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CORNEAL COMPLICATIONS OF CATARACT SURGERY

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CORNEAL COMPLICATIONS OF CATARACT SURGERY

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CORNEAL COMPLICATIONS OF CATARACT SURGERY

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PREFACE

Cataract surgery is the most commonly performed surgery in ophthalmology and this was our first and most coveted surgery during residency days. Nothing satisfies the surgeon more than a happy and satisfied patient having a fresh look at the world around him/her. Poor visual gains after cataract surgery, however, can be a nightmare. Corneal complications of cataract surgery are amongst the commonest causes. It seemed appropriate for the moment to dwell on this critical aspect in this CME series.

We had experts in corneal surgeries coming together with their expertise to give practical tips to the general ophthalmologist in preventing and managing corneal complications. Some may need referral to an expert cornea consultant and the book contains study material for the specialist too. It has been vividly illustrated with examples from the clinic to give the reader a virtual "hands on experience". References at the end of each chapter make for rich reading. Early and late onset corneal edema after cataract have different etiologies and have separate chapters dedicated to them. Preoperative and postoperative corneal/ocular surface evaluation have been extensively covered. Diagnosing and managing Descemet's membrane detachment after cataract surgery is included in a separate chapter. Tunnel infections can be quite devastating. It behooves every cataract surgeon to know about them and this book has a separate section exclusively dedicated to this.

We have rolled out this book – the second in the AIOS ARC CME series initiative as an ebook to enable universal access during these difficult times. It is always heartening to receive remarks from the readers both positive and negative, so that we may improve in our future endeavours. You may reach me directly at the email provided below. Happy learning and reading.

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EDITORIAL

Cataract Surgery is one of the most demanding surgery today. Expectations are sky-high, whatever be the nature of the cataract or the associated pathologies in the eye. Patients are expecting results akin to refractive surgery. Cornea is the clear front window of the eye which plays an important role in delivering such visual results. Preoperative corneal pathology, intraoperative and postoperative complications can all lead to a drop in vision and unhappy patients.

Post cataract surgery Ocular surface and Corneal Endothelial issues are the most commonly encountered problems, while Infections though rare can be devastating with poor outcomes. The practitioner faced with such a case is often in a dilemma as how best to evaluate and manage them. We have tried to discuss these commonly faced situations with the help of diagnostic and management algorithms and clinical cases encountered in our practice. We hope that the chapters will help the practicing ophthalmologists to correctly diagnose and treat the various corneal complications of cataract surgery that we have covered. We would like to thank the ARC – AIOS and Dr. Chitra Ramamurthy specifically for giving us this opportunity.

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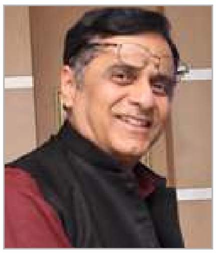

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CONTENTS

Chapter - 1

PREOPERATIVE CORNEAL ENDOTHELIAL EVALUATION

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Present day cataract surgery is considered a refractive procedure and a clear cornea after surgery is a necessity for the desired precision in visual outcomes. Hence a careful preoperative evaluation of the health of the cornea and the endothelium is mandatory. The cornea subserves its function of transmitting and refracting the incident light by maintaining its state of optimal hydration. This is effected chiefly by the endothelium, owing to its barrier function and an active, energy dependent pump which removes fluid from the stroma. Thus, a lot of emphasis is placed on evaluating the anatomy and function of the corneal endothelium, when the patient presents for cataract surgery.

The endothelium is the cellular monolayer on the posterior surface of the cornea, and has the unique distinction of being the only tissue with living cells that can be repeatedly examined in a non-invasive manner without deleterious effects. In childhood, the cell density is about 3500 to 4000 cells/mm2, and owing to an increase in corneal area and a gradual attrition with age, the numbers dwindle steadily at about 0.6% per year, to a count of about 2400 to 2600 cells/mm2 at the age of 75 years. These cells do not divide under normal conditions, and are arrested in the G1 phase of the cell cycle. Hence, any damage is countered by the sliding of adjacent cells to occupy the affected area, resulting in a decrease in cell density and function.

The number of cells required to maintain corneal hydration and vision is not clear, but it would appear that a density of 1000 cells/mm2 would just be adequate, although the health of the cells is also important. It is unlikely that a cell density of less than 500 cells/mm2 would be sufficient to maintain corneal clarity and in the range between 500 and 1000 cells/mm2, the corneas are in a borderline state. All surgical manoeuvres in the anterior chamber will cause a loss of endothelial cells, and with current surgical techniques of manual small incision cataract surgery and phacoemulsification, studies indicate a loss of between 5 and 10% of the endothelial cells, with possibly a slightly lesser loss with the first technique in dense cataracts.

Apart from surgical trauma, other factors can result in corneal edema after cataract surgery and preoperative evaluation is required to detect a comprised endothelium resulting from such conditions. The endothelial morphology can be studied to some extent using the slit-lamp. Indirect illumination using a slit beam and retroillumination with a dilated pupil will allow the detection of an irregular endothelium-Descemet's membrane (DM) complex **(Fig 1a, 1b)**.

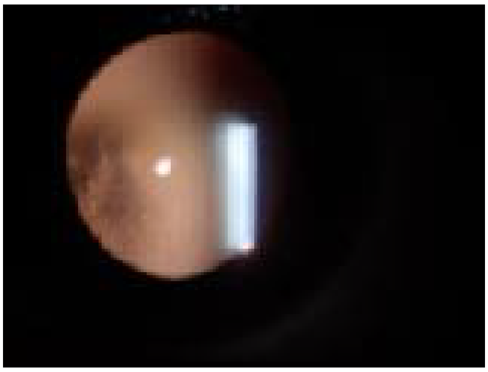

Fig: 1a Slit lamp assessment indirect illumination

Fig: 1b Slit lamp assessment retroillumination

These are termed corneal guttae and represent accumulation of a hyaline material between the stressed endothelial cell and DM. They result in irregular reflection of light resulting in the appearance of dark areas. While these changes in the ageing peripheral cornea are physiological and termed Hassal Henle bodies, their presence in the central cornea in younger individuals is pathological and is most often seen in Fuch's endothelial dystrophy.

In addition to these guttate changes, cysts and snail track-like lesions are seen in the DM in posterior polymorphous endothelial dystrophy. Other conditions that can result in altered endothelial morphology include congenital hereditary endothelial dystrophy, irido-corneal endothelial syndrome and macular corneal dystrophy - although in all of these, other characteristic features are present apart from the endothelial changes. The endothelium can also be damaged from past episodes of viral endotheliitis, trauma - at birth or in later life, peripheral laser iridotomy in eyes with a narrow angle, glaucoma, prior surgery like trabeculectomy, corneal transplantation, long-term contact lens use, systemic conditions like diabetes mellitus and renal failure on hemodialysis, and drugs like amantadine used in the treatment of Parkinsonism.

Using a 40x magnification on the slit-lamp, with maximal illumination, a short beam height and narrow width, and increasing the separation between the illumination and viewing axes, the individual endothelial cells can be visualised a clear cornea by a dark adapted examiner in a dark room, if a cooperative patient maintains steady fixation **(Fig 1c)**.

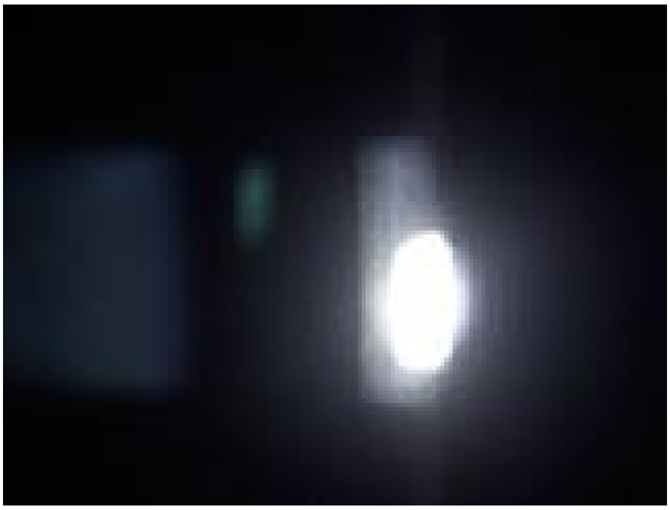

Fig: 1c Slit lamp assessment –specular reflection

All of these exacting requirements are necessary because while the curved endothelial layer reflects light back owing to the refractive index difference with the aqueous humour, only 0.022% of the light returns. A lighted room, inadequate illumination intensity, a large beam, corneal media opacities, patient eye movement, and inadequate separation of the illumination and viewing axes can interfere with the detection of this specularly reflected light.

Most current techniques of endothelial evaluation therefore, depend on instruments called specular microscopes to image these cells **(Fig 2)**.

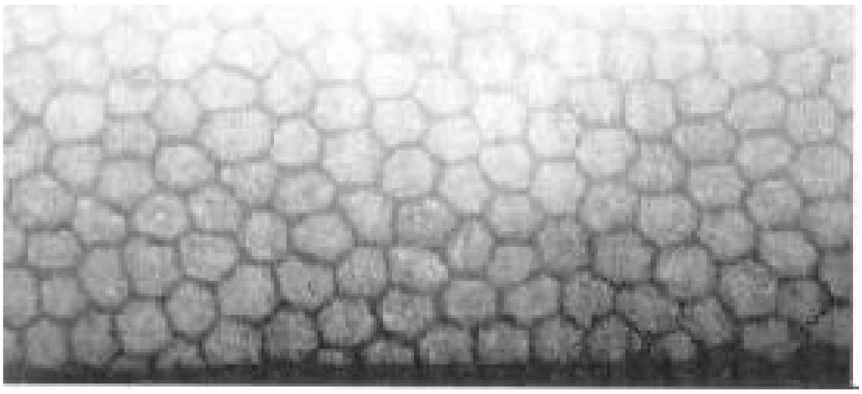

Fig: 2 Healthy endothelium - regular arrangement of predominantly hexagonal cells with minimal variation in cell size and shape

They can be broadly divided into contact and non-contact horizontal devices for clinical use. Most of the current non-contact devices can perform automated focussing and capture of the endothelial images. The non-contact instruments are thus easier to use, but provide a smaller image area unlike the contact instruments which applanate and flatten the cornea at the area of contact, thereby providing a larger image area. However, for clinical use, both devices are considered adequate. The obtained image is analysed using proprietary software available in the machine to provide morphometric details of the endothelium. Corneal endothelial images can also be obtained using a confocal microscope but these are not used for routine clinical purposes.

The parameters commonly derived are the cell density per mm2, the mean cell area in µm2 and standard deviation, and the number of cells with 6 sides. Most machines will also indicate the number of cells analysed by the program. Interpreting the cell density data requires an idea of the normal cell density expected for that age group and in a study by Rao et al normative data in Indian eyes was 2782 + 250 cells/mm2 in the 20-30 year age group, 2634 + 288 cells/mm2 in the 31-40 year age group, 2408 + 274 cells/mm2 in the 41-50 year age group, 2438 + 309 cells/mm2 in the 51-60 year age group, 2431 + 357 cells/mm2 in the 61-70 year age group, and 2360 + 357 cells/mm2 in the old than 70 year age group.

The variation in cell area is termed polymegathism and is determined by the coefficient of variation of cell area, determined as standard deviation in cell area / mean cell area in µm2 x 100. A value less than 33% is considered normal, with an increase in the index reflecting a greater variation in cell area. This can indicate endothelial damage and reflect the cell migration and expansion in size to cover the defective areas. The normal endothelial shape is a 6 sided regular hexagon, as this geometric shape confers the advantage of greatest surface area relative to its perimeter. The percentage of hexagonal cells in a healthy endothelium is expected to be about 60% and a decrease in this index reflects greater change in cell shape or pleomorphism, owing to an endothelial disturbance **(Fig 3)**.

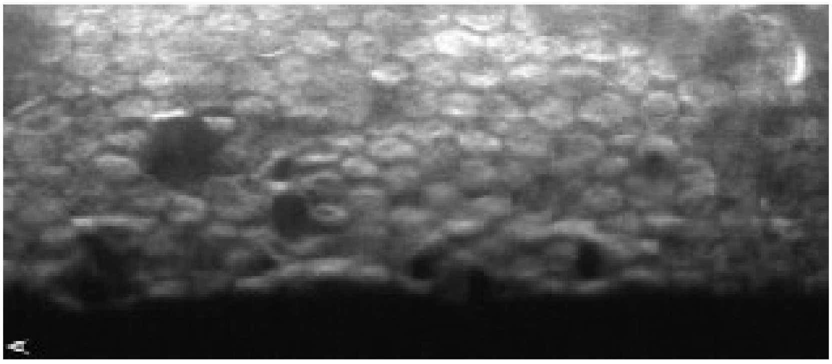

Fig: 3 Endothelium with guttae - dark areas, with irregular cellular morphology

When using this data, it is also extremely important to look at the quality of the image obtained as well the number of cells analysed. The automated program will perform an analysis even if the cellular detail in the image in not clear, and hence the data must be considered erroneous and discarded **(Fig 4)**.

Fig: 4 Poor quality image that cannot be analysed - any machine derived data to be disregarded

It is ideal to count as many cells as possible in the image, and the recommendations vary from a minimum of 30 cells to upwards of 100. Data obtained from the analysis of a small number of cells decreases the reliability of the obtained numbers. Some machines allow a semi-automated method of analysis, with the option of operator correction of the algorithm analysed image. Commonly used methods require the marking of the centers of the endothelial cells, or tracing the outline of the individual cells, within a defined frame. The data obtained from different instruments is also often not comparable, especially between the contact and non-contact devices, but also due to differences in the image analysis software. Hence, a familiarity with the machine being used, and an understanding of the various factors mentioned earlier is necessary for a proper interpretation of endothelial cell health. Standard comparison charts are also available which depict images of cell density ranges, and it is useful to compare these with the image from the instrument to ensure that gross deviations in the reported cell density are picked up.

Fig 2). True Guttae as mentioned earlier, represent the deposits secreted by a stressed endothelium, and the irregular elevation results in altered reflection of the light and a dark spot. Similar changes can also be seen if there are pigments or keratic precipitates on the endothelium, or if there is cellular swelling due to inflammation, and these are termed as pseudo-guttae or secondary guttae and may be reversible after the pathology resolves. Hence a thorough clinical evaluation of the corneal endothelium using the slit-lamp is necessary to understand the changes seen on specular microscopy.

Since the function of the endothelium is to maintain corneal hydration, the presence of epithelial edema, stromal edema and or folds or striae in the DM can indicate varying stages of loss of endothelial function. Pachymetry can also indicate this, and in an eye with corneal guttae, a thickness greater than 600 µm is considered a sign of a failing endothelium, although some use 640 µm as a cutoff. An increase in corneal thickness on serial pachymetry would of course be a 4 better indicator of deteriorating endothelial function. The corneal edema is often worse in the morning, owing to the lack of evaporation during closed eye sleep. Hence patient complaints of blurred vision in the morning, for some time, is a useful indicator of a failing endothelium.

