## Salient Features

A Unique Trabeculectomy Training Module which includes videos on

- Pre-operative work-up and anesthesia
- Surgical techniques
- Releasable Sutures
- Intra-and Post-Operative Complications
- Special Situations

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Joint initiative of

**All India Ophthalmological Society (AIOS)**

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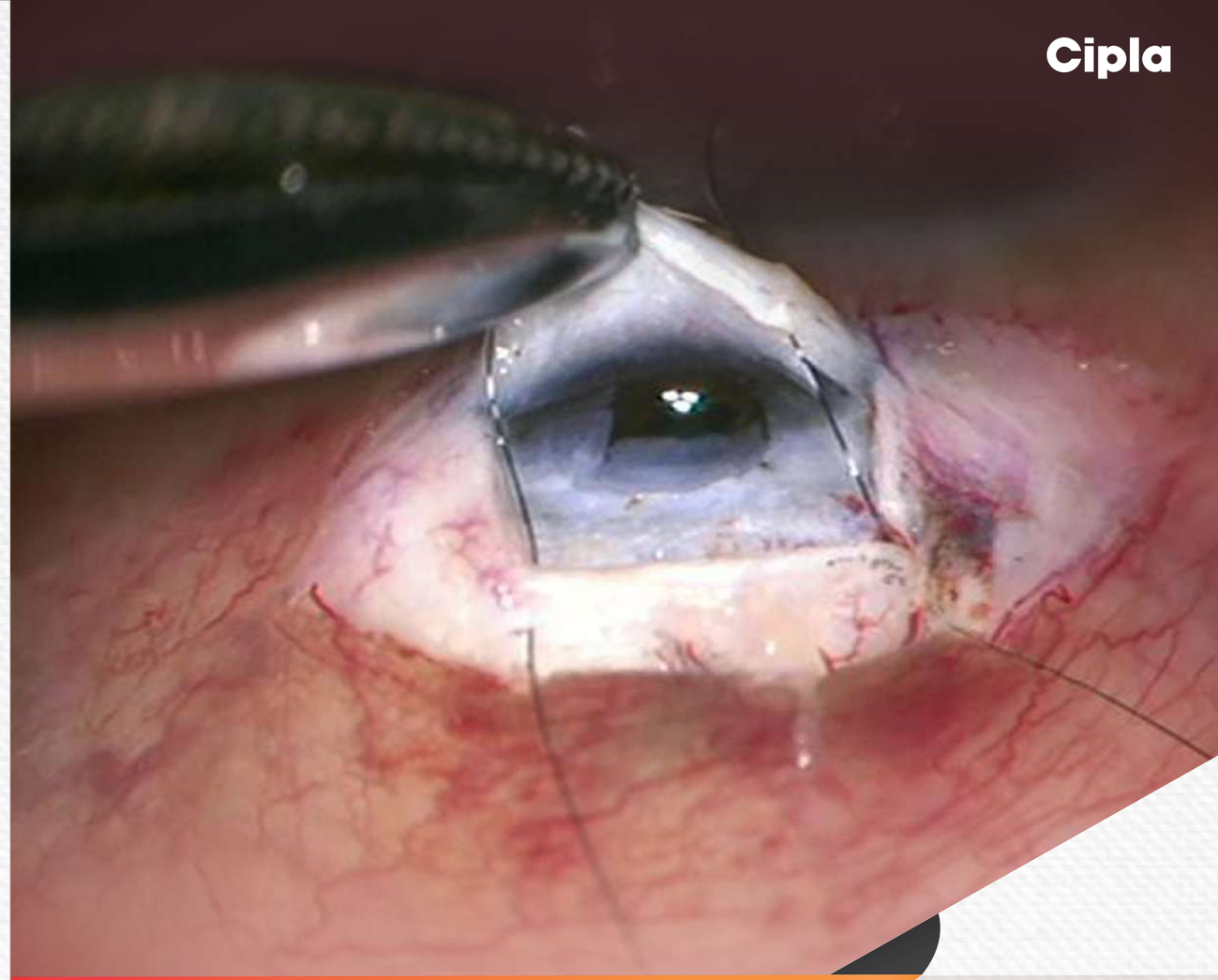

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# ALL INDIA OPHTHALMOLOGICAL SOCIETY

# TRABECULECTOMY

## Video-Assisted Skill Transfer

(Includes over 100 surgical videos)

# TRABECULECTOMY

## Video-Assisted Skill Transfer

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# Foreword

Dear Friends,

The All India Ophthalmological Society has always been a leading force for ophthalmic education for all its members. We are pleased to present a new audio-visual module “Trabeculectomy- A video-assisted skill transfer” compiled by world renowned experts from the top ophthalmic institutes of India.

This module includes videos demonstrating pre-operative work-up, surgical techniques and their modifications in special situations, as well as management of intra-& post-operative complications. Each surgeon has an individual unique wisdom acquired with time spent in the operation theatre and many experts tend to alter their techniques over time. This video module gives the collective expertise of glaucoma experts from different parts of the country, trained and working in different institutes. We hope that trainee surgeons will be able to learn and pick up key pearls for performing glaucoma surgery from this module.

I wish to thank Prof. Tanuj Dada for leading the project from its concept to the final implementation and all the faculty members and resident doctors who have contributed their valuable time and effort to bring out this outstanding educational resource.

I hope that the efforts of all the glaucoma experts under aegis of the All India Ophthalmological Society will be of immense use for practicing ophthalmologists in refining their surgical management of glaucoma.

**Dr. (Prof.) Namrata Sharma**
Hony. General Secretary
All India Ophthalmological Society


**Trabeculectomy** - Video-assisted Skill Transfer

# Foreword

Dear Friends,

Glaucoma is the leading cause of irreversible blindness worldwide impacting nearly 80 million patients. Glaucoma surgery in the form of Trabeculectomy is the preferred surgical approach for long-term intraocular pressure (IOP) control in majority of glaucoma patients which require a low target IOP. However this surgery has a steep learning curve and is associated with sight-threatening complications. With adequate training and knowledge of the various important perioperative factors that can impact Trabeculectomy outcomes, this surgery can be performed by general ophthalmologists and can prevent blindness in needy glaucoma patients.

The All India Ophthalmological Society has launched a unique learning resource to impart glaucoma surgical training. I am happy to present to you "Trabeculectomy- A video-assisted skill transfer" an audio-visual module with over 100 video clips. This comprehensive learning resource includes pre-operative work-up & anesthesia , surgical anatomy, various techniques for performing Trabeculectomy and application of releasable sutures along with surgical modifications in special situations such as post-keratoplasty or vitreo-retinal surgery. The authors have also incorporated prevention and management of various intra- and post-operative complications which will be a great help for trainee surgeons.

