8] Zeiter et al explained that calcium deposition takes place in the lens when it gets invaded by the uveal tissue following rupture of the lens capsule.[9]

In our case, there was no history of ocular trauma, surgery, infection or any systemic illness. Negative TORCH titers ruled out intrauterine infections. The absence of craniofacial, dental, ocular, or skin deformities excluded Hallerman-Strief-Francois syndrome, while the child's good cognitive function and appearance ruled out Down syndrome. By eliminating all the possible causes of lens absorption, we conclude that this case is idiopathic or, more effectively, "spontaneous."

Considering the absence of a white pupillary reflex in our case, we suggest that the crystalline lens may have undergone spontaneous absorption, placing it in "category 4" as per Pyle's classification. Spontaneous absorption of crystalline lens in pediatric patients is an intriguing phenomenon and this is the first reported case to the best of our knowledge.

Nystagmus and the inability to fixate, as seen in our patient, are common manifestations of significant visual impairment in children. These signs, coupled with a history of gradual vision loss, should prompt detailed ophthalmologic evaluation.

Management of such cases poses unique challenges. Temporary corrective measures, such as prescribing spectacles following retinoscopy, can help in the interim period. Definitive surgical intervention, in this case, intraocular lens (IOL) implantation in the sulcus with capsulotomy and bilateral anterior vitrectomy, was necessary to restore vision.

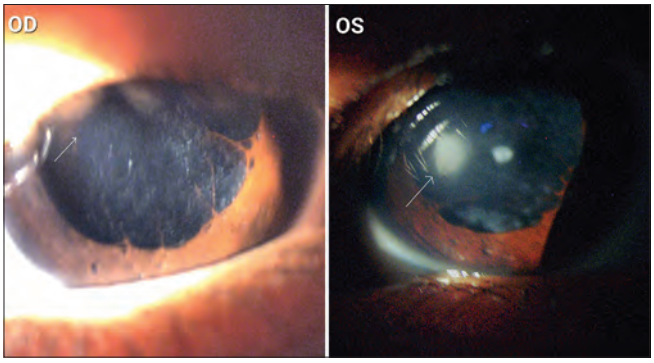

Figure 1: Slit-lamp examination at presentation (Note: The white arrow depicts an artifact)

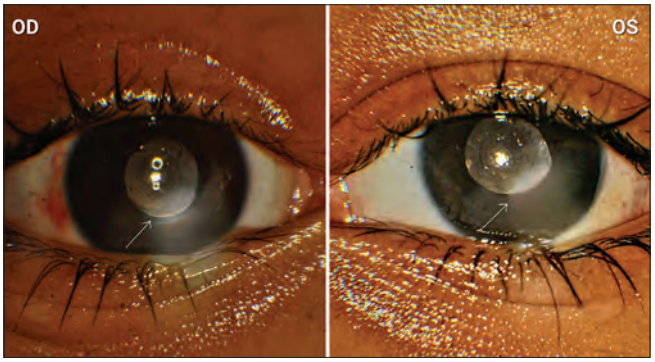

Figure 2: Postoperative picture with a well-centered intraocular lens and posterior capsulotomy (Note: The white arrow depicts an artifact)

IOL implantation in children is associated with a higher risk of complications such as secondary glaucoma, retinal detachment, or posterior capsule opacification; compared to adults, but it remains a viable option for visual rehabilitation.

The psychological and developmental impact of vision loss in children is profound. Early intervention not only aids in visual development but also enhances the child's overall quality of life. Postoperative improvement in our patient's behavior, becoming more playful and interactive, reflects the positive impact of restored vision.

Conclusion

While spontaneous absorption of a lens is rare, it is a critical diagnosis to consider in pediatric ophthalmology, especially in patients presenting with unexplained vision loss. Comprehensive evaluation and appropriate surgical management can lead to excellent visual and developmental outcomes, as demonstrated in this case. Further research is needed to understand the underlying mechanisms and to establish standardized guidelines for managing such unique cases.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the legal guardian has given his consent for images and other clinical information to be reported in the journal. The guardian understands that names and initials will not be published and due efforts will be made to conceal the identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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Case Report

Fungal Scleral Abscess

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ABSTRACT

This case describes an uncommon case of postoperative fungal infection of Sclerocorneal tunnel after complicated phacoemusification with vitreous loss. The patient was a diabetic with chronic renal failure which predisposed him to fungal infection dure to immune compromised status.

KEYWORDS: *cataract, infection,fungal*

A case of SCLERAL tunnel incision infection in a 69-year-old diabetic and chronic renal failure posteventful phacoemusification with posterior capsular rent and anterior chamber intraocular lens (ACIOL) implantation.[1] He had a vitreous loss with capsular rent necessitating an anterior vitrectomy followed by wound enlargement to insert an ACIOL and then sutured with 10/0 nylon.

This gentleman developed a linear stromal sclerocorneal infiltrate 20 days postoperative and presented with redness and pain with photophobia. Initial treatment with intensive topical and oral antibiotics showed poor response. The corneal scrape was negative for bacteria or fungi. The infection was indolent for a month the eye was relatively quiet with mild circumcilary congestion and the infiltrate appeared cheesy, and considering his immunocompromised status, he was put on empirical antifungal treatment. Topically hourly, voriconazole 1% and natamycin 5% drops were started (antibiotics drops were tapered) along with oral tablet voriconazole 200 mg/day.

The response observed was dramatic with wound infiltrate healing and the inflammation subsiding over 2 weeks. A suture removal was performed, and the medication continued for a month with gradual tapering of the drops, leading to complete healing.