All of these assessments are made to determine the risk of the cataract surgical procedure resulting in loss of endothelial function in a compromised cornea. While risk scores have been computed using these corneal characteristics - with cell density of 1000 cells/mm2 or lower, CV > 50, Hexagonality < 30, and pachymetry > 640 µm suggesting a high risk of corneal endothelial decompensation following cataract surgery, and a need for combined cataract surgery and corneal transplantation, other factors have to be considered as well. These include the health of the patient, with diabetic eyes having a weaker endothelium due to metabolic stress, medications like amantadine and acetazolamide which can compromise endothelial function or tamsulosin which can result in a floppy iris and more difficult surgery, ocular conditions like glaucoma which have been shown to be associated with a lower cell count, and prior Nd:YAG laser iridotomy which results in lower cell counts. Conditions that can make cataract surgery more challenging – dense corneal shagreen inhibiting visibility, a small corneal diameter, shallow anterior chamber and a short axial length with less space to perform surgery, a small pupil which may require additional manoeuvres, a very dense cataract which can increase the surgical time, a posterior polar cataract with a higher risk of posterior capsule rupture and anterior vitrectomy or a combination of some or all of these, can also increase endothelial trauma at the time of surgery.

Hence, the decision about proceeding with cataract surgery often depends not just on the above mentioned risk factors, but also on the confidence of the surgeon in his surgical ability, and the sophistication of the phaco machine used which will determine the efficiency of lens removal and the stability of the anterior chamber. In eyes with very dense cataracts, these considerations may prompt the consideration of a manual small incision approach for cataract surgery. Apart from damage to the endothelium, DM stripping during surgery can also result in suboptimal outcomes and eyes with dense arcus, corneal shagreen, significant Hasall-Henle bodies and a thicker peripheral cornea are more predisposed to this complication and hence must be noted in the preoperative corneal evaluation. Patients who have this complication in one eye, will often develop it in the other eye as well, even when the two eyes are operated by different surgeons, and hence extra care must be used in such situations.

Maintaining the health of the corneal endothelium is of paramount importance in cataract surgery. The preoperative evaluation must assess the various factors mentioned above and if some of them are present, apart from the existing guidelines, the surgeon must factor in his experience to make a case-by-case decision about the type and safety of the surgical procedure in that eye. In eyes with borderline corneal endothelial function, despite the adoption of best care surgical procedures, endothelial decompensation can still occur. Hence, a detailed discussion regarding the state of the endothelium, and the possible need for further surgical procedures to rehabilitate the cornea must be discussed with the patient prior to proceeding with cataract surgery.

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Chapter - 2

DIAGNOSTIC APPROACH TO EARLY ONSET CORNEAL EDEMA AFTER CATARACT SURGERY

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Most patients today expect an improvement in their unaided vision from day one following cataract surgery. Corneal edema immediately after cataract surgery can cause the vision to drop significantly and is therefore an important complication. There can be multiple etiologies and a careful evaluation is essential to come to a conclusion, so that the most appropriate treatment strategy can be followed.

Common Causes to Consider and Differentiate

- Raised Intraocular Pressure
- Surgical Trauma
- Descemet's membrane detachment (DMD) or Tear
- Toxic anterior segment shock syndrome (TASS)
- Endothelial Dystrophy / Guttata
- Hypotony / Wound Leak

Evaluation

When we examine the patient with corneal edema immediately following surgery, we need to follow the scheme in Figure 1 to help determine the possible cause.

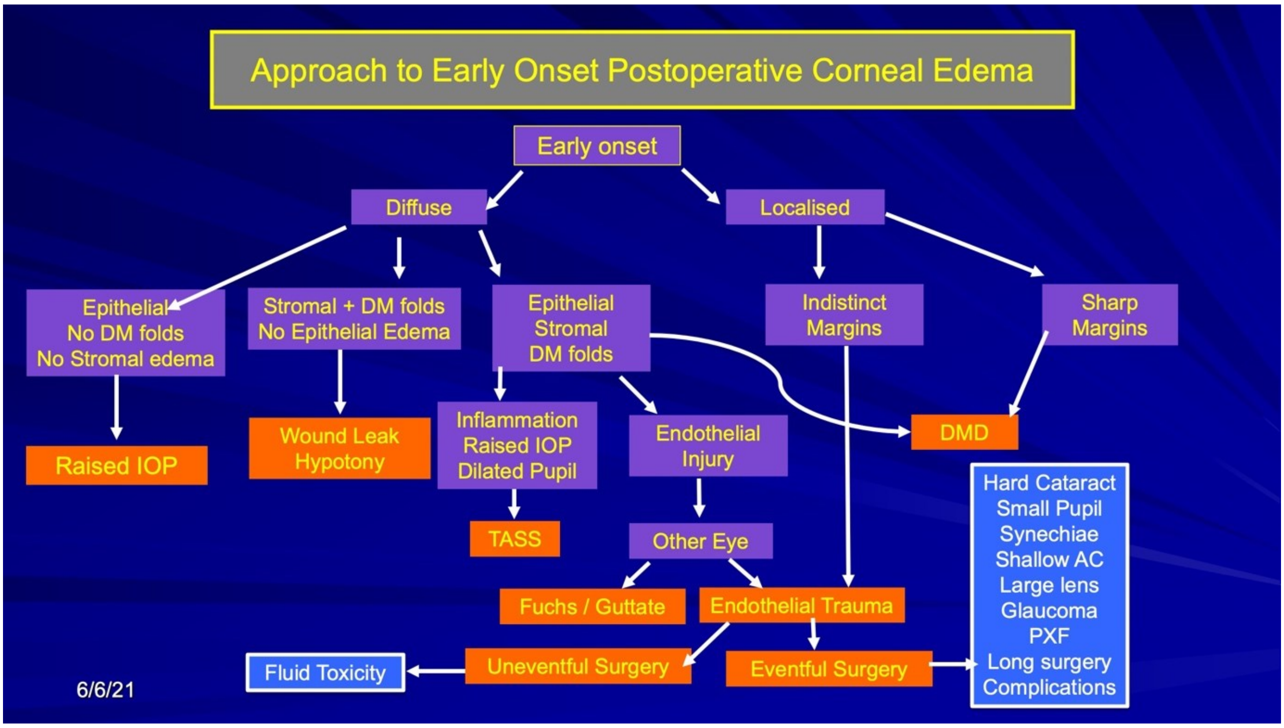

Fig: 1 Diagnostic Flowchart

A) **Diffuse Edema** – In a patient with diffuse corneal edema and haze we need to look if the edema involves only the epithelium with a compact stroma or involves all layers of the cornea.

1. Epithelial edema alone is often due to raised intraocular pressure (IOP) and can be confirmed by applanation tonometry. Lowering the IOP usually will resolve the corneal edema.
2. Patients with diffuse edema (epithelial + stromal + DM folds) in the absence of any raised pressure, dilated pupil and intraocular inflammation are likely to be related to endothelial injury. Examining the contralateral eye endothelial status can help us differentiate an intraoperative endothelial injury from a pre-existing compromised endothelium. Patients with compromised endothelium are more likely to develop corneal edema following an uneventful surgery. In presence of a normal endothelium in the other eye one should consider intraoperative factors such as a complicated surgery due to a hard cataract, small pupil, shallow chamber, large lens, posterior capsular rupture, vitreous disturbance etc. In instances when the surgeon has had an uneventful smooth surgery, toxic damage to the endothelium should be considered due to irrigating fluids and intracameral drugs.
3. A total descemet's membrane detachment / tear / extensive loss can also present as a diffuse corneal edema. Operative history and clinical evaluation can usually help to pick it up. If clinical evaluation is difficult due to a very hazy cornea an AS-OCT or UBM can be helpful in imaging the detached membrane. It is important to identify this condition as the edema in a DMD can be reversed easily by air or gas injection.
4. In patients where the corneal edema is severe limbus to limbus and associated with raised IOP, severe fibrinous inflammation, iris atrophy and a dilated fixed pupil (in the absence of vitritis) a possibility of TASS should be strongly considered. This condition requires a much more aggressive management of inflammation and glaucoma and carries a poorer long-term prognosis. Postoperative Endophthalmitis can also present similarly however is distinguished by the presence of vitreous exudates.
5. Patients with a wound leak with hypotony usually present with stromal edema and DM folds but no epithelial edema. They may have shallow AC and choroidal detachments. Seidel's test can help confirm the leakage.

B) **Localised Edema** – These patients would have a focal or a localised patch of edema and the rest of the cornea is clear. This would indicate a more localized injury to the endothelium. We need to closely look if the margins of the edema patch are fuzzy or sharp and well demarcated.

1) When the edges of the edema are indistinct and the edema slowly reduces as we move to the normal clear cornea it is indicative of an intraoperative surgical trauma like an instrument touch or a focal descemet's injury. Most of these usually recover spontaneously over time.
2) When the edematous and the clear cornea are separated by a sharp distinct margin one should strongly consider the presence of a localized descemet's detachment. (Figure 2)

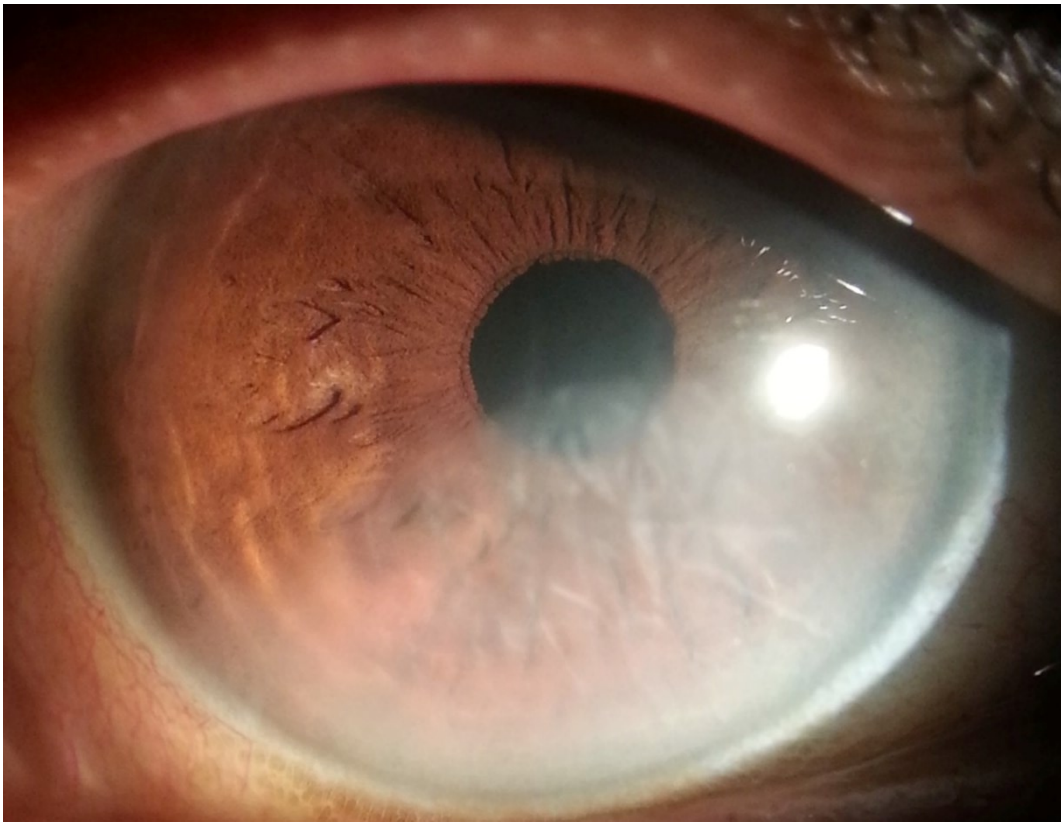

Fig: 2 – DMD with a sharp transition of edematous and clear cornea.

Chapter - 3

DIAGNOSTIC APPROACH TO LATE ONSET CORNEAL EDEMA AFTER CATARACT SURGERY

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Gokhale Eye Hospital, Mumbai

There is no definition for a late onset, but it refers to a patient who had a clear cornea postoperatively for at least a few days or weeks and then develops corneal edema. The diagnostic algorithm (Figure 1) presented here will mainly discuss these etiologies with case examples. Extremely late onset (after more than a year of surgery) has a different set of causes and will be discussed briefly later in this article.

Most of the causes are causally related to the surgical procedure. However, patients with pre-existing corneal disease or low endothelial cell counts, chronic uveitis and glaucoma may develop a late onset slowly progressive corneal edema despite an uneventful cataract surgery. Similarly, a sudden onset of viral endothelitis or a late onset DMD can cause corneal edema after an otherwise uneventful surgery.

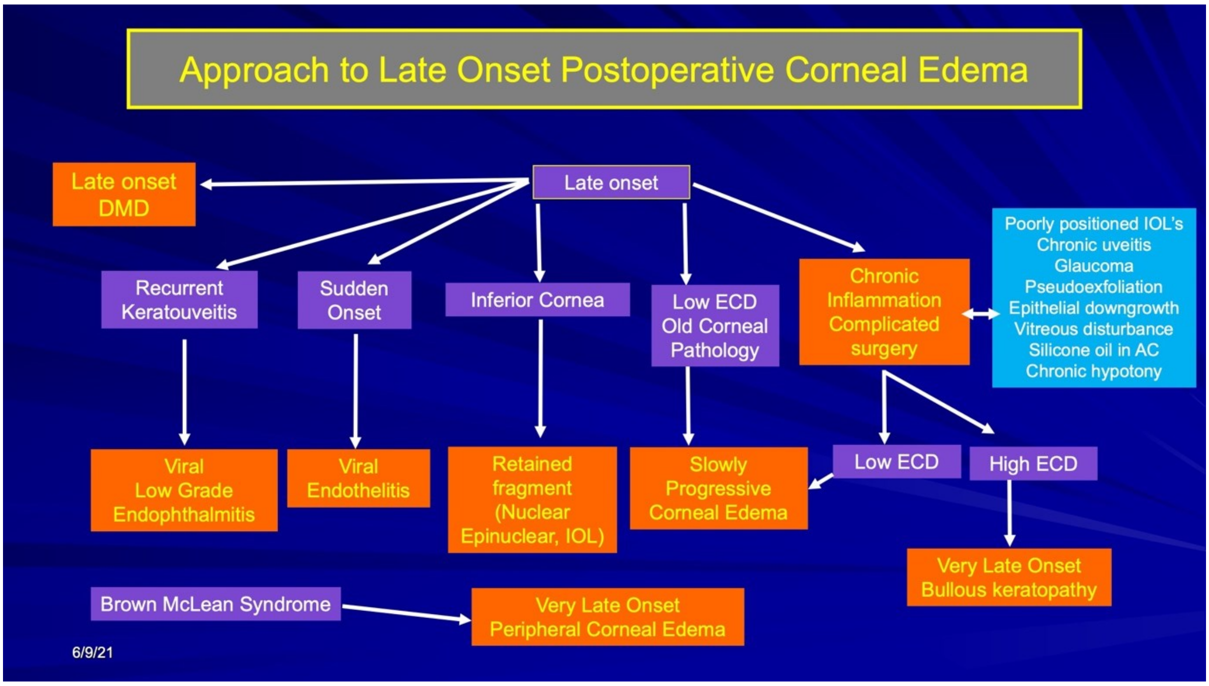

Fig: 1 Diagnostic Algorithm

Retained Lens Fragments

Patients with retained lens fragments typically present with episodes of recurrent inflammation with or without glaucoma following an uneventful surgery. Over a period of time (usually several weeks) corneal edema evolves, typically inferiorly, where the fragment is in constant touch with the endothelium. (Figure 2) If not diagnosed and addressed the edema spreads centrally and eventually can lead to a total corneal decompensation. A late onset inferior corneal edema after an uneventful surgery should raise a strong suspicion of a retained lens fragment. Nuclear or Epinuclear fragments that are typically mobile in the anterior chamber and often have sharp or irregular edges are the usual culprits. Rarely a IOL fragment (Figure 3) like a broken loop or even a descemet's scroll can also lead to corneal edema.[1] Careful slit lamp examination, gonioscopy, AS-OCT and Ultrasound biomicroscopy can all aid in the diagnosis. Immediate removal is the key and if done early, the cornea can recover fully.