In keeping up with the technology of the modern era , the module has QR codes which can be scanned from any mobile and viewed at any time by trainee surgeons, even in the operation theatre for assistance during surgery. What makes this module unique is that it amalgamates the collective expertise of glaucoma experts from the top five ophthalmic institutes of the country and produces a skill & knowledge bank that is unparalleled in the world. I am sure that this will become a historic educational tool for global training and help to alleviate suffering of glaucoma patients and ultimately in preventing blindness.

I would like to express my heartfelt gratitude to the Editors and all the faculty members and residents who have contributed their valuable time and effort in making the module.

**Dr. Lalit Verma**
President
All India Ophthalmological Society
2022-2023



# Foreword

Dear Friends,

It is prudent to evolve with changing times while honoring time revered traditions and practices. We live in an era where the field of glaucoma surgery has undergone rapid advancements in minimally invasive techniques for management of glaucoma patients. However, a large majority of these procedures involve very expensive instrumentation or devices which are not affordable to our population. Additionally, glaucoma patients require further surgery with long-term intraocular pressure (IOP) control at low target IOP which is not achieved by these procedures. In this regard, glaucoma filtering surgery in the form of Trabeculectomy remains the "Gold Standard" as the initial surgical option for most glaucoma patients. However, there is an unmet need for better training in the art of Trabeculectomy and surgical expertise in management of its complications.

Keeping the legacy of AIOS as a leader in providing educational opportunities and tools for practitioners throughout the country, we are happy to present this new audio-visual module "Trabeculectomy- A video-assisted skill transfer". This contains over 100 video clips with an assortment of techniques of trabeculectomy, its modifications in special situations & management of various intra- and post-operative complications associated with it.

Under the able leadership of glaucoma experts from the top five ophthalmic institutes of the country, AIOS is proud to present a new initiative of video-based learning for upgrading the surgical skills of trainee surgeons and practicing ophthalmologists in the country. I would like to thank all the faculty members and residents who have contributed their valuable time and effort in compiling this module.

I hope that this AIOS initiative will help to improve the standard of surgical training in the country and ultimately contribute to improving the standard of care for glaucoma patients and their well being. I have no hesitation in recommending this module to ophthalmologists in training as well as in practice.

**Dr. Barun Kumar Nayak**
Immediate Past President
All India Ophthalmological Society
2021-2022

## Editorial

With over 70 million patients, glaucoma is the leading cause of irreversible blindness in the world. Even though there have been rapid advancements in the field of glaucoma surgery in the era of minimally invasive glaucoma surgeries, Trabeculectomy remains the gold standard as the initial surgical procedure for eyes with medically uncontrolled glaucoma.

Trabeculectomy is a high yield, high risk and high maintenance surgery which has a steep learning curve and needs a lot of surgical refinement to get optimal results. There is an unmet need to impart training to resident doctors on performing a safe Trabeculectomy.

There is no one correct method of performing a successful Trabeculectomy or managing its complications. We have included surgical videos of Trabeculectomy and its rescue operations with different techniques to show how individual surgeons modify their surgical technique based on their expertise over the years.

We hope that this video atlas, compiled with collective effort and wisdom of leading glaucoma experts of the country will provide a useful practical reference to help ophthalmologists in performing Trabeculectomy, understanding the need as well as intricacies of various modifications in techniques and managing complications which one might encounter while doing surgery or in the post-operative period.

We would like to express our immense gratitude to Chief RP Centre, **Prof. Jeewan S. Titiyal** for his constant encouragement and guidance.

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# Section 1 Photo Atlas- Trabeculectomy Technique

Despite development of many new techniques and devices, trabeculectomy remains to be the gold standard in management of medically refractory glaucoma.[1,2] In this section, we are presenting step by step trabeculectomy as well as few additions/modifications which can be done to augment, facilitate and safeguard trabeculectomy.[3,4]

## Photo Atlas

Fig. 1- Ong speculum in situ with downward rotation of eyeball

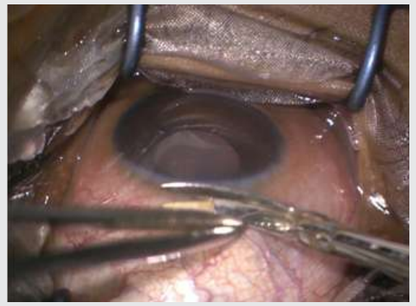

Fig. 2 - Conjunctival peritomy done with vannas scissor, for fornix based flap technique.

Fig. 3- Completed peritomy

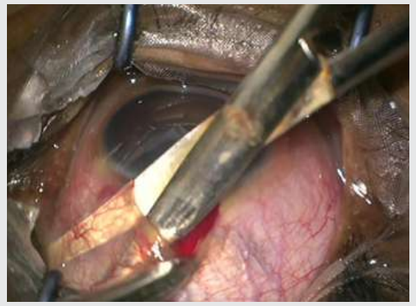

Fig. 4 - Posteriorly directed subconjunctival dissection being done with conjunctival scissor.

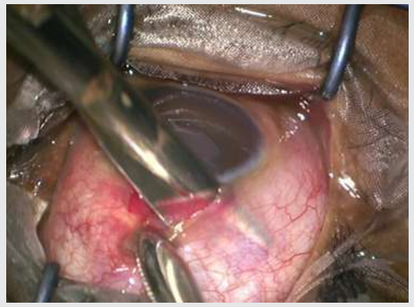

Fig. 5- Completion of subconjunctival dissection both nasally and temporally to assure formation of adequate sized bleb.

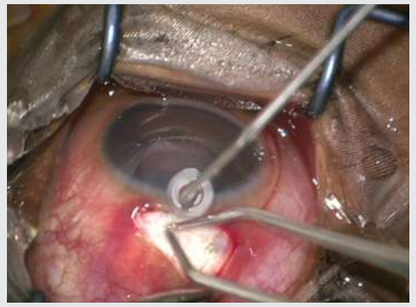

Fig. 6 - Gentle cautery to achieve hemostasis.

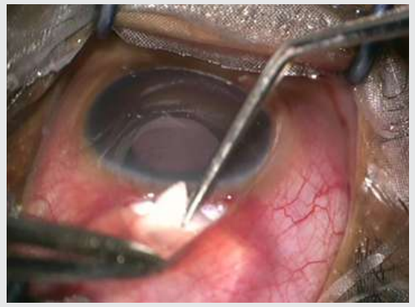

Fig. 7- Mitomycin C (antifibrotic agent) soaked sponges being inserted in the sub tenon space.

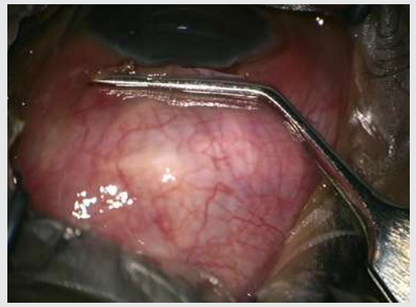

Fig. 8 - Three to four small pieces of Mitomycin C soaked sponges are inserted as posteriorly as possible for minimum dose and duration (0.2 mg/ml for 1-2 minutes). Take special care so that the antifibrotic agent does not come in contact with edge of peritomy.