Hence, this case highlights the probability of fungal infection in elderly uncontrolled diabetics postcataract surgery and the effectivity of newer antifungal medications in avoiding a surgical intervention.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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Letter to Editor

Filling in the Void!

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I take this opportunity to congratulate Dr. Cyrus Mehta and his team on launching this *Indian Journal of Cataract and Refractive Surgery*. India having the largest population in the world and the one of the highest number of eye surgeons are treating a large volume of cataract patients providing succour to the blind.

The expertise and experience of our surgeons are world renowned with many stalwarts innovating constantly novel surgical techniques and technologies to provide ophthalmic care at economical price without compromising on results. This journal will be a medium to disseminate and discuss advances in cataract and refractive surgery among colleagues and giving the young surgeons an impetus to publish their work.

Indian companies manufacturing phacoemusification machines, intraocular lenses, and instruments and drugs can publish the results of their multicentral trials conducted and India can export our ophthalmic products worldwide.

This journal will a fillip and push ophthalmic academia and postgraduate training in India in the medical colleges and ophthalmic institutes as the mantra today is - publish or perish.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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Letter to Editor

Lubricants in Vitreoretinal Surgery

Ocular surface changes following vitreoretinal procedures where dry eyes are a common problem in postoperative patients due to poor lid hygiene (fear of water entering the eyes) and meibomitis with blepharitis.

Scleral buckling surgery needs a 360 peritomy which leads to damage to limbal stem cells, corneal nerves, and mucin-secreting cells of conjunctiva; this leads to ocular surface dysfunction along with irrigating fluids and corneal epithelial trauma and suture irritation.

Microincision vitrectomy systems with 25G and 27G systems and noncontact retinal viewing systems lead to the least anatomical distortions in the ocular surface and minimal conjunctival and corneal afflictions.

Intravitreal injections are today performed in millions, and the povidone iodine used disrupts the corneal integrity along with the preservative antibiotics drops. This leads to dry eyes as most of the patients are diabetic and have neurotrophic cornea with reduced tear secretion, and the retinal laser photocoagulation causes further damage to corneal nerves.

As a rule, I add sodium hyaluronate (0.1%) and carboxymethylcellulose-based lubricants in all patients, postvitreoretinal surgery along with preservative-free antibiotic and steroid drops and keep the use of nepafenac and other nonsteroidal anti-inflammatory drugs drops to minimum (toxic to corneal epithelium). Lid hygiene and meibomitis maneuvers are initiated as early as possible postoperative with sterile lid wipes and warm water compresses. Early suture removal where needed and watching out for dellen and superficial punctate opacities and treatment with lubricating ointments.

Retinal surgery postoperative comfort for patients has improved with microincision sutureless vitrectomy, but scleral bucking with sutures in conjunctiva leads to irritation and lubricant drops alleviate the pain and discomfort.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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Letter to Editor

Management of Dislocated Lens Fragments

It is a big conundrum deciding the predictive factors and visual outcomes after immediate pars plana vitrectomy for dislocated lens fragments versus delayed surgery.[1] I feel there is no immediacy of surgery and the timing for vitrectomy should depend on the clarity of cornea (striate keratopathy) and a well-dilated pupil and a properly counseled patient. A dislocated nucleus is "not toxic" to retina, although the referring surgeon is on fire and pushes for early intervention.

In our set up, a patient referred is counseled and put to rest and the patient started on oral steroids and acetazolamide to control inflammation and glaucoma and corneal edema and striate keratopathy clear and pupils dilated well (as described in the paper pupil size is a risk factor for poor outcome).

My surgical steps are as follows:

1. A parsplana 23 G core vitrectomy is performed to clear the vitreous and a corticotomy is done. I don't induce a posterior vitreous detachment in all cases (unlike the authors) unless it is already separated. The posterior cortical vitreous acts as a buffer on which the nucleus sits protecting the macula (hence I don't use perflurocarbon liquids (PFCL) in any case)
2. The soft cataracts are extracted with the cutter by chopping and stuffing the pieces with the light pipe. The cut rate is reduced to1000 cuts/min and vacuum raised to 400 mm Hg (Stellaris machine)
3. Hard nucleus is tackled using phacofragmentation by enlarging one sclerotomy and the nuclear fragments are chopped in the midvitreous with the light pipe. The chips which scatter on the retina are carefully lifted off using a flute needle
4. Brown and black nuclei are levitated up using PFCL after a complete vitrectomy and delivered in the iris plane and viscoexpressed with a Vectis through an enlarged sclerocorneal tunnel incision
5. Before intraocular lens (IOL) insertion, the peripheral retina is inspected for any tears and endo laser is performed to them to prevent retinal detachment (10.81% incidence in the article). Vitreous is thoroughly cleaned from the anterior chamber, iris and wound to reduce the incidence of cystoid macular edema (13.51% in study) and uveitis
6. The IOL insertion choice is usually a three-piece posterior chamber IOL over the residual capsular support or if no adequate support a Kelman multiflex anterior chamber IOL (ACIOL) or a posteriorly fixated iris claw is inserted. I prefer ACIOL as the pupil is circular and dilates well postop unlike the cats' undulating pupils with iris claw lenses. The wound is thoroughly sutured using 10/0 nylon.

Like the authors I avoid suture support or glued IOL or a Yamane fixation as excessive manipulation in the region of vitreous base increases the risk of retinal detachment and prolonged surgical time leads to further endothelial cell loss.

Hence, a properly managed dislocated nucleus has a very good long-term visual prognosis in the proper hands.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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