Low Endothelial Cell Counts

Patients with pre-existing corneal pathology, poor endothelial function, severe guttata or very low cell counts may have a relatively clear cornea after cataract surgery, however with continued endothelial cell loss, they may show slowly progressive corneal edema. These patients may present with slowly progressive corneal edema after an otherwise uneventful surgery.

Chronic Inflammation / Complicated Surgery

Any surgical complication that causes chronic inflammation or a breakdown of the blood aqueous barrier can lead to accelerated endothelial cell loss. Patients with longstanding glaucoma, pseudoexfoliation, chronic uveitis, vitreous disturbance and poorly positioned IOL's are at a higher risk. Improperly sized or positioned anterior chamber IOL's, PC IOL's with a loop in anterior chamber or uveal touch, single piece acrylic IOL's placed in the sulcus are some of the circumstances which lead to chronic inflammation and may lead to accelerated endothelial cell loss.

In patients with a good endothelial reserve these causes will lead to corneal decompensation years to decades after cataract surgery and can be labelled as very late onset corneal edema.

Viral Endotheliitis

Sudden onset of mild to severe corneal edema associated with KP's, with or without AC reaction has been reported after cataract surgery.[2] These patients may not necessarily have associated signs of previous viral keratitis such as old scars. Most cases present in the first few weeks after cataract surgery (75% within a month) and old age and diabetes are a known risk factor. Though Herpes Simplex and Cytomegalovirus have been identified by PCR testing after an AC tap, the diagnosis is often clinical. Bilateral occurrence following cataract surgery has also been reported. Some patients may have epithelial involvement associated with endotheliitis. Early diagnosis is essential because these patients respond very well and fully resolve with timely steroids and oral antiviral therapy.

Recurrent Keratouveitis

Some patients present with recurrent inflammation associated with corneal edema weeks after surgery which seems to respond to steroids, only to recur on stopping therapy. One must look for KP's, posterior capsular plaques, vitreous involvement, retained lens or nuclear fragments and also rule out viral and primary uveitic pathologies. Identifying the primary cause and distinguishing sterile from infectious etiologies is important in these cases. A high index of suspicion for a low grade endophthalmitis needs to be kept in the back of the mind. These cases are often referred to the cornea specialist but do require an additional vitreoretinal cross reference.

Late Onset Descemet's membrane detachment

Typically a DMD presents in the immediate postoperative period with corneal edema. However in rare instances patients who had clear corneas postoperatively have gone on to develop a DMD after 2-4 weeks of surgery.[3] This has been seen more often with clear corneal phacoemulsification surgeries. Some cases show a DMD that starts in the wound area and then slowly progresses centrally causing a drop in vision. These have also been reported to occur bilaterally indicating a genetic predisposition to poor adhesion of the DM.[4] The management is typically like a routine early onset DMD.

Brown McLean Syndrome

This is a rare form of peripheral corneal edema that presents decades after cataract surgery. It has been reported after intracapsular, extracapsular and even post phacoemulsification surgery. It starts in the inferior cornea and progresses very slowly circumferentially. Subepithelial scarring and pigment dispersion on the endothelium is seen in the edematous cornea. The central cornea is usually spared (but may show guttata) and patients maintain good vision for very long.

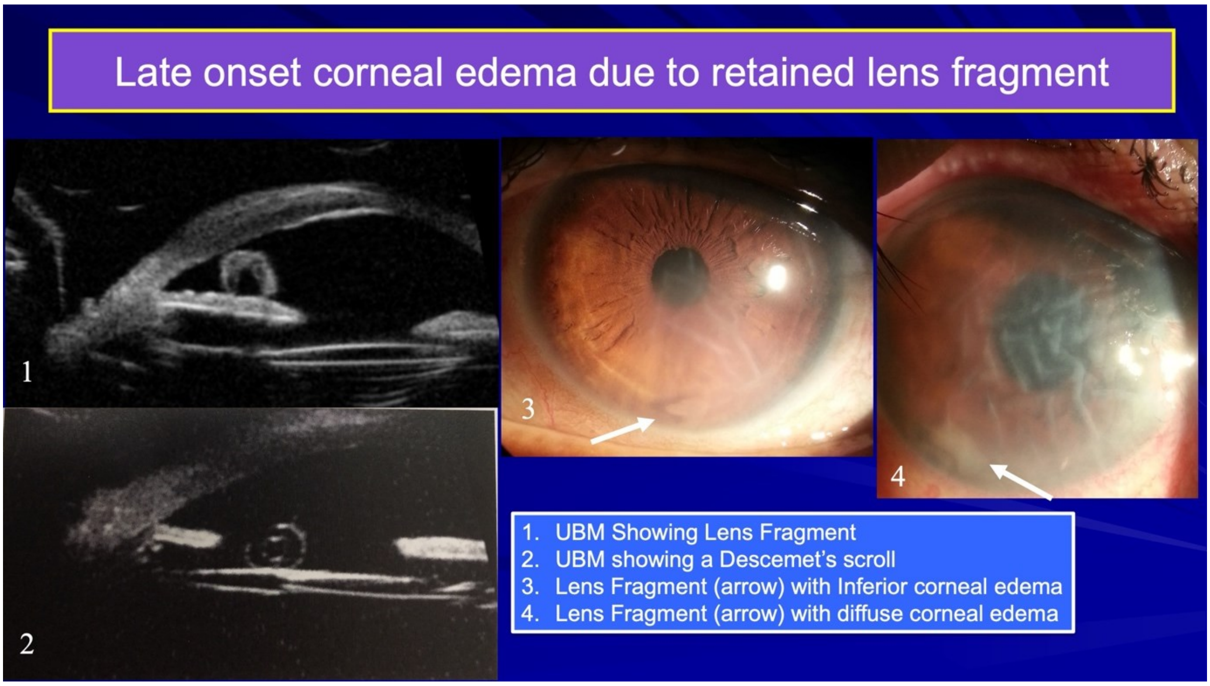
Late onset corneal edema due to retained lens fragment
1
2
3
4
1. UBM Showing Lens Fragment
2. UBM showing a Descemet's scroll
3. Lens Fragment (arrow) with Inferior corneal edema
4. Lens Fragment (arrow) with diffuse corneal edema

Fig: 2

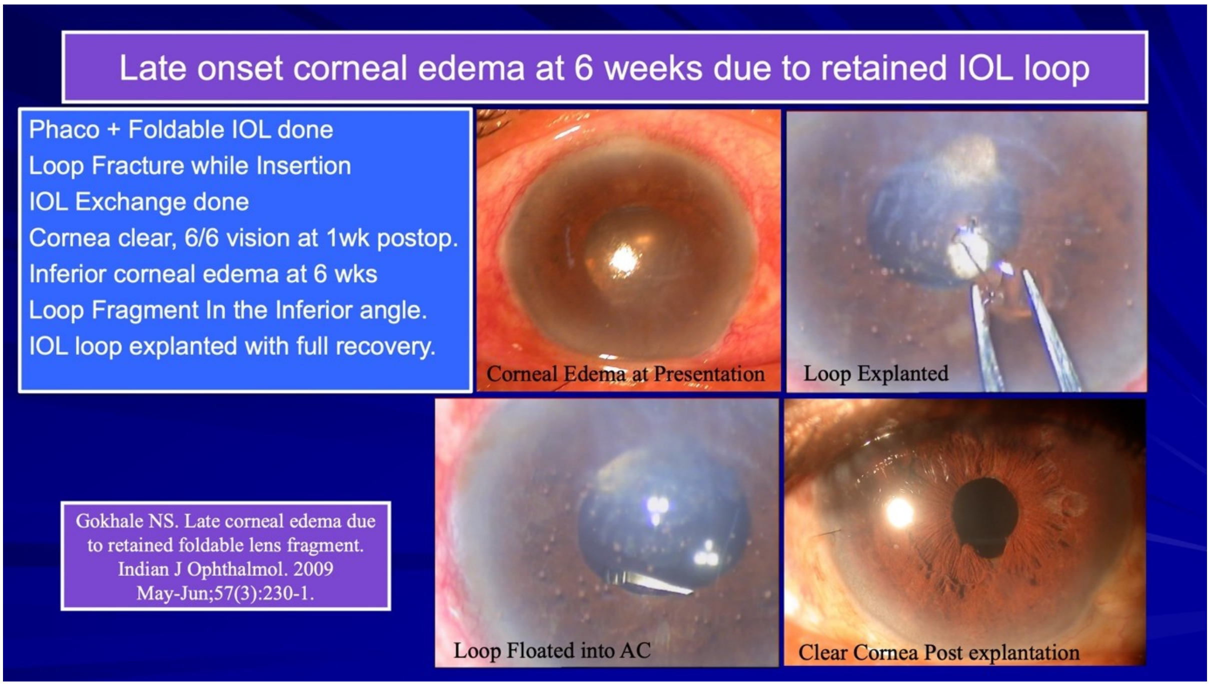
Late onset corneal edema at 6 weeks due to retained IOL loop
Phaco + Foldable IOL done
Loop Fracture while Insertion
IOL Exchange done
Cornea clear, 6/6 vision at 1wk postop.
Inferior corneal edema at 6 wks
Loop Fragment In the Inferior angle.
IOL loop explanted with full recovery.
Corneal Edema at Presentation
Loop Explanted
Gokhale NS. Late corneal edema due to retained foldable lens fragment. Indian J Ophthalmol. 2009 May-Jun;57(3):230-1.
Loop Floated into AC
Clear Cornea Post explantation

Fig: 3

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Chapter – 4

MANAGEMENT OF DESCEMET'S MEMBRANE DETACHMENT

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Developmentally, the Descemet's membrane (DM) has a potential plane of separation from the corneal stroma, predisposing to its easy detachment. This property is used to facilitate the procedure of deep anterior lamellar keratoplasty, retaining the patient endothelium and improving surgical outcomes. However, if this separation occurs inadvertently during cataract surgery, the resulting DM detachment produces corneal edema, vision loss, and if unaddressed corneal decompensation. Understanding the embryological development of the cornea helps us appreciate the reasons for a Descemet's membrane (DM) detachment during surgery. After the lens vesicle separates from the surface epithelium, a wave of mesenchyme forms the primary corneal stroma. A second wave then forms the endothelium, which secretes the DM. Throughout the life of an individual, the DM thickens as the posterior non-banded layer is secreted by the endothelium. The anterior fetal banded layer tends to remain the same. However, in most instances, the separation happens between the DM and the cornea stroma. The thickness of the DM varies between 10 and 15 microns, increasing with age. The DM does not regenerate after any damage.

Although uncommon, a post-cataract DM detachment occurs in 0.26% of extracapsular cataract extraction surgeries, 0.1% of manual small incision cataract surgeries, and 0.04% of phacoemulsification procedures. The DM detachment can occur at any stage of surgery, often while introducing instruments into the eye, or when hydrating the wounds at the end of the procedure. It is especially common in eyes with a dense arcus and shagreen, with endothelial disease, and is often bilateral - leading to speculation that some patients may be predisposed to this complication. Such corneas, with peripheral thickening and Hassal Henle bodies, are especially at risk, partly because of a thickened DM and weak endothelial adhesion, but also because of reduced visibility from the dense arcus, which precludes a view of the inner lip of the incision when instruments are introduced.

Preventing a DM detachment is better than managing one, and attention must be paid to surgical manoeuvres to avoid this complication. Using blunt instruments to create corneal incisions predisposes to this problem, as the tip of the keratome or slit knife may then push on the elastic DM, separating it from the stroma instead of perforating it. The same can happen if the eye is significantly hypotonic at the time of incision creation, as some resistance from the intraocular pressure allows the knife to penetrate the tissues easily. When introducing instruments into the eye, it is essential to ensure that the anterior chamber is formed. With the availability of OVDs, it is easy to form the chamber first before introducing a Simcoe's cannula, phacoemulsification probe, or irrigation aspiration cannula into the eye. It permits the surgeon to depress gently on the posterior lip of the wound at the time of entry into the eye, to avoid catching and stripping the cut edge of the DM at the roof of the entry tunnel. The infusion on the instrument should only be turned on after the probe enters the AC, and the infusion port clears the inner lip of the incision, as the fluid exiting the irrigation ports can strip the DM during the introduction through the tunnel. Such tears at the incision site can fibrose, and predispose to a late onset DM detachment as well. Gentle hydration of the ports after surgery is mandatory, taking care to nestle the opening of the cannula against the stroma in the walls of the corneal opening and not at the entry into the eye to avoid DM stripping. In predisposed eyes, using a superior scleral incision can be considered, as it is easier to manage a superior DM detachment if it occurs.

The DM detachment can be categorised depending on the separation of the DM from the posterior stroma, as this has prognostic significance. Mackool et al classified DM detachment as planar when the separation is 1mm or less, and such detachments can be watched as they can resolve spontaneously. Larger separations are termed non-planar and these need surgery. DM detachments are also categorized as - peripheral or central, superior or inferior, and single or multiple. Delayed onset DM detachments have also been described. These often occur in the setting of tears in the DM at the sites of corneal incisions. As these untreated tears fibrose in the postoperative period, they can separate from the corneal stroma, and a detachment can occur.

As with any surgical complication, early detection, and proper assessment can aid in management. A DM detachment must be suspected when unexpected corneal edema is noted on the day after surgery. In the presence of significant edema, it is not unusual for an underlying DM detachment to be missed unless specifically looked for. If suspected, dilating the pupil may help, as some of the features of a DM detachment may be better seen on retro illumination against the red fundal glow seen with a dilated pupil. When assessing a DM detachment, the following features are essential - configuration, material causing the detachment, presentation of the DM, and area of detachment. These features help in surgical planning and in predicting the prognosis for surgical repair. A hammock configuration is a separation starting at the corneal ports of entry - due to injections during hydration. The fluid enters the aforementioned potential plane, separating the DM sheet to varying extents. The opening in this type of detachment is, therefore, at the site of the port. A detachment with a tear is often from the phaco wound. It may be associated with a DM separation due to the entry of fluid into the DM-stroma interface. The most severe kind is a complete tear separating the detachment into two or more flaps and is due to physical trauma resulting from contact of instruments or the nucleus of the lens during extraction, with the endothelium. The interface material can be air, saline, viscoelastic or blood, and influences the surgical plan. A careful exam is performed that maps the detachment - noting fibrosis, scrolling, and areas of DM loss. Detailed drawings are made in the notes documenting all the above findings to help during surgical repair.

An anterior segment OCT can help differentiate - a loose flap with a tear, hammock, attachment to iris, and DM scrolling. To improve visibility during the assessment, deturgescing the cornea with hypertonic saline or glycerol can help. Various classification and management protocols based on different AS-OCT criteria have been proposed including those by Jacob et al, Sharma et al and Kumar et al. All of these different protocols use the type, extent, and location of the DM detachment to help plan management. Apart from the characteristics of the DM detachment itself, it is essential also to note additional findings like the extent of corneal edema that can preclude visualization during surgery, the presence and stability of an intraocular lens, the integrity of the posterior capsule and the presence of vitreous in the anterior chamber, and any iris defects or synechiae. Assessment of the health of the posterior segment after complicated cataract surgery helps determine the visual prognosis.