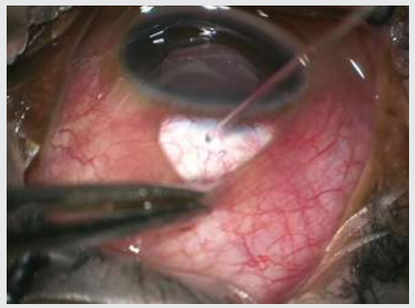

Fig. 9- Thorough wash with BSS to remove excess Mitomycin C

Fig. 10 - Initiation of a partial thickness scleral flap in the superior sclera with the help of crescent blade.

Fig. 11- After marking the posterior edge of the scleral flap, flap dissection is initiated with crescent knife.

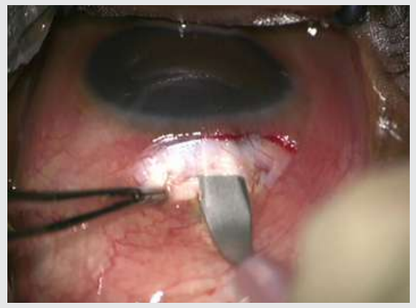

Fig. 12 - Rectangular scleral flap dissection being advancement upto limbus.



Fig. 13- Edges of scleral flap being cut with scissors.

Fig. 14- A partial thickness scleral flap in the superior sclera, hinged at the limbus.

Fig. 15- Preplaced sutures (with 10-0 ethilon) being placed at temporal edge of scleral flap.

Fig. 16- Preplaced sutures (with 10-0 ethilon) being placed at nasal edge of scleral flap.

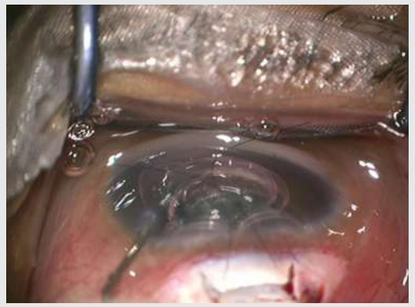

Fig. 17- Air being injected in anterior chamber through side port.

Fig. 18- MVR blade used to enter the anterior chamber from just behind the hinge of the scleral flap

Fig. 19- Two enteries made into anterior chamber; will act as lateral edges of ostium.

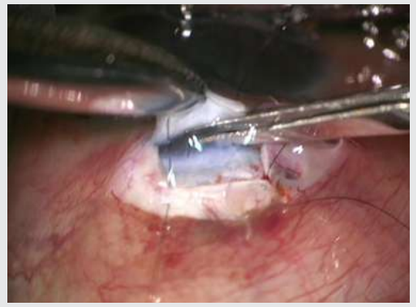

Fig. 20- Anterior edge of ostium being cut with vannas scissor.

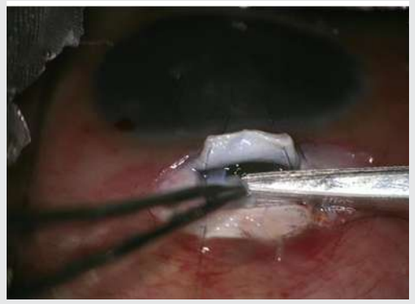

Fig. 21- Posterior edge of ostium being cut with vannas scissor.

Fig. 22- Completed ostium

Fig. 23- Small peripheral iridectomy being done with Vannas scissor

Fig. 24- Scleral flap closed with 10-0 ethilon sutures.



Fig.25- Scleral flaps closed with 10-0 MFN.

Fig. 26- Conjunctival suturing with 10-0 vicryl suture.

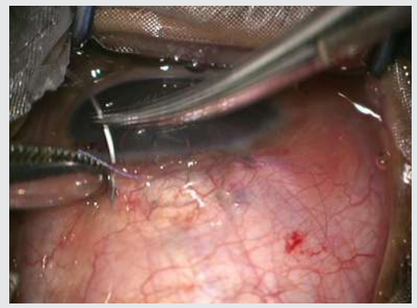

Fig. 27- Continuous suturing to get watertight wound.

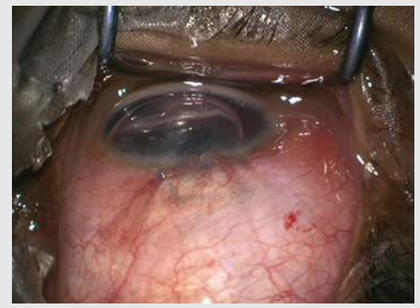

Fig. 28- Bleb appearance at the end of surgery.

## Alternate method of making ostium with Kelly's Descemet Punch

Fig. 29- Kelly's Descemet Punch being used to make ostium.

Fig. 30- Completed scleral ostium made with Kelly's descemet punch.

## Making of Lamellar Deep Sclerectomy

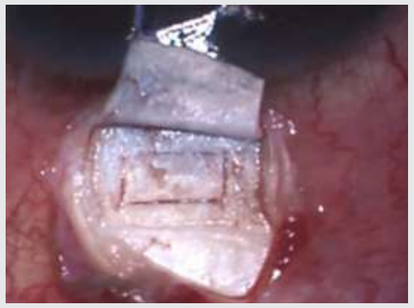

Fig. 31- At the base of scleral bed after raising flap, a 2*1 mm rectangular area is marked with a blade.

Fig. 32- A thin lamella of sclera is then dissected with the help of crescent knife.

Fig. 33- Completed deep lamellar sclerectomy.


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# Section 2 Post-Operative Complications

In this section, we will be elaborating on the various complications after trabeculectomy and its management.

| No. | Title |
|---|---|
| 1 | Management of shallow anterior chamber in early post-operative periods |
| 2 | Early post-operative high intraocular pressure (IOP) with deep anterior chamber |
| 3 | High bleb phase and Encysted bleb |
| 4 | Late-onset low IOP (bleb leak, over filtering bleb/ hypotony maculopathy |
| 5 | Late bleb failure |
| 6 | Bleb-related infections |
| 7 | Corneal and ocular surface complications |
| 8 | Refractive error and astigmatism changes after trabeculectomy |
| 9 | Failed trabeculectomy-revision trabeculectomy and other options |
| 10 | Cataract formation after trabeculectomy |
| 11 | Long-term trabeculectomy outcomes – overview of success rates, failures, complications |

Trabeculectomy has been considered as the standard of care for medically refractory glaucoma.[1] Trabeculectomy creates a non-physiological outflow route for aqueous humor.[2] Post-operatively, this procedure is associated with several complications despite the best effort from the surgeon.[2] An uneventful surgery is a half-done job and timely detection and management of post-operative events are critical for good long-term outcomes. Each post-operative visit should consist of the evaluation of visual acuity, IOP, anterior/posterior chamber, and bleb morphology. During the early follow-up periods, patients should be instructed to avoid eye rubbing, strenuous exercises and should stress for good ocular hygiene. The patient should be instructed to put topical antibiotics, strong cycloplegics, and frequent steroid drops. The frequency of follow-up visits varies according to IOP, anterior chamber depth (ACD), bleb characteristics, and visual prognosis.