Surgical planning requires mapping of the area of detachment, its relation to the wound, and areas of DM attachment, as the latter will serve as portals of entry during the surgery. Areas where the DM is detached, are poor sites for entry ports as manipulation through these areas will worsen the DM detachment. Areas of maximal separation are noted, as the venting incisions can be sited here, to allow removal of the material within the DM detachment. A single, hammock type, superior separation, presenting early, has a good prognosis. Fibrotic, torn membranes with loss of DM and interface viscoelastic have a more guarded prognosis. Peripheral, planar detachments, with a clear central cornea, can be observed.

Surgery is best performed under periorbital anesthesia, as repeated anterior chamber entry, pressurizing the chamber, and the duration of surgery make topical anesthesia suboptimal. To improve visibility during surgery, hypertonic saline or glycerol help reduce epithelial edema, dilating the pupil enhances visibility against the red reflex, a light pipe provides tangential illumination to improve DM scroll visibility, and if necessary, removing the corneal epithelium can help. Accessing the AC requires paracenteses, which are sited in areas of attached DM, typically perpendicular to the area of detachment, and sometimes, multiple ports are required. After making the paracentesis, a small air bubble is injected into the anterior chamber. Venting incisions are made to evacuate fluid from the interface after removing corneal epithelium at the site, to avoid the possibility of epithelial ingrowth. The site of venting incision is chosen at the site of maximal separation, and away from the visual axis. Careful entry using a sharp knife is made into the cavity of the detachment and is stopped at the first sign of egress of fluid. The air in the anterior chamber serves to facilitate this maneuver since the escape of air through the vent implies a full-thickness incision in the cornea. However, a large air bubble must be avoided, as the pressure in the anterior chamber can result in an upward movement of the DM and injury, when the detachment cavity is decompressed by the venting incision. If there is a DM scroll, small amounts of air or saline can be used with a 30G cannula or stroking maneuvers on the surface can be used to unfurl the DM, and direct manipulation is best avoided **(Fig 1)**.

Figure 1 - DM detachment repair – Technique

1. Inferior paracentesis - at the site where the DM is attached

2. Inferior peripheral iridotomy to minimize the chance of pupillary block postoperatively

3. Removing corneal epithelium at the site of venting incision

4. Venting incision away from the visual axis, at the site of maximum separation of the DM (noted during preoperative slit-lamp evaluation)

5. Fluid egress at the site of venting incision indicating entry into the pocket of DM detachment

6. Complete air fill at the completion of the procedure

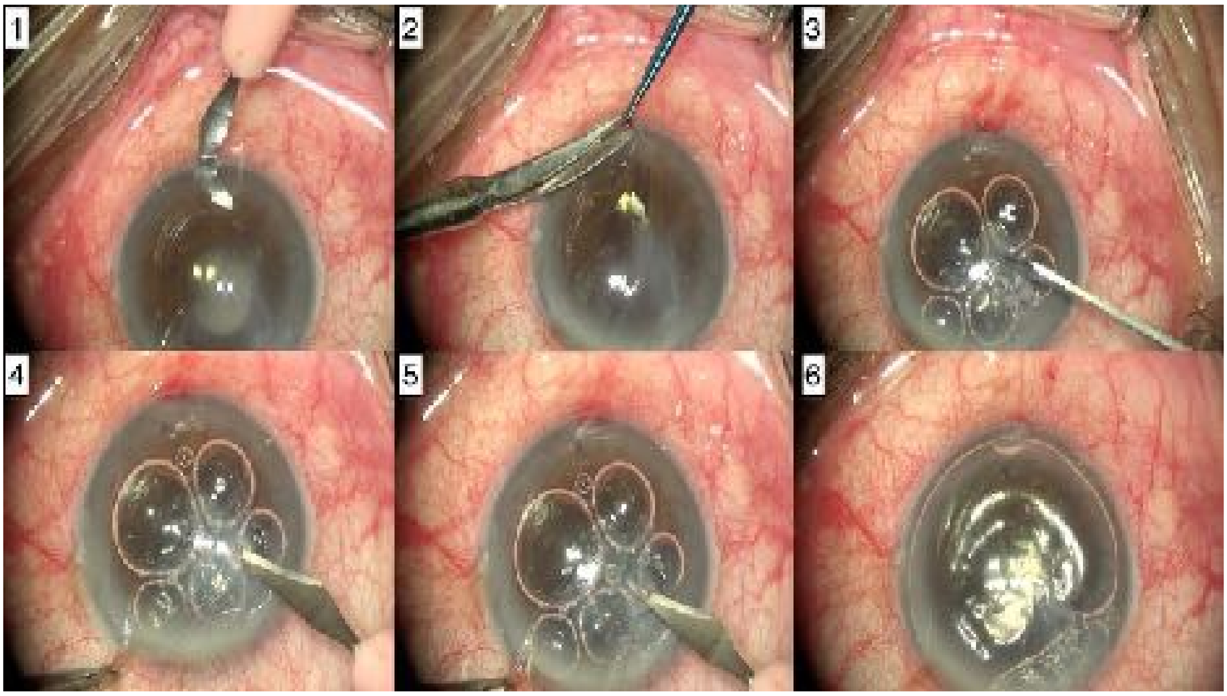

Fig: 1

A choice of tamponading agents is available. For hammocks, air is used, while detachments with tears will require a long-acting agent, like 20% SF6 or 14% C3F8. When there are tears, hanging membranes and fish mouthing at the wound, full-thickness 10-0 nylon sutures, with buried knots are used, avoiding the visual axis, to anchor the DM. After the use of a tamponading agent, proper head positioning is important, and a pupillary block must be avoided with an inferior iridotomy, dilating the pupil, and burping air at the slit lamp in the first hour after surgery, when necessary.

Although the DM is often successfully repositioned at the conclusion of surgery, the endothelial pump needs time to create the attachment forces that prevent a re-detachment of the DM. Hence, for the first few hours after surgery, proper positioning of the patient's head is essential to allow the air to tamponade and promote the attachment of the DM. In central detachments, a supine position without pillows is helpful, while in superior detachments, a reclining position in the bed allows better tamponade. Inferior detachments require hyperextension of the neck to allow the air in the chamber to tamponade the inferior DM, and it is often difficult for the patient to maintain this position for more than a few hours. Usually, the attachment is achieved in the initial postoperative period, and if successful, the DM is attached on the first postoperative day. The air bubble in the AC is absorbed over varying periods, and if it occupies a significant portion of the chamber, positioning is maintained over the next few days. If long-acting gases are used, in more complicated configurations of the detachment, they can take between 2 and 3 weeks to get absorbed, and flying in unpressurized aircrafts must be avoided during this time. With the use of any tamponading agent, pupillary block and increased intraocular pressure in the postoperative period is possible and must be carefully monitored. Routine postoperative medications include topical antibiotics, steroids, and cycloplegic agents. If there is residual edema in the early postoperative period, hypertonic saline drops and ointment can help speed up the resolution of corneal clarity.

If performed using the principles outlined, the success rates are 70 to 75%, especially in uncomplicated DM detachments **(Fig 2)**.

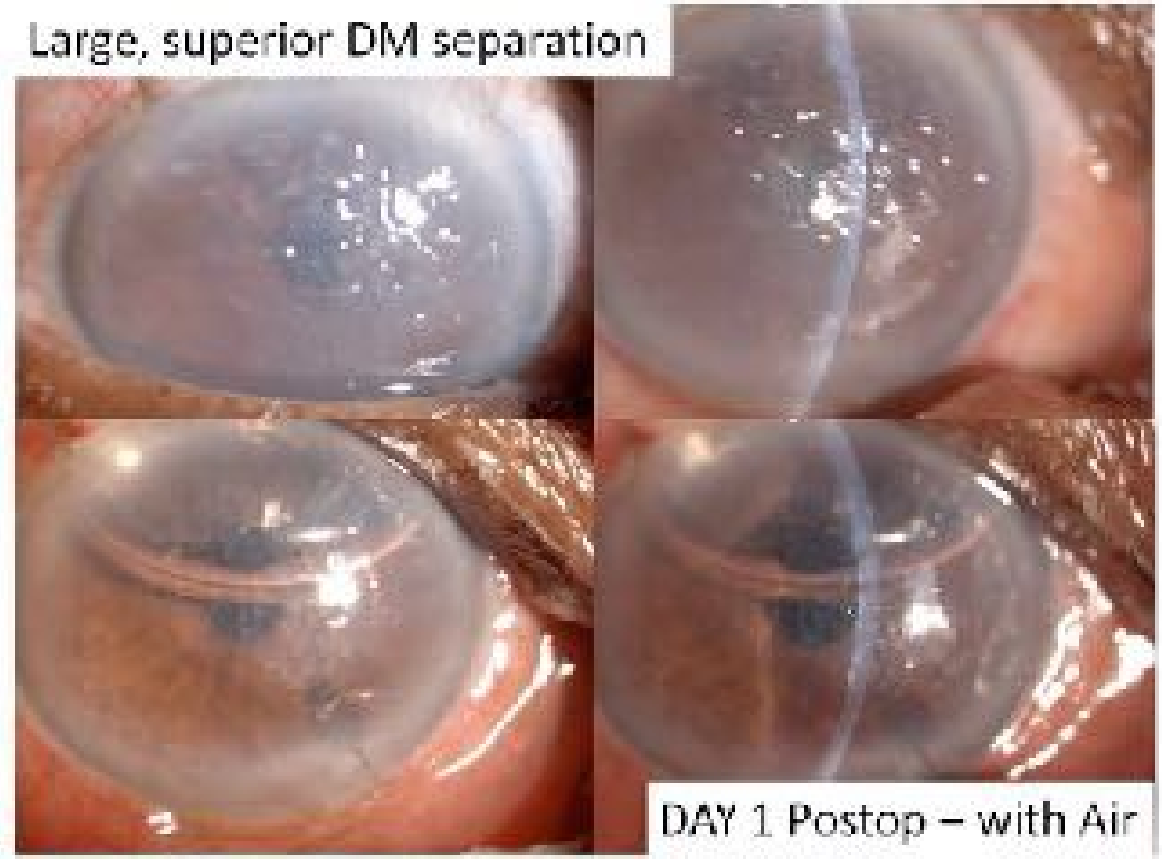

Fig: 2 - Pre- and postoperative pictures of an eye with DM detachment, following surgical repair

However, complications are possible as the surgical maneuvers can sometimes result in trauma, further separation, and tearing of the DM. The site of the venting incision can predispose to epithelial ingrowth, and the full-thickness corneal sutures used to secure hanging flaps of DM can serve as portals of entry, allowing the spread of infections into the cornea or the eye. Sometimes, especially in extensive detachments, despite following the principles of repair, the DM fails to reattach partially or wholly. In such situations, while further injections of air can be tried, recourse to corneal replacement surgery may be required.

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Chapter - 5

TIPS FOR CATARACT SURGERY IN EYES WITH COMPROMISED ENDOTHELIUM

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Excellent unaided vision on the day after cataract surgery using present day techniques is the expectation of both the patient and the surgeon. One of the reasons that this is not achieved is corneal edema. Although this is often transient and does not interfere with the long-term visual outcome following cataract surgery, in some eyes it can be permanent, necessitating further corneal surgery for rehabilitation. In eyes with conditions like Fuch's endothelial dystrophy and advanced corneal changes, combining cataract surgery with a corneal replacement procedure is performed, and the factors that aid decision-making in this situation have been discussed in another section. In eyes with a compromised endothelium (see section on corneal evaluation before cataract surgery), it may be possible to minimise surgery induced damage by following certain steps and these will be highlighted in this section. This is extremely important since a study has shown that corneal surgery in eyes with guttate changes may result in 24% endothelial cell loss, compared to about 10% in eyes that do not have these changes.[1] Although these pointers are essential during surgery in eyes with a weak endothelium, they will also help during cataract surgery in eyes with a normal cornea and in those with other factors that increase the technical difficulty of cataract surgery.

These risk factors include increasing age, female sex, prior ocular surgery, past infections or trauma, pseudoexfoliation, diabetes mellitus duration longer than 10 years, renal insufficiency, and chronic pulmonary disease, which are known to be associated with increased endothelial cell loss after cataract surgery, and ocular conditions like extensive corneal shagreen, a very shallow anterior chamber (AC), angle closure glaucoma, a small pupil, use of tamsulosin preoperatively, or a very dense cataract which either in isolation or in combination, increase the surgical time and complexity, thereby promoting endothelial damage. When planning surgery in such eyes, apart from considering these preoperative factors, one must pay attention to the cataract surgical technique, incision site, phacoemulsification technique and parameters, the irrigating solution used and the choice of ophthalmic viscoelastic device (OVD).

It has been shown that while phacoemulsification and manual small incision surgical techniques (SICS) are both safe and effective in normal eyes with similar endothelial cell loss rates, manual SICS may be better in eyes with dense cataracts. This may be because the nucleus is extracted quickly and hence with greater endothelial safety, provided of course that the wound size is adequate to allow easy extraction of a large nucleus, and adequate viscoelastic - which can be hydroxypropylmethylcellulose (HPMC), is used to protect the endothelium. As the degree of endothelial compromise in an eye increases, a larger incision and in toto nucleus extraction, with two instruments, viz., a Sinskey hook on the top and a vectis in the bottom, may be preferable to techniques that require nucleus hemi- or tri-section in the AC, which has the potential to increase endothelial damage. The use of an AC maintainer to provide a “pushing” force and keep the AC formed during extraction is also preferable.

If phacoemulsification is chosen as the method of choice, then it is imperative that the surgeon is confident about his surgical skills, and is using a phacoemulsifier with advanced fluidic systems in order to minimise the time spent in the AC for nucleus removal, and minimise AC volume fluctuation due to factors like surge. It is also ideal to use a device that allows torsional phacoemulsification as this has been shown to be associated with less heat generation at the wound, reduced chatter of the nuclear material, and lower energy levels and less endothelial time.[2] A Kelman tip is preferred as it offers greater efficiency and the bent tip works at a deeper plane, away from the endothelium. There is not much evidence supporting the use of a Femtosecond laser in this situation, although there is a theoretical benefit from the nucleus cleavage which necessitates less phaco time, but the procedure is also known to generate more free radicals in the AC and cause pupillary constriction, both of which can compromise the endothelium. Causes for endothelial trauma during phacoemulsification include mechanical trauma, hydrodynamic, heat, chemical, and free radical formation induced changes. Mechanical trauma can be limited by appropriate phaco parameters of energy, flow rate and vacuum that allow a controlled removal of the nucleus with minimal heat generation, chatter of nuclear fragments and chamber collapse. The less time spent in the AC for nucleus removal, the better. A larger capsulorhexis that does not restrict removal of nuclear pieces, thorough hydrodissection to allow easy access to all parts of the nucleus, a chopping technique which is faster than divide-and-conquer, and division of the nucleus into smaller segments that can be removed in the plane of the capsular bag, avoiding iris plane and AC emulsification would also help lessen hydrodynamic damage. Torsional phaco reduces heat and avoidance of intracameral agents, unless absolutely necessary would reduce the risk of chemical induced damage, as would proper sterilisation techniques of hollow bore instruments.

In eyes with a weak endothelium, a scleral tunnel incision is considered better as it minimises corneal trauma, both during creation of the incision and during repeated instrument entry through the wound. A scleral wound can also be extended with less corneal trauma, in the event of a complication which requires wound enlargement. Adhesional forces of the Descemet's membrane and endothelium can be weaker in eyes with guttae and hence care must be taken to minimise the number of times the AC is entered with instruments through the wound, taking care to enter the eye with the AC filled with OVD, entering with the instrument bevel facing down, and turning on irrigation after the ports of the probe have entered the AC. Similarly, greater care must be taken when hydrating corneal incisions in such eyes to avoid DM stripping, and wound closure with a suture may be prudent as the compromised endothelium may not produce a perfect seal at the inner lip of the incision. There is no convincing evidence in literature that micro-incision phaco surgery with a smaller tunnel reduces endothelial damage.

Hank Edelhauser showed that the irrigating solution used is more important to endothelial survival than irrigation time.[4] Although the off-label use of Ringer's Lactate (RL) for cataract surgery is common in India and generally produces good results, a solution that closely resembles the composition of the aqueous humour is considered to be safer in eyes with compromised endothelial function. The ideal solution should have a pH between 6.7 and 8.1 and osmolarity between 270 and 350 mOsm/kg, as this helps to maintain the endothelial ultrastructure and the junctional integrity of the cellular layer. Thus, while balanced salt solution or BSS is better than RL, in eyes with weak endothelium BSS plus is preferred as it contains buffers and other ingredients that help protect the endothelium. The composition of the three irrigating solutions is given below in a comparative **Table**, and while BSS plus may not be necessary in all eyes, it can offer additional protection and safety in eyes with endothelial compromise, although it comes at a cost.

Composition mg/ml solution	RL	BSS	BSS plus
Sodium chloride	6	6.4	7.14
Potassium chloride	0.3	0.75	0.38
Calcium chloride	0.2	0.48	0.154
Magnesium chloride	-	0.3	0.2
Sodium lactate	3.1		
Sodium acetate	-	3.9	-
Sodium citrate	-	1.7	-
Sodium phosphate	-	-	0.42
Sodium bicarbonate	-	-	2.1
Dextrose	-	-	0.92
Glutathione	-	-	0.184
HCL NF or NaOH NF	Used as buffer to adjust pH		
Water for injection	Used to make up the volume (500 ml)		
pH	6.2	7.5	7.4
Osmolarity	275	300	305
Cost (approximate) - INR	50 too 100/-	650/-	1750/-

Since the endothelium is the roof of the AC and hence sustains trauma during AC phaco, an OVD can be used to protect the cells, increase anterior chamber space, and allow more gentle tissue manipulation. Cohesive OVDs have greater viscosity and are used for their better visibility and space maintenance properties. However, their cohesive properties also allow easier removal from the AC, and dispersive OVDs which are removed piecemeal stay longer in the eye. In order to use the benefits of both, Dr Steve Arshinoff suggested the soft shell technique, in which a bolus of dispersive OVD, like chondroitin sulphate is injected in the AC, and a cohesive OVD like sodium hyaluronate then injected in the center of the bolus to push the dispersive OVD against the endothelium prior to phacoemulsification, as shown in the **Figure**.[1] Similarly to enable easier removal of the OVD after intraocular lens placement, the reverse is done so that the outer layer of cohesive OVD allows easier removal of the dispersive OVD with less AC irrigation time at the conclusion of surgery. These agents can be used as two separate components viz., cohesive - sodium hyaluronate as - 1%, 1.4% or 2.3%, and dispersive - HPMC 2% or chondroitin sulphate 4%. Of the latter two, chondroitin sulfate is available in combination with 1.6% sodium hyaluronate. Although the protective properties of chondroitin are superior to HPMC, it is more expensive. To counter this, frequent use of HPMC in the AC, often at 1-minute intervals during phacoemulsification, can be used to protect the endothelial cells. However, the repeated stoppage and increased number of instrument entries into the wound must be factored with this approach. There are manufacturers who provide a combination of the two - cohesive and dispersive OVD as 2 separate syringes in one pack for use during different stages of the procedure. Another approach is to combine both OVDs in one syringe to try and get the beneficial properties of both. Finally, while sodium hyaluronate is a cohesive OVD, the product Healon 5 which uses a 2.3% sodium hyaluronate, is classified as a Visco-adaptive OVD, since it can change its rheology. It is more viscous at low flow rates allowing space maintenance during AC manoeuvres, but becomes pseudo-dispersive at higher flow rates for better endothelial protection during phacoemulsification.

In summary, paying attention to the risk factors, type of surgery, incision construction, phacoemusification parameters and technique, the irrigating solution and OVD used can help achieve better outcomes after cataract surgery in eyes with a compromised endothelium.

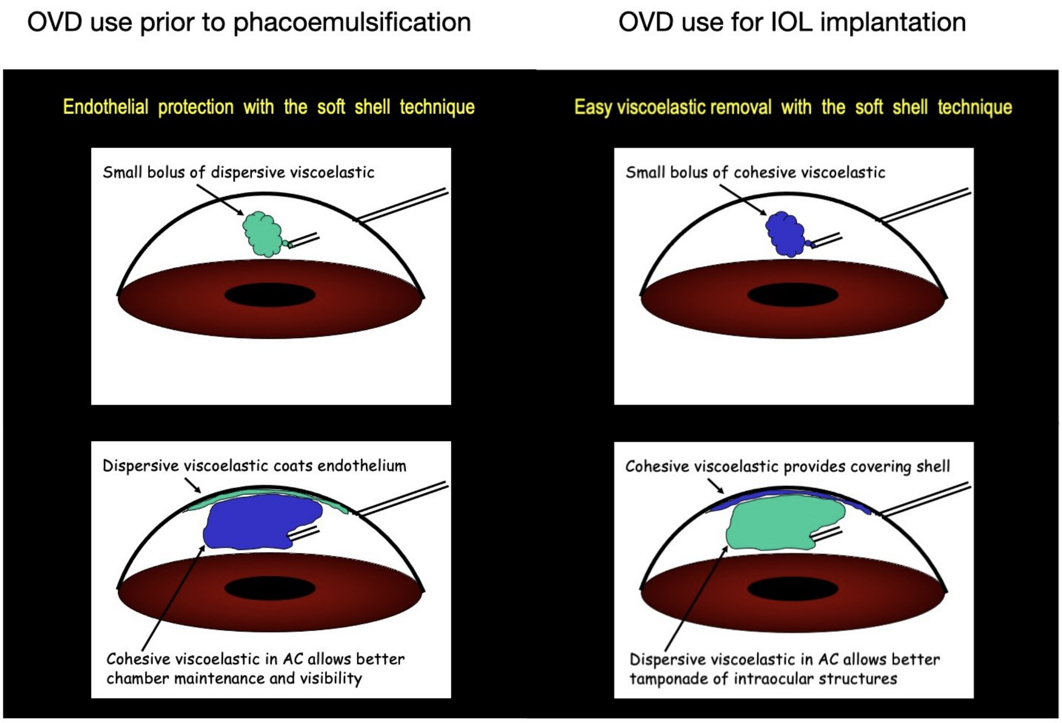

Fig: 1

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Chapter - 6

OCULAR SURFACE EVALUATION BEFORE CATARACT SURGERY

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A healthy ocular surface is vital for comfort and clear vision, and an important factor in maintaining the normal homeostasis is the tear film. As we age, there is a deterioration in the quantum and quality of tears, especially in women following menopause, and since cataract is also prevalent in this age group, it is imperative to ensure the health of the ocular surface before performing the surgical procedure. An unhealthy ocular surface can interfere with preoperative planning - intraocular lens (IOL) power, axis and magnitude of the toric IOL, keratometry and topo- or tomographic assessment of the cornea.[1] In the presence of tear dysfunction or surface irregularity the ability to measure corneal curvature and astigmatism is compromised and especially if a premium IOL is being planned, can result in suboptimal visual outcomes. Healing of the surgical wounds can be delayed if ocular surface disease (OSD) is not managed pre-operatively. The most common cause of infections after cataract surgery are from commensals on the lid margin and hence, the presence of lid margin changes and meibomean gland dysfunction (MGD) must be detected and managed before surgery. Finally, studies have shown that post-operative dry eye disease (DED) is the major cause of patient dissatisfaction (35%) after well performed cataract surgery and can interfere with quality of life indices.

This is an important area of concern because cataract surgery is the most commonly performed ophthalmic procedure today. It has been noted that approximately 50% of patients undergoing cataract surgery have OSD, but the majority are asymptomatic. It has also been noted that up to 87% of patients with pre-existing dry eye become symptomatic after cataract surgery.[2] This is because cataract surgery has been shown to worsen various ocular parameters and aggravate dry eye, and can also induce dry eye. These changes can be seen as early as 1 day after surgery, and peak by about 1 month, and usually return to the pre-operative baseline by 3 months, although they can persist for longer in some eyes. Hence, the American Academy of Ophthalmology PPP suggests that all patients undergoing cataract surgery be screened for OSD.[3]

When evaluating for OSD in these patients, it is important to be aware of risk factors that predispose to this condition. These include increasing age, female sex, prior corneal surgery like LASIK, diabetes mellitus, rheumatoid arthritis and other mixed connective diseases, smoking, the use of medications like anti-depressants and conditions like Stevens-Johnson syndrome (SJS) , ocular cicatricial pemphigoid (OCP) and graft-versus-host disease (GVHD) - all of which can be associated with significant DED. Although the focus is on DED, since it is the most common subtype of ocular surface dysfunction, there are also other conditions which can present along with or masquerade as DED. These include blepharitis, MGD, epithelial basement membrane (EBM) dystrophy, Salzmann's nodular degeneration, pterygium, allergic conjunctivitis, conjunctivochalasis, floppy eyelid syndrome and others. Assessing the ocular surface health requires paying attention to patient symptoms, clinical evaluation of the ocular surface and the use of tests.

The American Society for Cataract and Refractive Surgery has suggested an algorithmic approach for ocular surface evaluation prior to cataract surgery.[4] A modified Standardised Patient Evaluation of Eye Dryness (SPEED II) questionnaire is used to document patient symptomatology, as this is specific for patients undergoing surgery. They suggest that the next step is to perform two objective point-of-care tests. The TearLab® device is used to measure tear osmolarity and a value greater than 307 mOsm/L or a difference between the two eyes of greater than 7 mOsm/L is considered significant. Heteroscedasticity or increased variability on repeated testing is also important. The second test is performed using the InflammaDry® test to detect matrixmetalloproteinase-9 (MMP-9) levels greater than 40ng/ml in the tear sample, as this suggests the presence of inflammation on the ocular surface. If any of the above 3 are positive, it is considered that the patient is at risk for OSD after cataract surgery. They then perform objective tests, although they mention that these are optional. These tests include lipid layer thickness measurement, meibography, NIBUT, tear meniscus height measurement, tear lactoferrin level, topo- or tomography, aberrometry and objective light scatter.

Whether these objective tests are performed or not, a clinical exam is essential. In order to remember the testing order, they suggest the following - Look, Lift, Pull, and Push. Look refers to an assessment of the blink quality and quantity, lid malposition, lagophthalmos, proptosis and exposure, entropion or ectropion, trichiasis, subjective assessment of the tear meniscus height, anterior and posterior blepharitis, the interpalpebral ocular surface for congestion and irregularities, and the cornea for punctate epithelial erosions or superficial punctate keratitis. Using fluorescein to stain the ocular surface allows easy detection of these changes. Lift and Pull refers to the upper lid. Elevating the lid allows assessment of the superior cornea and limbus for conditions like superior limbic keratoconjunctivitis, superior EBM dystrophy, lid laxity and floppy eyelid syndrome. Finally, Push refers to the pressure exerted on the lower lid either using a device like the Korb evaluator or the thumb to study the quantity, quality and flow of meibum from the gland orifices.

Based on the information from the above evaluation, they suggest that the condition be termed visually significant OSD (VS-OSD) - if there is corneal staining, dry eye affecting vision requiring the patient to blink frequently to see clearly, or the SPEED II score is > 8. These patients are required to undergo management of the OSD and depending on the condition of the surface, this can take 4 to 6 weeks, before they can undergo surgery. Changes that are not significant are categorised as non-visually significant OSD (NVS-OSD) and these patients can undergo cataract surgery without further delay.

The various factors known to increase the occurrence of OSD after cataract surgery include - increase in extent of surgical incision, the operating time, excessive irrigation of the ocular surface with saline during the procedure, microscope light exposure, povidone-iodine irrigation to prepare the ocular surface for surgery and the use of peri-operative drops - both with and without preservative. The suggested hypotheses by which these factors induce damage are - transection of the corneal nerves by the incision, toxicity from the drops and povidone-iodine, microscope light induced damage, elevation of inflammatory markers from ocular surface damage during surgery, and loss of goblet cells due to exposure and damage. The changes noted in the ocular surface after cataract surgery include - increase in OSDI scores, decrease in TBUT and Schirmer test values, increase in fluorescein staining, decrease in goblet cell density and decrease in sensitivity at the corneal centre and over the temporal incision. Hence, it is important to recognise the factors that put the ocular surface at risk, and aggressively treat such patients prior to the cataract surgery. Although these changes can also be treated after cataract surgery, as mentioned previously, pre-treatment improves the safety and outcomes of the surgical procedure.

Another interesting finding that was described by David Hardten is the ocular surface stress test. When patients present to the clinic, they wait before they see the optometrist, who performs vision testing, uses topical aesthetic and performs contact tests like tonometry. The patient again waits and is dilated with drops before finally meeting the ophthalmologist 90 to 120 minutes later. At this time, if a haze is seen in the corneal epithelium, which takes up fluorescein stain, he suggested that the finding represented a stressed ocular surface that could not withstand the rigours of a normal eye exam and that such patients must be evaluated in more detail for OSD.

Since proper exposure is vital for safe cataract surgery, the evaluation should also note the presence and extent of symblephara - seen in SJS, OCP, GVHD and after chemical or thermal injuries to determine if a speculum can be placed. The presence of scleral thinning suggesting past scleritis and corneal scars suggestive of past immune melts must be noted as in the former, a corneal incision and in the latter, a scleral incision may be prudent. A systemic evaluation and preoperative immunosuppressants may also be required. Evidence of past viral keratitis may suggest the need for peri-operative antiviral therapy to prevent a recurrence. The presence of extensive pterygia and corneal scars is noted as this may require a change in the position of the surgical incision and can interfere with visualisation of the surgical maneuvres in the anterior chamber. Excessively small or large corneal diameters, and very thick or thin corneas must also be noted as these can have implications for the surgical technique, choice of intraocular lens (IOL) and wound integrity. Finally, irregularities in corneal shape may require special attention to IOL power calculations.

In summary, a significant proportion of elderly patients presenting for cataract surgery have pre-existing OSD - the commonest of which is DED, but other conditions may co-exist. These can interfere with the planning, surgical and visual outcomes of cataract surgery, and also result in patient dissatisfaction after the procedure. Hence, it is important to assess all patients undergoing cataract surgery for the presence of OSD using patient questionnaires, careful clinical evaluation, and objective tests. It has been shown that traditional tests like Schirmer, TBUT and surface staining are sufficient to detect the presence of changes in the ocular surface, if more sophisticated instrumentation is not available. If detected, it is important to address these changes and restore the ocular surface health before performing surgery, to achieve optimal outcomes.

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Chapter - 7

APPROACH TO DRY EYE / SURFACE PROBLEMS AFTER CATATRACT SURGERY

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Cataract surgery is one of the most successful procedure with excellent visual outcomes. However, the occurrence of dry eye and surface problems postoperatively can transform such a patient into a very unhappy and frustrated patient. This is often because these patients are not detected early and not treated appropriately and they don't seem to feel the improvement with the late treatment. The incidence and prevalence of dry eye after cataract surgery is reported between 9.8 – 34%.[1] We need to evaluate patients for dry eye disease preoperatively and take steps before, during and after surgery to tackle these problems and avoid unhappy patients after surgery.