### A normal filtering bleb

The outcome of trabeculectomy is assessed based on the control of IOP and the morphologic features of the filtering bleb. Low-lying and diffuse blebs having low vascularity with plenty of microcysts in the epithelium are often associated with good IOP control. (Video 6.1)

# 1. Shallow anterior chamber

Post-operatively shallow anterior chamber (AC) can be associated with low or high IOP.

**I. Shallow AC with low IOP**

Low IOP is usually associated with a shallow/flat AC leading to iridocorneal or corneo-lenticular touch. This spontaneously resolves within 1 – 2 weeks but if prolongs can cause corneal decompensation, cataract, and peripheral anterior synechiae formation. Usual causes are serous choroidal detachment, conjunctival wound leak, over filtration, and rarely cyclodialysis cleft.

**A. Serous choroidal detachment**

Hypotony is the precipitating factor for choroidal detachment. Hypotony, inflammation, and venous congestion lead to the accumulation of proteins from the choroidal capillaries into suprachoroidal space causing ciliary body detachment and continue as a vicious cycle. All patients with shallow AC should undergo a dilated fundus examination to r/o choroidal detachment (Figure 1A). If media is hazy, one should perform B scan ultrasonography. (Figure 1B)

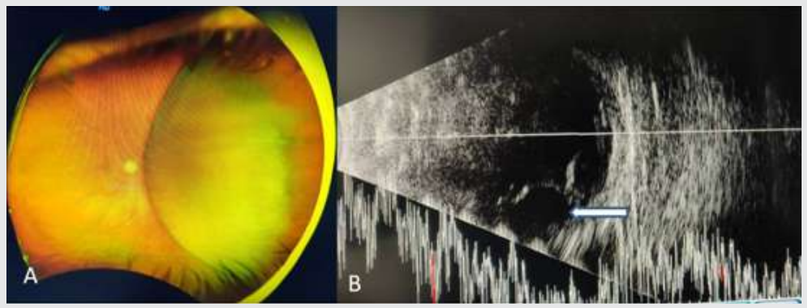


Figure 1: A; Shows temporal serous choroidal detachment in the right eye. B; Shows ultrasonic appearance of serous choroidal detachment (white arrow)

Most cases usually resolve on conservative therapy consisting of cycloplegics and topical steroids with or without oral steroids. Surgical intervention in the form of choroidal drainage with AC formation is indicated in non-resolving choroidal detachment, in cornea-lenticular touch, and in kissing choroidal for more than 48 hours.

**B. Conjunctival wound leak**

Low IOP with conjunctival wound leak is often seen in early post-operative days. A poorly formed bleb with low IOP and shallow/flat bleb should alert the surgeon for conjunctival wound leak. The conjunctival surface, as well as wound margin, should be checked for any leak with fluorescence strip i.e. Seidel's test (Figure 2).

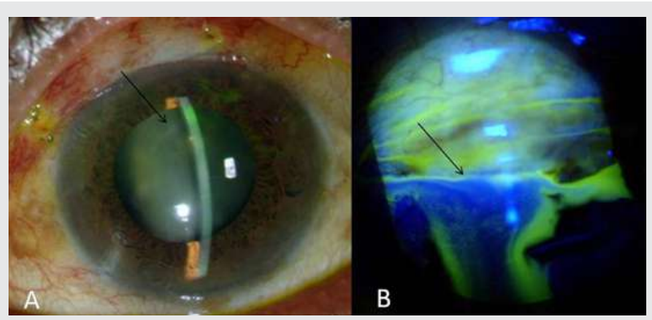


Figure 2: A; Shows shallow AC. B; on fluorescein staining Seidel's test positive



The management depends upon the position, size of the bleb, and depth of the bleb. A small leak at the suture line/limbus usually heals spontaneously. A deep anterior chamber with a small leak can be observed or treated conservatively with patching, aqueous suppressants, and antibiotics. Large leaks at the limbus /wound margin usually need closure. Various techniques include a bandage contact lens,[3] tamponades with Simmond's shell,[4] cyanoacrylate glue,[5] fibrin glue.[6] If the leak fails to heal with the above-mentioned treatment or in presence of large defect (Figure 3), one must go for re-suturing (Video 6.2).

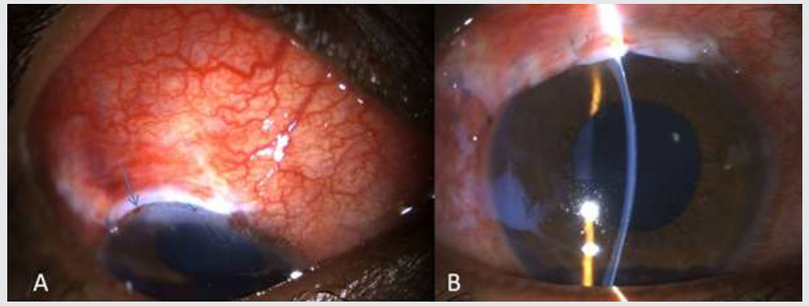


Figure 3: A; Shows large conjunctival wound retraction (blue arrow) which required conjunctival resuturing (B)

**C. Over-filtering bleb**

Low IOP with shallow/flat anterior chamber and elevated bleb or shallow well-diffused bleb (Figure 4) is indicative of over-filtration.

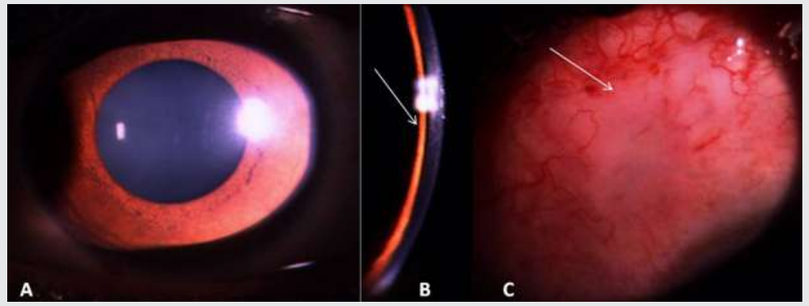


Figure 4: A; Post-operative day 3 shallow AC on diffuse illumination. B; Slit view shows flat AC. C; Diffuse elevated bleb.

The common cause for early post-operative excessively filtering bleb is loose scleral flap suture. Other causes are early suture lysis or early removal of releasable sutures. Initial management includes aggressive management with strong cycloplegics with or without pressure patching to restore the AC depth. Surgical AC reformation with BSS, viscoelastic or air indicated in eyes not responding to conservative management for 5-7 days or corneal-lenticular touch.[7]

**II. Shallow/Flat AC with elevated IOP**

Shallow/flat AC with high IOP is often seen after trabeculectomy. Various reasons include pupillary block, aqueous misdirection, and suprachoroidal hemorrhage.

### A. Pupillary block

The pupillary block following trabeculectomy is rare. Signs include high IOP with peripherally flat and centrally well-formed AC. Treatment includes widening of peripheral iridectomy or creation of new iridectomy with Nd: YAG laser.

### B. Malignant glaucoma

Malignant glaucoma following trabeculectomy is not uncommon and is a vision-threatening complication. Risk factors are eyes with pre-existing shallow AC, angle-closure glaucoma, short axial length (<21 mm), female gender, and malignant glaucoma in the fellow eye. It is caused by the posterior diversion of the aqueous into the vitreous cavity. Aqueous misdirected posteriorly into the vitreous cavity-causing simultaneous flattening of central and peripheral AC despite patent peripheral iridectomy (PI) (Figure 5) and forward rotation of the ciliary processes detected by ultrasound biomicroscope. Before making a diagnosis one should rule out pupillary block.

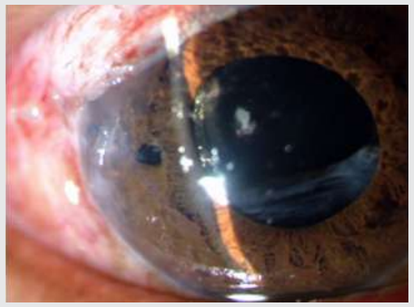

Figure 5: Shows shallow AC (peripheral and central) with patent iridotomy suggestive of aqueous misdirection

IOP may be normal or high. The initial management includes aqueous suppressants and strong cycloplegics. If medical therapy fails, surgical treatment is indicated. In pseudophakic or aphakic eyes, laser hyaloidotomy with posterior capsulotomy can be tried.[7] Surgical treatment includes vitreous aspiration, pars plana vitrectomy, or pars plana vitrectomy with zonulectomy and iridectomy (Video 6.3). Long-term cycloplegics are needed even after the reversal of misdirection.[2]

### C. Suprachoroidal hemorrhage

Suprachoroidal hemorrhage is an uncommon but potentially vision-threatening event. The three month cumulative incidence of post-operative suprachoroidal hemorrhage is 0.6-1.4% after glaucoma surgery.[8] Various risk factors have been associated with suprachoroidal hemorrhage after trabeculectomy including high pre-operative IOP, severe post-operative hypotony, aphakia, prior vitrectomy, hypertension, anticoagulation, and ischemic heart disease.[8]

Clinically, this condition presents with severe pain, redness, diminution of vision with nausea and vomiting. Examination shows a peripheral and central shallow AC with high IOP and loss of red reflex.[2] Posterior segment examination shows dark brown dome-shaped choroidal expansion. Serial ultrasound (Figure 6) evaluation is necessary to assess the size and also liquefaction of the clot. Small hemorrhage can be managed conservatively with topical and oral steroids. Drainage is indicated in non-resolving choroidal detachment or large detachment and is usually done once liquefaction occurs (usually after 10-15 days).



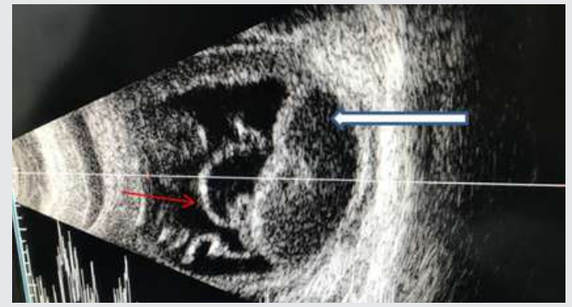

Figure 6: Shows retinal detachment (red arrow) with suprachoroidal hemorrhage (white arrow; large elevated lesion with underlying multiple pinpoint echoes).

## 2. Early post-operative raised IOP with deep anterior chamber

### A. At the level of the scleral flap

Usually in the first few post-operative days

- Cause: The most common cause of raised IOP in the early post-operative period is under filtration through the partial thickness scleral flap, commonly due to the tight suturing techniques used.
- Treatment: A gentle massage (Video 6.4) at the slit-lamp usually restores outflow and reduces the IOP. The idea is to open up the scleral flap momentarily and allow egress of fluid from the anterior chamber to the sub-tenon's space. This is also important to maintain the patency of the bleb and avoid early scarring of the conjunctiva to sclera which would result in an early bleb failure.

### B. At the level of the bleb

- Cause: Early healing due to post-operative inflammation.
- Treatment: This is usually seen in the first 7-10 days. At this time, a gentle massage to re-establish flow followed by inj. 5-fluorouracil for its anti-mitotic properties to inhibit fibrosis (5 mg in 0.1 ml) is given in the subconjunctival space but away from the bleb (Video 6.5). A similar procedure may be needed if an accumulation of blood occurs at the scleral flap site, as the presence of blood puts it at risk of fibrosis and thus failure. Injection 5-Fluorouracil (5-FU) (5 mg in 0.1mL) is of value in such cases (Video 6.6).
- A flat bleb may need the removal of a releasable suture followed by a bleb massage to allow the passage of fluid from beneath the flap into the subconjunctival space. Simultaneous injection of 5-FU (5 mg in 0.1 mL) should also be given at a site away from the bleb if there is a presence of cork-screwing of vessels (Video 6.7).
- Removal of sutures in the absence of releasable sutures can also be done by using the laser. Argon laser the most commonly used laser for this purpose, also double frequency Nd-YAG laser can be used. The suture to be lysed should be made taut and focussed with Hoskins lens. (Video 6.8)

### C. At the level of the ostium

- Scleral ostium blockage is an uncommon occurrence in the early post-operative period. Sometimes there may be a blood clot that gets dislodged after a massage and is seen as a trickle of hyphema in the AC (Video 6.9).
- In the later period, the iris may plug the sclerostomy ostium and cause blockage of aqueous outflow. Surgically enlarging the iridectomy usually is all that is needed. Sometimes, a vigorous massage may also result in the iris blocking the sclerostomy. Surgical revision is usually needed in this case. (Video 6.10).

## 3. High bleb phase and encysted bleb

### A. High bleb phase

In the first 6-8 weeks after trabeculectomy, elevated IOP associated with a high bleb[9] develops in some patients. (Video 6.11)

- Treatment: If recognized in time, it may be managed by aqueous suppressants and a short course of steroids.

### B. Encysted Bleb

When a high bleb persists, it may get localized and fibrosis around the edges (Figure 7) makes it less amenable to medical treatment. Such cases often require needling revision to repair it and to restore IOP control.

Figure 7: Shows a thick encysted bleb around the scleral flap area.