Possible Causes of Dry Eye after Cataract Surgery

PREOPERATIVE FACTORS	INTRAOPERATIVE FACTORS	POSTOPERATIVE FACTORS
Old Age	Preserved Eye Drops	Preserved Eye Drops
Pre-existing Dry Eye	Incisions	NSAID eye drops
Meibomian gland Dysfn.	Sutures	Antibiotic eye drops
Long term use of drops	Suction Ring (FLACS)	Inflammation
Preoperative Eye Drops	Surgical time	
Ocular Surface Disease	Irrigating solutions	

Pre-operative Factors

Dry Disease is prevalent in 5-50% of adult population and is much higher in the elderly age groups.[2] Asymptomatic meibomian gland dysfunction (MGD) is also common in the elderly age group.[3] Established and asymptomatic dry eye and MGD are therefore a common occurrence in patients undergoing cataract surgery. Elderly patients using eye drops (especially with preservatives) for a long period time of time may also have ocular surface problems. Glaucoma patients typically are at a high risk of having a dry eye that could worsen following surgery. Patients with pre-existing ocular surface disease or corneal pathology may also be at higher risk of post-surgery dry eye. Use of several types of preserved drops in the preoperative period may add to the problems in high-risk patients.

Intraoperative Factors

Frequent instillation of antibiotic drops, mydriatics and anesthetic drops can all cause ocular surface toxicity especially if they contain preservatives like benzalkonium chloride. Irrigating solutions, microscope light and the surface dry up (if not moistened constantly) may all cause injury to the ocular surface epithelium. The presence of the lid speculum and the inability to blink also hampers the tear film dynamics. Prolonged operating time tends to increase the impact of these factors on the surface. The suction ring during the femtosecond procedure may cause additional injury leading to hyperemia, inflammatory edema and goblet cell damage.[4] Large incisions also damage the corneal nerves and contribute to postoperative dry eye. Sutures especially if tight, lead to a dellen effect and cause surface dryness.

Post-operative Factors

The use of medications following surgery can cause ocular surface problems by a dual mechanism. Medications themselves can cause direct toxicity in addition to the preservative induced toxicity. Frequent instillation of antibiotics, NSAID drops and steroids may all work together to worsen and precipitate a dry eye. (Figure 1) The inflammation that follows any surgery may additionally impact the ocular surface. Pre-existing dry eye with delayed tear clearance and ocular surface disease are the most important risk factors predisposing a patient to the risk of medication toxicity.

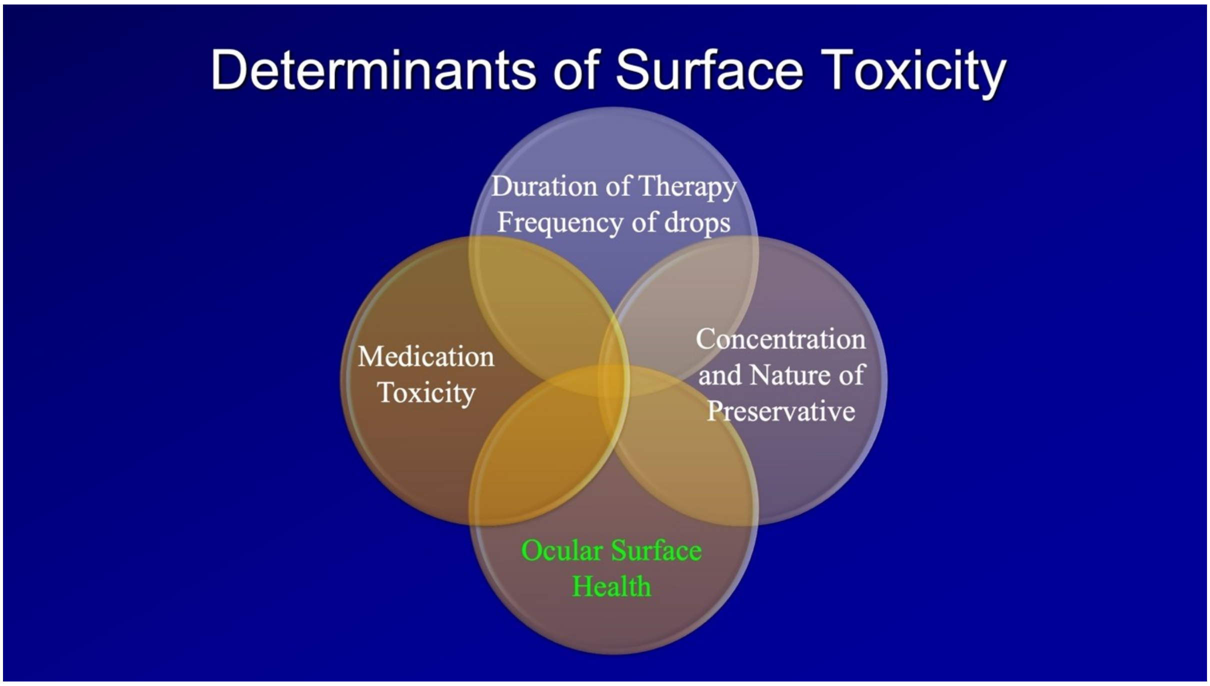

Fig: 1 Determinants of Ocular Surface Toxicity

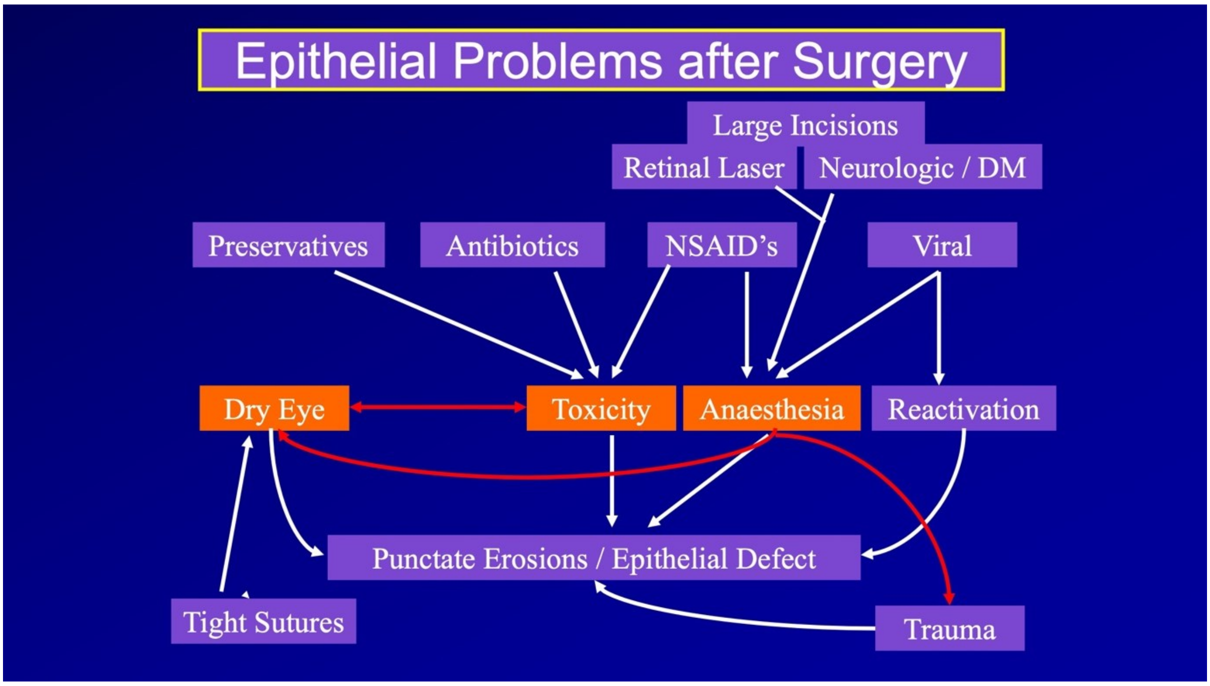

Fig: 2 Mechanisms of Epithelial Problems after Cataract Surgery

Mechanisms Algorithms and Management

Figure 2 shows the mechanisms involved in eventually causing a dry eye and epithelial breakdown with positive ocular surface staining. Preservatives, antibiotics and NSAID's all can cause epithelial toxicity. This toxicity is exaggerated in patients with pre-existing dry eye with delayed tear clearance. Damage to corneal nerves can cause a reduction in the afferent inputs from the ocular surface and can delay epithelial healing and also cause a 30% drop in tear production. Pre-existing corneal or ocular surface disease such as dry eye, old viral scars, previous retinal laser (with burn injury to the ciliary nerves) or systemic disease such as diabetic neuropathy may impair corneal nerve function and predispose these patients to postoperative dry eye and surface breakdown. Large surgical incisions may also severe corneal nerves and predispose to neuropathic changes after surgery. Patients with corneal anesthesia are also prone to injuries with the eye drop bottle tips (as they do not feel the pain on touch) which can cause corneal abrasion's.

Figure 3 shows the cycle of progression in a dry eye patient if not detected or treated appropriately. Most patients would present initially to the cataract surgeon with non-specific symptoms of redness, irritation and watering. These symptoms are often not evaluated critically and sometimes treated with an increase in frequency of drops or the addition of more drops. The patients often get worse with more drops and may develop punctate corneal staining. If missed at this time, they evolve into more confluent and diffuse punctate staining and pseudo-dendritic figures. Antivirals are sometimes prescribed at this stage which make matters worse. These patients may develop epithelial defects and if persistent run the risk of progressing to corneal melting and secondary infection. Though rare a corneal surgeon may see patients referred in these late stages when the treatment becomes extremely difficult.

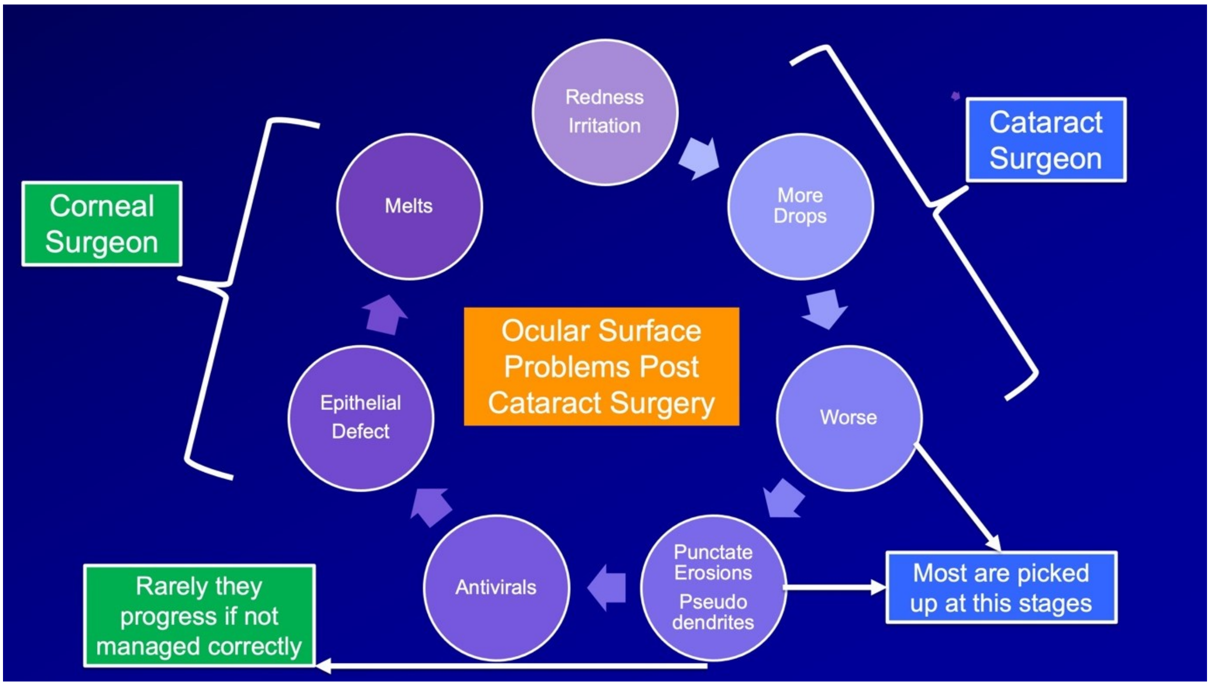

Fig: 3 Progression of Dry Eye and Ocular Surface injury after surgery

Figure 4 shows the recommended approach to avoid postoperative dry eye after cataract surgery. A dry eye evaluation inclusive of symptom scores, meibomian gland evaluation and surface staining should be done in all patients. Established dry eye patients must be treated before cataract surgery. Extra care must be taken pre, intra and postoperatively in all patients with established dry eye and in those with risk factors for a dry eye. All patients especially those at risk need a closer observation postoperatively and an aggressive management if they do develop a dry eye.