## 4. Late-onset low IOP (bleb leak, over filtering bleb/ hypotony maculopathy

The use of anti-metabolites like Mitomycin C (MCC) and 5-FU has increased the success of trabeculectomy in terms of target IOP. However, the long-term complications like bleb thinning, bleb leak, and chronic hypotony have increased.[1-2]

### A. Late bleb leak

- The late bleb leak is usually due to thin-walled bleb[10] and the leak may be focal or diffuse. The reported incidence of late bleb leak ranges from 1.8-10%.[11] Preventive strategies include the avoidance of thin scleral flaps and an adequate titration of the use of antifibrotic agents, and avoiding excessive exposure to the anti-fibrotic agent. Bleb leak can be detected by Seidel's test: A fluorescein strip is gently applied over the bleb and the eye should be examined under a cobalt blue filter. A leaky bleb shows the flow of unstained aqueous surrounded by dark green colored tear film.[2](Figure 8).

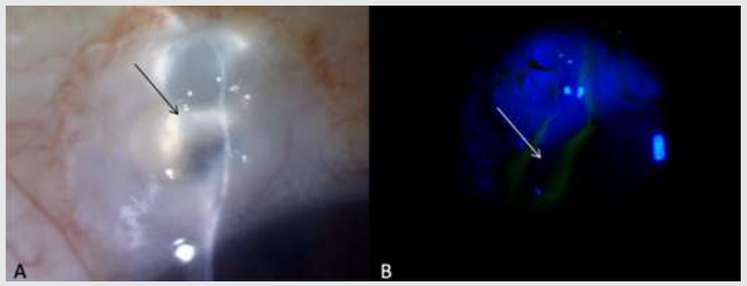


Figure 8: A; Shows a thin cystic bleb with the underlying thinned sclera. B; Seidel's test shows bleb leak.




Figure 9: Shows fundus picture of a 38 years old patient having over filtering bleb; shows multiple ILM fold suggestive of maculopathy

Chronic hypotony due to over filtration can be kept under observation if the visual acuity is not deteriorating. Non-surgical management includes soft contact lens, bleb size reduction by cryotherapy or argon laser.[16] Surgical modalities include bleb limitation like compression suture or surgical revision with the closure of scleral flap (Video 6.13).

## 5. Late bleb failure

Late bleb failures are commonly due to progressive sub-tenon's or sub-scleral fibrosis. This condition would usually require surgical intervention. Various surgical techniques have been reported to re-establish the filtration of aqueous humor in a failed trabeculectomy bleb. Depending upon the extent of scarring and patency of the sclerostomy, it may be treatable with a sub-tenon's needling procedure,[17]or may require a sub-scleral intervention via an external approach,[18] or internal bleb revision, using an ab-interno approach through a goniolens, as described by Grover et al.[19]

### A. Sub-tenon's fibrosis

Late onset- sub tenon's fibrosis can be managed by sub-tenon's needling done either on the slit-lamp or in the operating room (Video 6.14) depending upon the anticipation of combining the procedure with a sub-scleral approach.

### B. Sub-scleral Fibrosis

Sub-scleral release of fibrosis may be a little tricky owing to the blind nature of the procedure and the possibility of injury to underlying structures with the sharp needle. External bleb repair is a more invasive surgery requiring conjunctival dissection and reopening of the scleral flap. A newer procedure an ab-interno sub-scleral revision technique (Video 6.15) has been described,[19] and it appears to be a less invasive procedure with a more controlled and predictable approach. A gonioscopy is mandatory to document an open sclerostomy since the spatula will enter the subscleral space through this opening.

Pre-surgery preparation for ab-interno bleb revision

- Office-based slit-lamp procedure, to be done 5 days before surgery.
- Subconjunctival injection of antimetabolite agent MMC 0.1 mg/ml (0.1 ml) injected in sub-tenon plane using a 30 G needle and 1 ml syringe, in the region of the failed bleb. The injection is then spread using a cotton swab.

# 6. Bleb-related infections

Bleb-related infections (BRI) may develop days to years after a glaucoma filtration surgery (GFS). An infected bleb can soon become a devastating situation, since the fluid within the bleb is continuous with the anterior chamber, and the infection can rapidly spread posteriorly to the vitreous.

Adjuvant use of 5-FU and MMC, diabetes, inferior bleb position, thin cystic bleb, bleb leak, bleb manipulation, blepharitis, and bacterial conjunctivitis are known risk factors for BRI. The incidence of blebitis is 2-5% and of bleb-related endophthalmitis after GFS is 0.2 to 9.6 %.[9]

Bleb-related infection is usually bacterial and the source of bacteria is usually ocular flora. Common organisms responsible for endophthalmitis can be *Staphylococcus, Streptococcus species*, or sometimes gram-negative bacteria (*Haemophilus influenza*).

**Classifications of bleb-related infections**

There are two major forms of BRI: blebitis (Figure 9A) and bleb-associated endophthalmitis (BRE), BRE being a more fatal sight-threatening condition.

**Clinical features**

BRI usually begins with acute pain, purulent discharge, and conjunctival injection with a peri-bleb halo of blood vessels with or without a hypopyon. Later, it can progress to vision loss and a milky white bleb characteristic of bleb-related endophthalmitis (Figure 9B). Detailed eye examination, Seidel's test, USG (for vitreous involvement), and culture of bleb surface, conjunctiva should be immediately performed.

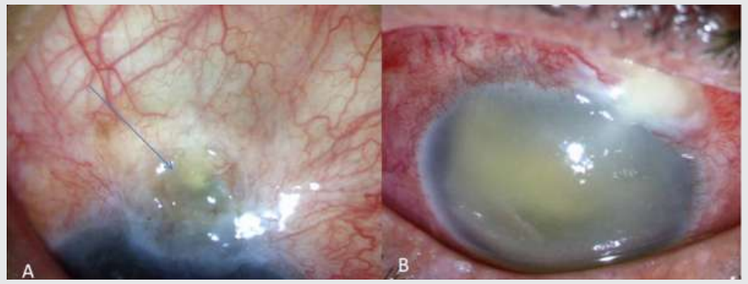


Figure 9: A: Shows thin avascular bleb with infiltrate (blue arrow) suggestive of blebitis. B: Show bleb-related endophthalmitis

**Treatment:**

Topical antibiotics like fluoroquinolones, cycloplegics, and topical steroids should be started immediately. Stage I is likely to respond well to intensive topical antibiotics. When the anterior chamber or vitreous cavity is involved, a vitreous tap along with an intravitreal injection of vancomycin and ceftazidime should be given. Topical and systemic antibiotics should be advocated. Oral prednisolone (1 mg/kg) is started after ruling out fungal endophthalmitis. If the response to intravitreal antibiotic is poor or eye is worsening clinically then pars-plana vitrectomy with bleb excision should be done in consultation with a retina specialist.

# 7.Corneal and ocular surface complications of trabeculectomy

Often trabeculectomy can adversely affect the cornea and ocular surface.[20] Ocular surface complications like corneal epithelial defects, Dellen, limbal stem cell deficiency, overhanging bleb, and filamentary keratitis are not rare.[21,22] The risk factors for these complications are dry eye, long-term use of anti-glaucoma medications, intra-operative use of anti-metabolite like MCC or 5-FU, and systemic disease like diabetes mellitus.[20]



Studies have reported more corneal endothelial loss and related complications in trabeculectomy with antimetabolites as compared to trabeculectomy without anti-metabolites.[22,23] Endothelial loss also increases in complicated trabeculectomy.[24] The use of viscoelastic during surgery may help reduce endothelial cell loss when MMC is employed. Various reports have been suggested that the endothelial cell loss is higher in two-site phaco-trabeculectomy as compared to single-site phaco-trabeculectomy. Post-operative 5-FU supplementation should be performed cautiously as accidental inoculation can lead to endothelial toxicity or spillage over the ocular surface can lead to epithelial toxicity (Figure 10.). Endothelial toxicity is managed by aggressive topical steroids and often the toxicity is irreversible.

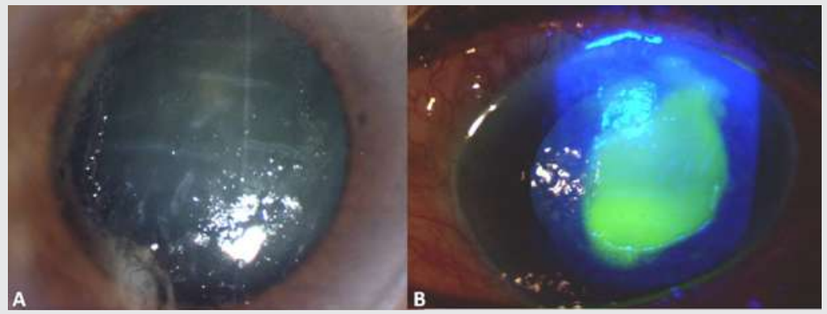


Figure 10: A: Shows signs of endothelial toxicity (corneal edema and Descemet's fold) and epithelial toxicity. B: Shows epithelial toxicity/Epithelail defects on fluorescein staining

The reported incidence of epithelial defects is 0-16%[21,25], and most often it is partial defects (Figure 11). Common reasons are surgical trauma, improper pad, and patching of eye post-operatively or retention of suture remnants in the fornix. Management includes removal of any suture remnants, avoid eye rubbing, frequent lubrication with carboxymethyl cellulose, topical antibiotics and bandage contact lens. The antimetabolite-induced epithelial toxicity should be treated with aggressive topical steroids and lubricants.

Figure 11: Shows partial epithelial defects (dark arrow).

Dellen is a small, saucer-like excavation at the corneal periphery and the reported incidence is 2-9% and the incidence is lower in fornix-based trabeculectomy.[20] Dellen is thought to be associated with large elevated bleb (which disrupt the tear film stability) which is often seen in limbal-based trabeculectomy. Dellen can be managed conservatively by frequent use of lubricating eye drops, which stabilize the tear film. Bleb suturing or reduction of bleb size is rarely required.[26]

Overhanging bleb (figure 12) and intracorneal dissecting of a drainage bleb are late complications that lead to astigmatism and dysesthesia. The management is surgical in the form of blunt dissection of overhanging bleb from the cornea and followed by bleb excision at the limbus. The dissecting bleb requires excision and refashioning of the bleb (Video 6.16).

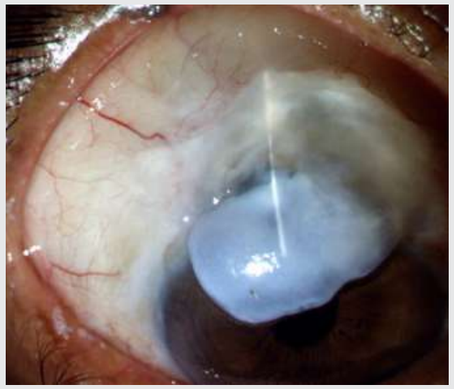

Figure 10: Shows overhanging dysesthetic bleb

## 8. Refractive error/astigmatism induced by trabeculectomy

Despite the wide popularity of trabeculectomy, the effects on refraction, particularly on astigmatism, are incompletely understood. It is not uncommon for patients who underwent trabeculectomy to have a drop in visual acuity for initial post-operative periods. In some patients it can persist for long-term. [27]

Apart from reduced IOP, changes in axial length and the direct effect of trabeculectomy on astigmatism can lead to a decrease in visual acuity. Other causes of diminution of vision are a decrease in contrast sensitivity and an increase in corneal higher-order aberration. Various studies have shown an induced hyperopia following trabeculectomy and usually, it stabilizes by 3 months post-operatively.[28-30] One study by Cunliffe et al[31] reported a myopic shift following trabeculectomy due to decreased anterior chamber depth. Induced astigmatism may cause a decrease in visual acuity following a successful trabeculectomy. Studies have reported that trabeculectomy can lead to a considerable amount of with the rule astigmatism (a mean of 0.8131.08) in the initial few months followed by a gradual against the rule shift.[32-36] Literature showed that use of MCC is associated with longer duration of astigmatism changes as compared to trabeculectomy without MCC.[27]

Causes for induced astigmatism are large and broad scleral flap, large sclerostomy, excessive scleral cauterization, over-tight suture or unequal tension on the scleral flap, excessive intra-corneal dissection, and overhanging of the bleb.

Prevention of hypotony is foremost important to prevent induced axial refractive error. The induced astigmatism tends to stabilize by 3 months post-operatively. It is therefore important to advise or counsel the patient for a waiting period of 3 months. Often after this waiting period, the residual error may not be visually significant. For astigmatic correction, prescription of spectacle is the first option. Sequential cataract surgery can be done, following suitable intervals after filtration surgery with a toric intraocular lens.[28,36] Other options included a limbal relaxing incision or laser procedure like photorefractive keratectomy.[36] While planning phaco-trabeculectomy, one should be aware of the refractive changes following trabeculectomy especially for toric intraocular lens.



## 9. Failed trabeculectomy – Needling/ bleb revision/Repeat trabeculectomy

Late failure of the filtering bleb is mainly due to fibrosis at the sub-tenon's level and rarely due to an obstructed ostium. The management depends upon the cause and usually requires surgical interventions. Various surgical techniques have been reported to re-establish the filtration of aqueous humor in a failed trabeculectomy bleb.

### A. Needling

- Bleb needling can be done in whom trabeculectomy was successful long-term and who have favorable conjunctival features.
- Sub-tenon's needling may be done either on the slit-lamp or in the operating room (most preferred) (Video 6.14) depending upon the anticipation of combining the procedure with a sub-scleral approach.
- Bleb needling with MCC/ 5-FU can be an effective option, especially if a low target pressure with less medication is needed. (video 6.7)
- The needling technique can be successful in early and late cases.
- The risk is low for serious post-operative complications that result in the loss of vision or need for reoperation.