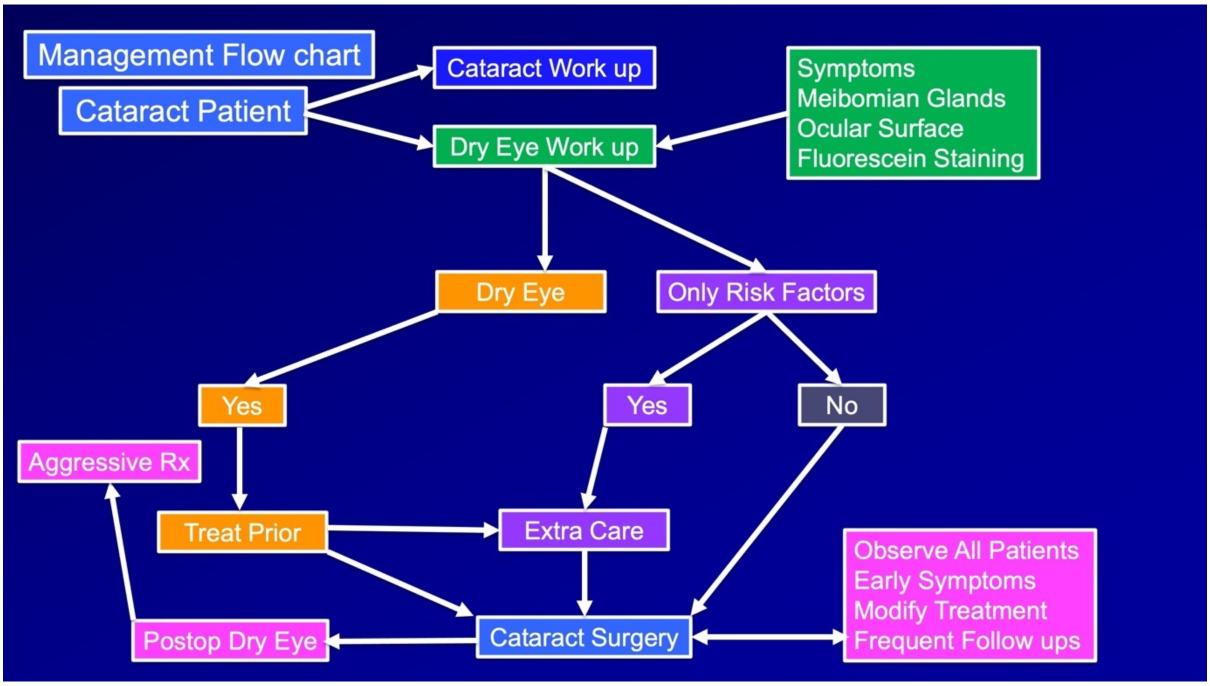

Fig: 4 Cataract Management Flow chart

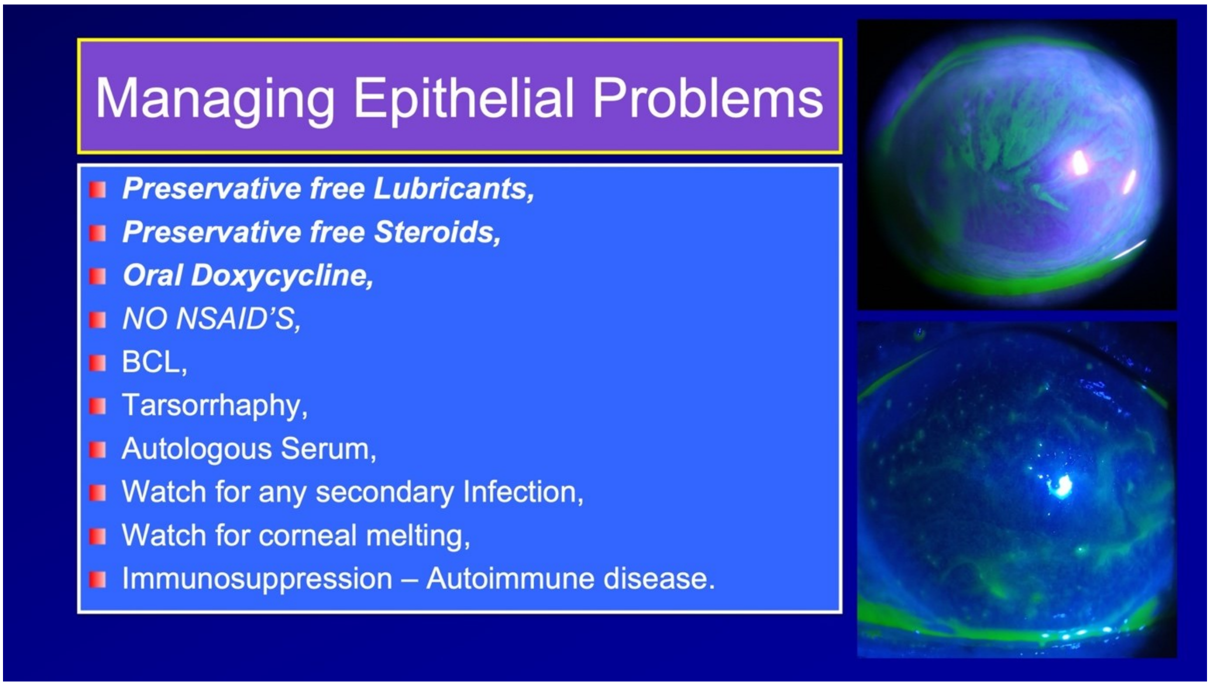

Fig: 5 Management of Epithelial Problems.

Most patients who develop early signs and symptoms of dry eye can be effectively managed with addition of preservative free lubricants and shifting to preservative free steroids along with the discontinuation of epitheliotoxic antibiotics and NSAID's (Figure 5). Patients presenting late may need more aggressive management including surgical interventions. A special mention is needed in patients who have underlying immune based or surface disease based problems as they are at higher risk of complications. Patients with rheumatoid arthritis for example may progress rapidly to corneal melting and perforation. It is essential to distinguish if the pathology is due to surface disease, immune disease or a combination of both. While an immune disease may need systemic immunosuppressive treatment a surface disease may require local measures such as intensive lubrication, an amniotic membrane graft or a tarsorrhaphy.

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Chapter - 8

MANAGEMENT OF POST CATARACT SURGERY TUNNEL INFECTIONS

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Infectious complications after cataract surgery pose a serious threat to vision. While postoperative endophthalmitis has been extensively studied and reported there is limited data on infection of the cataract wound, especially postoperative tunnel infections. A variety of organisms have been reported in literature including filamentous fungi, yeast, gram positive organisms including methicillin resistant staphylococcus and atypical organisms like Nocardia and atypical mycobacteria. The spectrum of presentations may vary based on the,

a) Site of Infection - Corneal / Scleral / Corneoscleral/ Main port or Side port
b) Extent of spread of infection - With or without Endophthalmitis
c) Nature of organisms involved - Early or Late onset infections

Problems with Tunnel Infections

a) The clinical features of tunnel infections often do not give a clue of the possible causative organisms. The time to presentation can give some clues (Figure 1). These infections cannot be treated empirically because of a wide variety of possible organisms that can be causative, including atypical organisms. Therefore, a detailed microbiological work up is mandatory for all such cases.
b) Microbiology evaluation is often challenging as the infiltrates are usually deep seated and often not amenable to routine corneal scrapings. Corneal biopsy or scrapings from the internal surfaces of the tunnel may be often required. Anterior chamber and vitreous aspirates may also needed to be taken for analysis.(Figure 1)

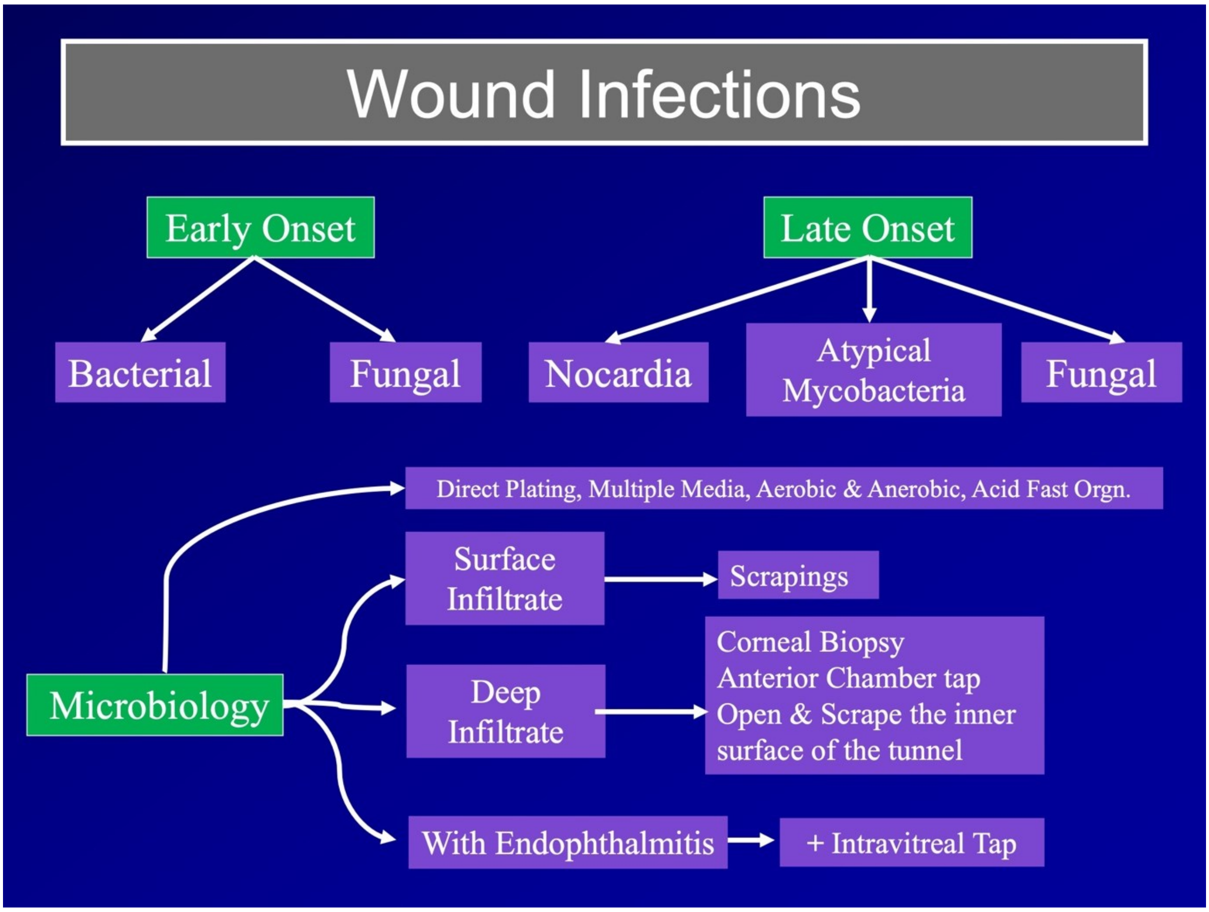

Fig: 1 Approach to Wound Infections after Cataract Surgery.

c) Contribution of Infection and Inflammation are often difficult to differentiate in early cases. Because patients are on steroids postoperatively the presentation is often delayed. Abrupt stoppage of steroids after diagnosis often leads to a severe rebound inflammation.

d) Due to the deep seated location of infection, a high load of infection and likelihood of resistant and slowly replicating unusual organisms the response to medical therapy is often poor (despite at times the organism being sensitive in vitro reports).

e) Surgical interventions are often required in these patients and these are technically challenging and with variable results (Figure 2).

f) In presence of associated endophthalmitis the management is even more challenging with very often poorer results. Co-management of the patient by an anterior segment and a posterior segment surgeon is needed (Figure 2).

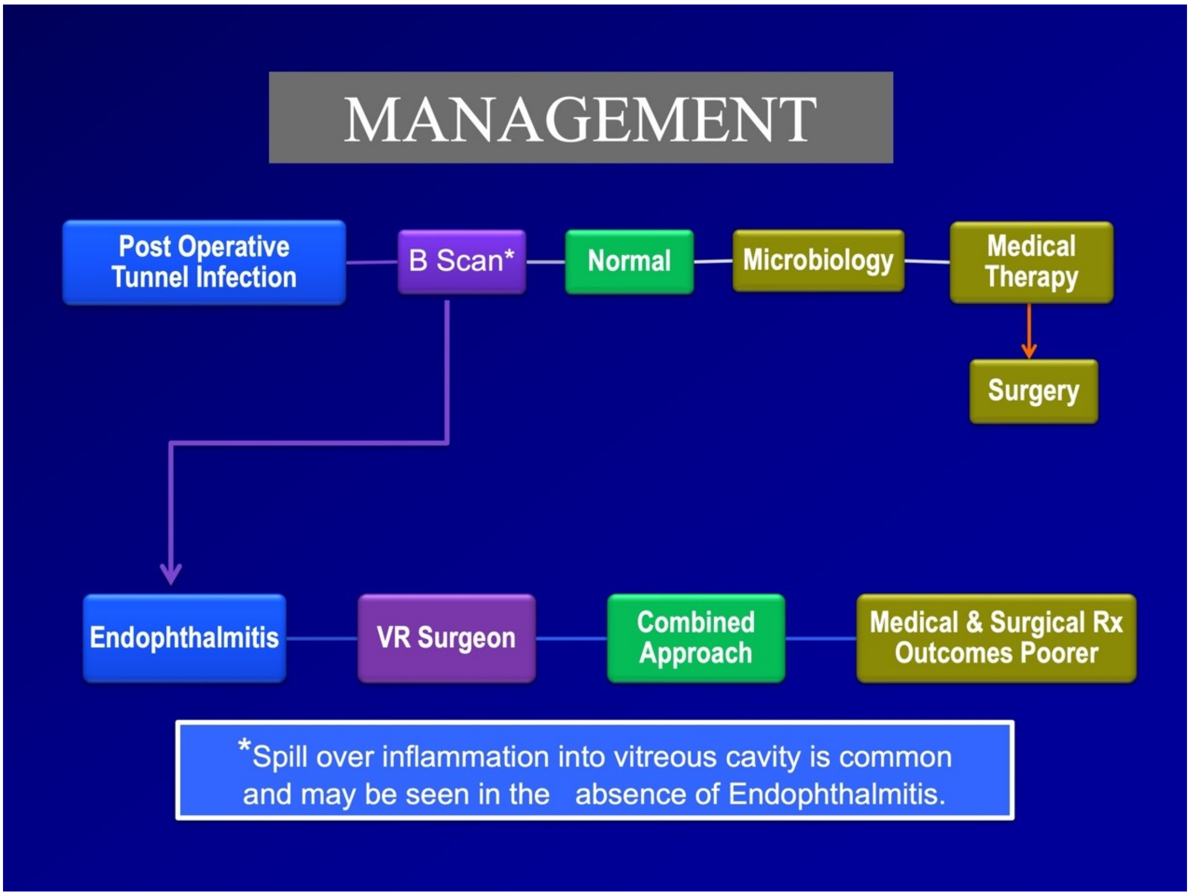

Fig: 2 Management Approach to Tunnel Infections

Medical Management

Empirical treatment can be started based on clinical suspicion however this should be modified as soon as microbiology reports are available. Systemic antimicrobials may also be started based on the nature of the infection. It is best to discontinue steroids in this situation. Most patients worsen with an increase in inflammation and exudation in the early phase and need to constantly evaluated for the development of endophthalmitis, as this requires additional interventions. Co-management by a cataract, corneal and a vitreoretinal surgeon is the best approach in this situation (Figure 2).

Surgical Management

Patients often require therapeutic patch grafts because they are refractory to medical therapy. Response to medical therapy is often poor due to a high load of infection, deep seated infection, poor drug penetration and drug resistance. Rapid spread of infection, melting and perforation also necessitate surgical interventions. Patients with associated endophthalmitis may require additional vitrectomy with removal of the capsular bag and the intraocular lens. It's always advisable to intervene early if the patient continues to worsen despite appropriate therapy. Results of surgery are variable but in the absence of endophthalmitis patients undergoing therapeutic patch grafts can have very good outcomes.

Case examples and their management outcomes

Case A : Figure 3 shows a main tunnel infection following a manual small incision surgery that presented in the first week after surgery. Methicillin resistant staphylococcus aureus sensitive to vancomycin was isolated on microbiological workup. B scan was normal and there was no endophthalmitis. However, the patient continued to worsen despite use of topical Vancomycin 5% eye drops along with other supportive therapy. Patient was advised a

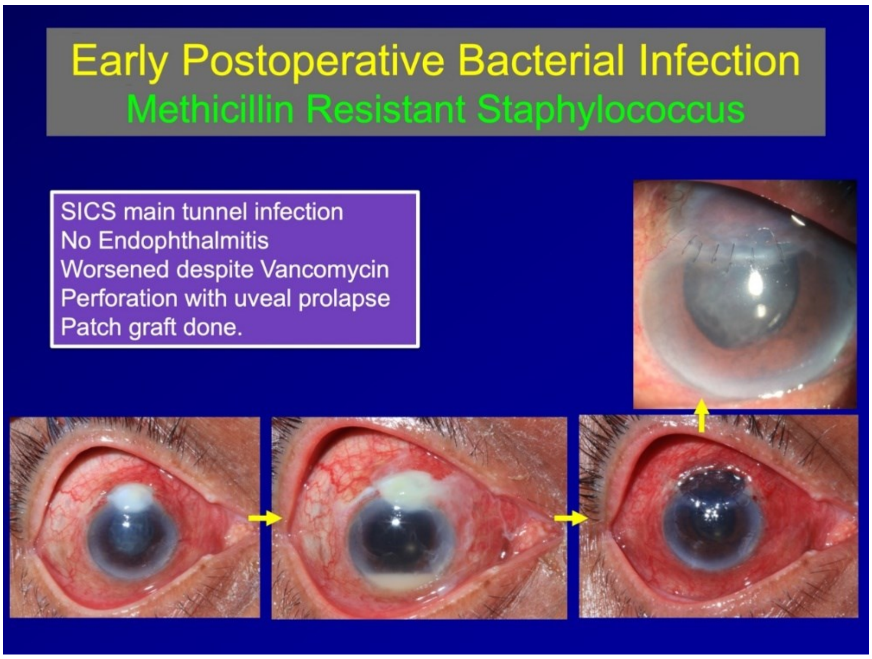

Fig: 3 Bacterial Tunnel Infection

therapeutic keratoplasty and till the cornea was available there was melting, perforation and uveal prolapse. A 7 mm full thickness patch graft was done to excise the infected tissue with a clear uninvolved 1mm rim. There was resolution of infection and patient recovered 6/18 vision at last follow up.

Case B: Figure 4 shows a tunnel infection due to a filamentous fungus (Fusarium sp.) which rapidly progressed to perforation with uveal prolapse necessitating a therapeutic patch graft which was successful in salvaging the eye. No endophthalmitis was associated in this case.

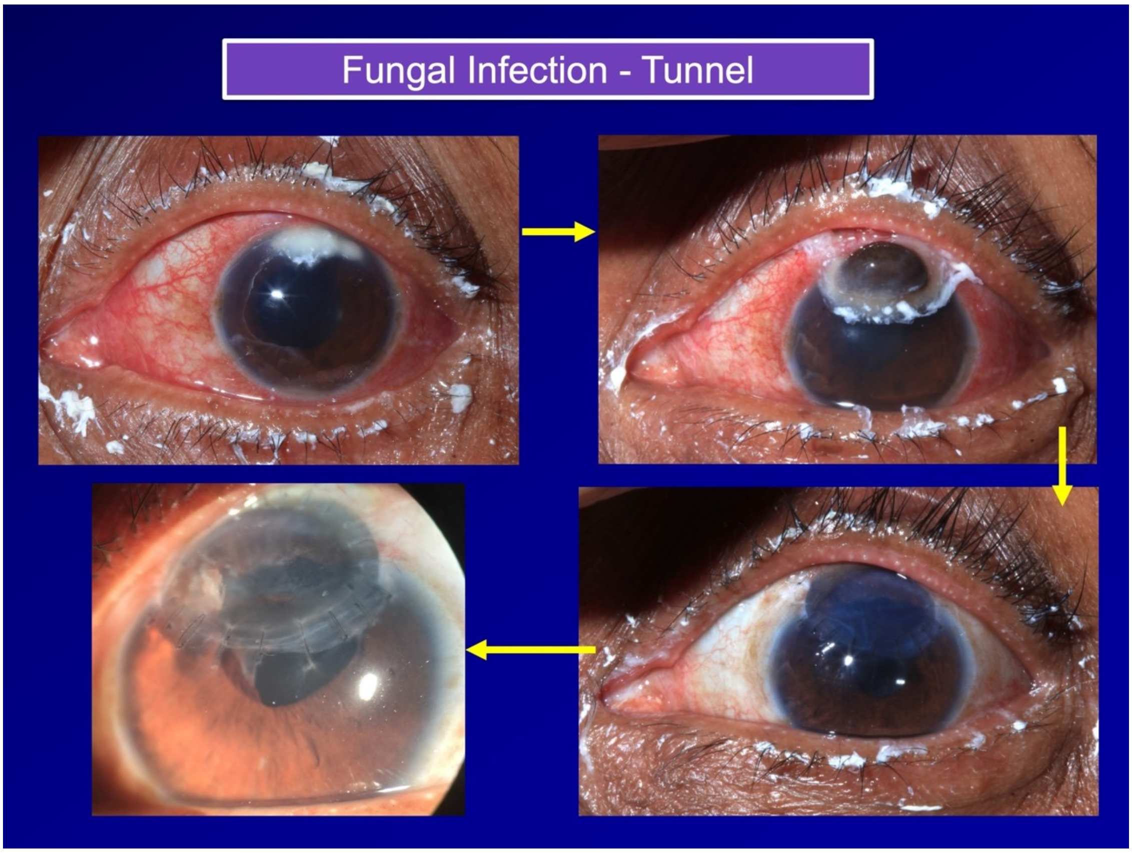

Fig: 4 Fungal Tunnel Infection

Case C: Figure 5 shows 2 cases presenting (as a cluster infection) with side port infections 17 days (Case 1) & 34 days (Case 2) after cataract surgery. Both were identified as Nocardia infections after a corneal biopsy and failed to respond to medical therapy. Both underwent therapeutic patch grafts to salvage the eye.

Nocardia infections present late, respond poorly to medical therapy and most often need patch grafts. They sometimes present as multiple cluster infections due to a possible failure in the sterilization protocols. Fortified Amikacin (15-40mg/ml), Fortified Cefazolin (50mg/ml), Co-trimaxazole drops (16mg & 80mg/ml) and fluoroquinolones are commonly used to treat these infections.

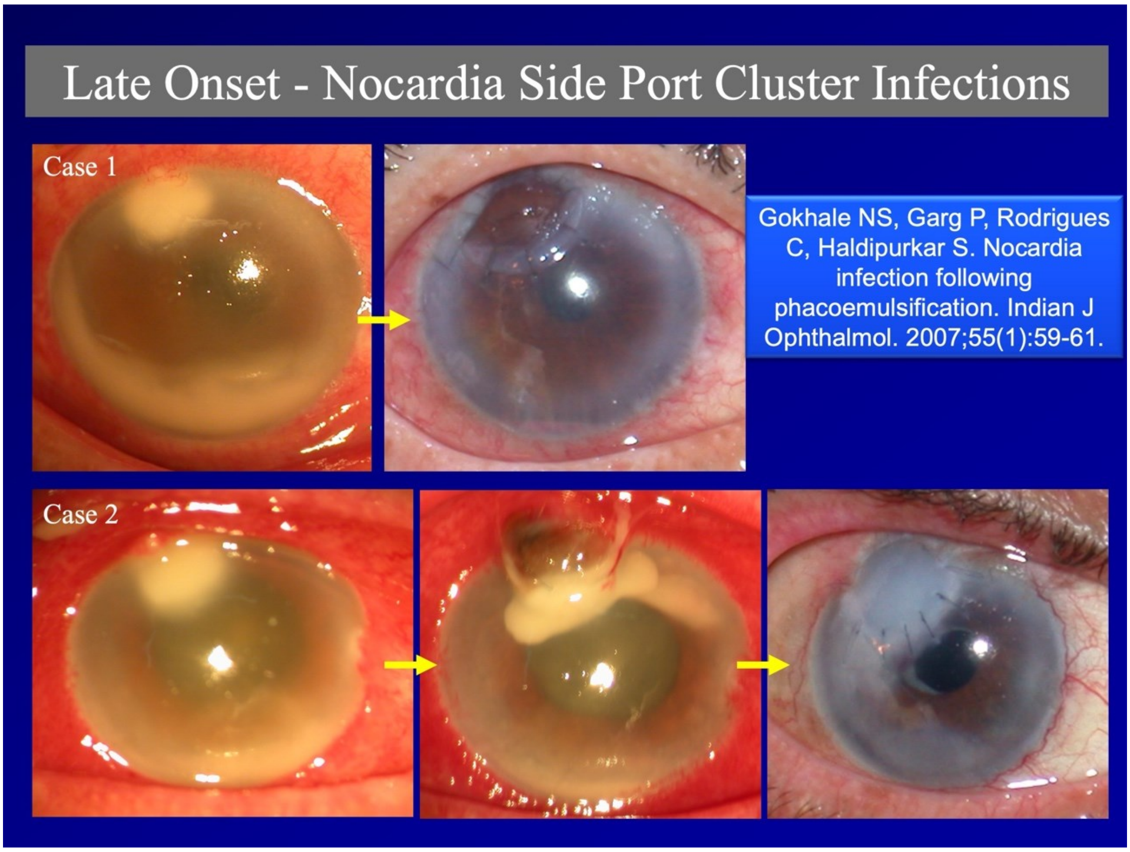

Fig: 5 Nocardia Sideport Infection

Case D: Figure 6 shows a one eyed patient (as a part of the cluster of 5 infections) with a clear corneal phaco tunnel infection due to Nocardia species. Wrong microbiology reports can misguide and delay appropriate treatment. An anterior chamber aspirate of this patient was sent for PCR testing initially by the referring surgeon which revealed Staphylococcus and misguided the initial treatment. Eventually the patient recovered 6/9 vision after a patch graft.

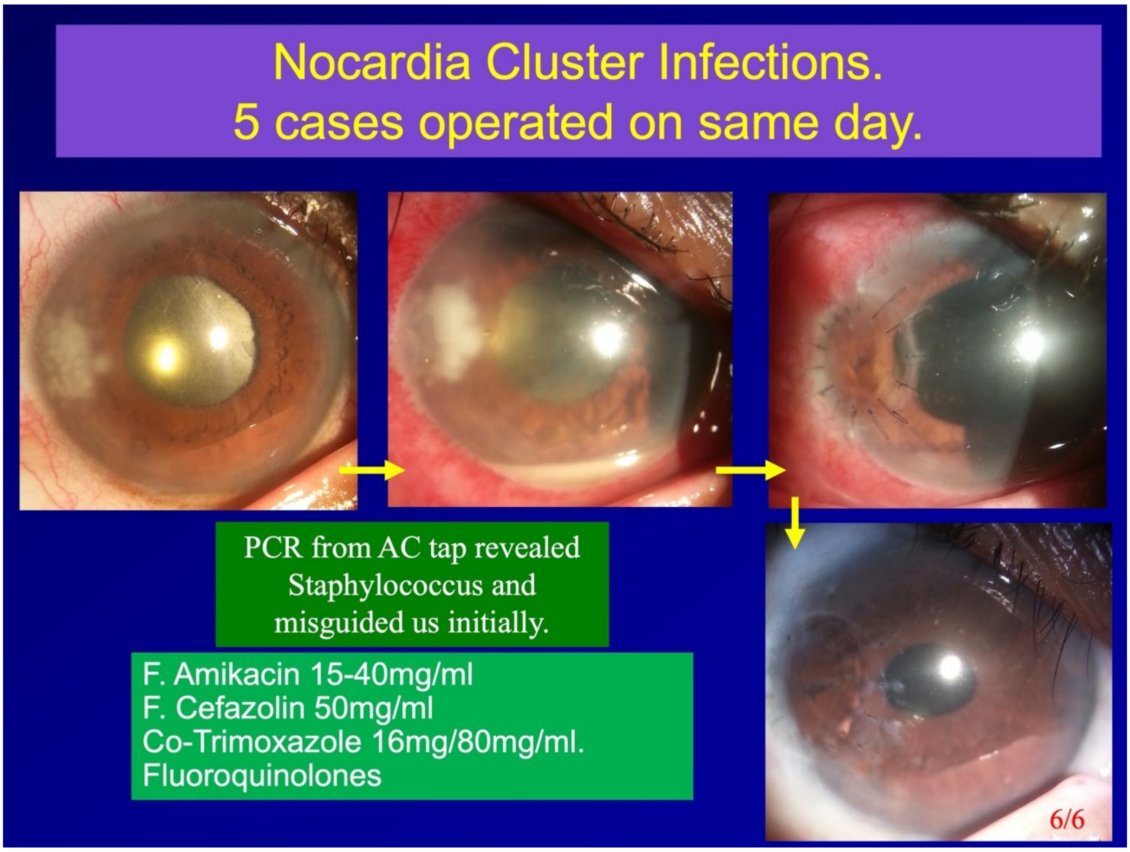

Fig: 6 Nocardia Clear Corneal Tunnel Infection

Case E: Medical therapy alone can also be successful in some cases. Figure 7 shows 2 cases that healed with medical therapy alone. Case 1 was a patient with a sclero-corneal abcess due to Aspergillus sp. which healed after intensive antifungal therapy. The patient developed an immune mediated scleritis long after resolution of infection which responded to medical therapy leaving behind scleral thinning. The patient has a stable vision of 6/9 at 5 years of follow up. Case 2 was a Nocardia clear corneal tunnel infection in a diabetic patient which responded to intensive Amikacin therapy leaving behind a vascularized scar.

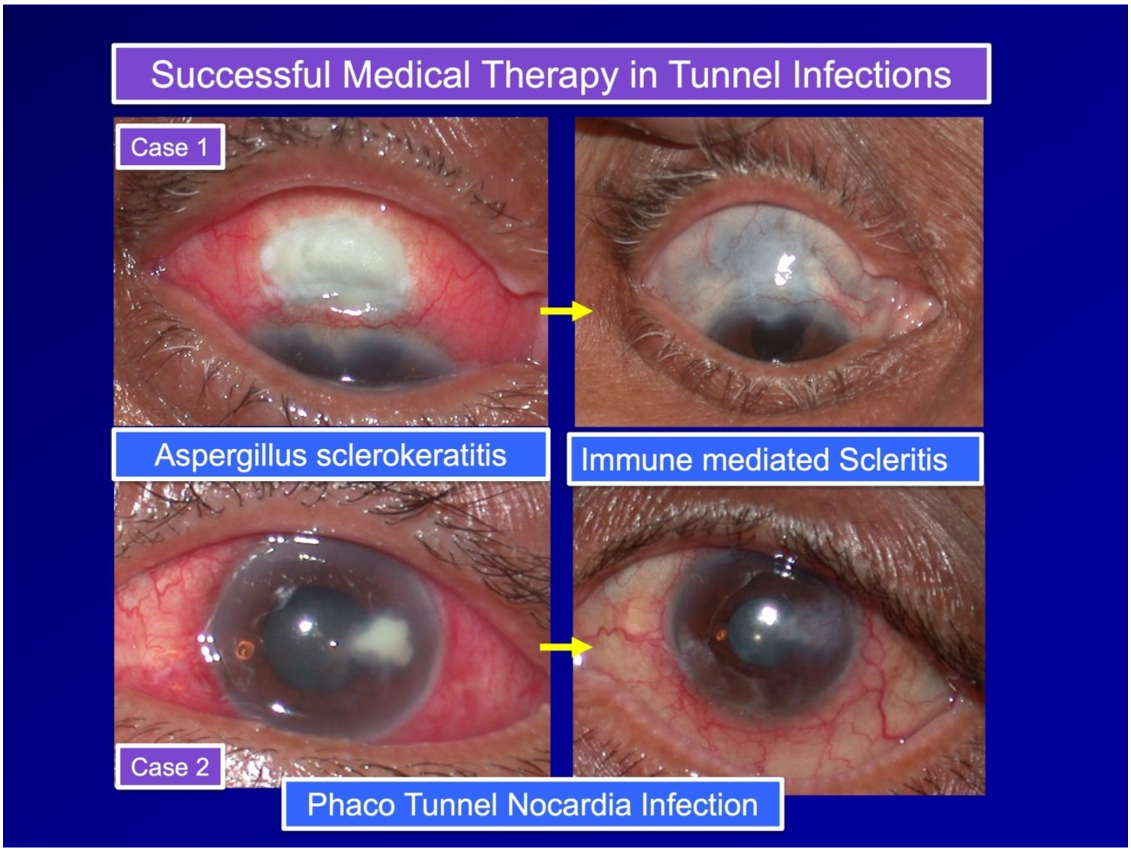

Fig: 7 Successful Medical therapy

Conclusion:

Patients with tunnel infections need aggressive medical management followed by surgical intervention if not responding. They require co-management by an anterior and posterior segment surgeon. Considering the rarity of these cases, the treating surgeon must have considerable experience in treating infections. Access to emergency donor corneal tissue and good microbiology facilities are essential. Delayed treatment can result in poor outcomes and loss of the eye. It is therefore imperative that such cases should be referred for better management to well-equipped tertiary care centers.

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