### B. Blebotomy/external limited bleb revision

Blebotomy can be performed in eyes with localized encysted bleb and when the surrounding conjunctiva is favorable. Blebotomy is easy to perform, minimally invasive and done through a fornical approach. (Video 6.14)

### C. Limited external bleb revision

Limited posterior bleb revision is also an effective procedure in scarred blebs involving limited dissection at the bleb site through a posterior fornical small conjunctival incision. It is more invasive than a blebotomy. The external bleb revision (Video 6.17) can be augment with anti-metabolite like MMC.

### D. Repeat trabeculectomy

Same-site trabeculectomy revision with MMC should be considered as a viable option to achieve reasonable IOP targets after a first failed trabeculectomy. Repeat trabeculectomy can also be performed in previously failed needling or external bleb revision. With the advertant of drainage implants, number of repeat trabeculectomy has decreased significantly. Repeat trabeculectomy has a lower success rate than the first, concerning IOP and medication reduction. (Video 6.18).

## 10. Cataract formation and management

Eyes which are undergoing trabeculectomy have an increased risk of cataract formation or progression of existing cataract.[37] Landmark studies like Advanced Glaucoma Intervention study[38], the Collaborative Normal-tension Glaucoma Study[39] and the Collaborative Initial Glaucoma Treatment Study[40] have shown a higher risk of cataract formation in trabeculectomy arm as compared to non-surgical arm. The reported increase in the risk of cataractogenesis is as high as 78%[37] and if the trabeculectomy is complicated then this figure will be even more. Approximately 50% of patients will require cataract surgery within 5 years of glaucoma filtration surgery.[41-43] The etiopathogenesis of cataract formation following trabeculectomy is multifactorial.[44] Various patient factors that have been associated with increased risk of cataract formations are pseudoexfoliation, myopia, and diabetes.[40] Flat anterior chamber and post-operative inflammation are the two major risk factors of cataractogenesis.[37]

Cataract leads to a decline in visual acuity and visual field performance and hence determination of glaucoma progression is difficult. On the other hand, cataract surgery in eyes with previous trabeculectomy may lead to an adverse event on long-term survival of filtering bleb that is bleb failure and loss of IOP control.[37] Various reports suggest that phacoemulsification in eyes with filtering can lead to a 33% increased risk of bleb failure consistent with bleb morphological changes.[41] Various risk factors for failure of bleb include the shorter interval between cataract surgery and phacoemulsification, high IOP before cataract surgery, age less than 50 years, myopia, intra-operative iris manipulation, posterior capsule rupture, and vitreous loss.[37,38]

The timing of cataract surgery after trabeculectomy is most important. The shorter the interval, the greater the risk of bleb failure. Optimum interval is not known, however, studies have shown that a delay of 1-2 years reduces the chances of bleb failure.[37,47] Pre-operative evaluation should include evaluation of bleb morphology, IOP measurement, gonioscopy to evaluate the patency of ostium, specular microscopy, assessment of optic nerve damage, corneal astigmatism pupillary dilatation and detailed posterior segment evaluation.

Intra-operative measures: Intra-operatively gentle and minimal manipulation of anterior chamber and bleb can prevent tissue trauma and inflammation and chances of bleb failure.

- Topical anesthesia is preferred over peribulbar anesthesia.
- Phacoemulsification incision site should be clear corneal and away from the site of trabeculectomy.
- While doing paracentesis, extra caution should be taken to avoid iris and anterior capsule touch in eyes with shallow anterior chamber.
- The corneal endothelium should be protected with dispersive viscoelastic, preferably chondroitin sulfate.
- Non dilation of the pupil is commonly encountered due to various reasons. Very gentle synechiolysis with injection of high cohesive viscoelastic is performed. Gentle use of iris hook or pupil expanding devices is advocated.
- While staining of the anterior capsule with trypan blue, one can observe the staining of conjunctiva over the bleb area, if the bleb is functional.
- Phaco setting should be optimized. A low bottle height can lead to a shallow anterior chamber. A very high bottle height setting to prevent chamber collapse may lead to intra-operative corneal edema in eyes with compromised endothelium. The phacoemulsification should be performed in the bag by using a standard technique.



- A thorough cortical clean-up is mandatory as retained cortical matter leads to inflammation.
- Aspheric monofocal intraocular lens in the bag is preferred. Multifocal IOL is contraindicated.
- Thorough removal of viscoelastic is mandatory including from behind the IOL. If the bleb is not raised while forming the anterior chamber, an internal bleb revision is performed.
- Evidence suggests that a single subconjunctival injection of 5-FU (5 mg) has protective effects on bleb.

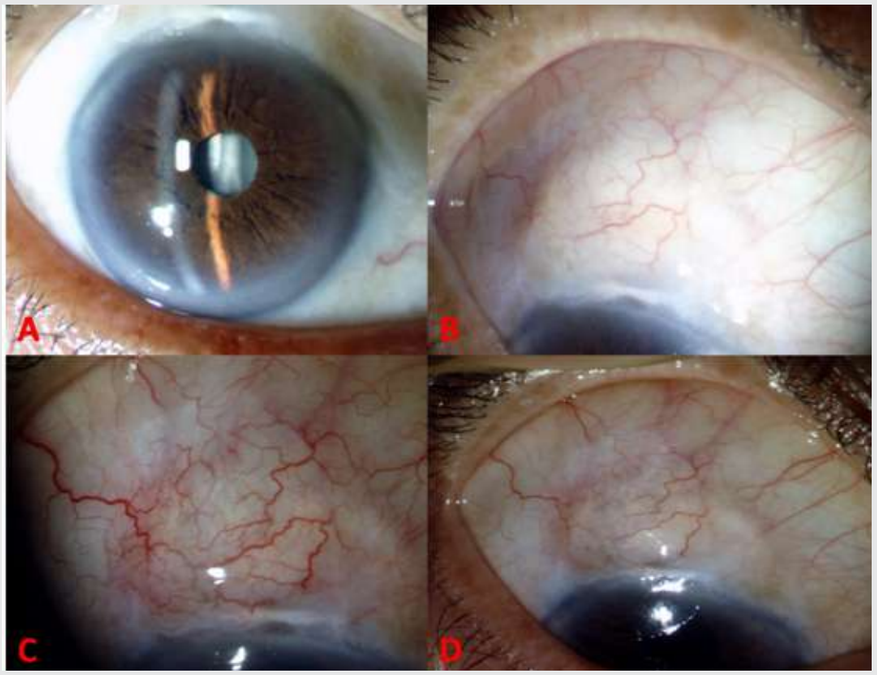


Figure 11: A: Showing visually significant cataract, B: Functioning bleb, C: Post-phacoemulsification 1 week bleb is more congested and vascularised and 5-FU augmentation done. D: Post-operative 1 month congestion and vascularity reduced, but more scarring as compared to pre-operative bleb.

Post-operatively close follow-up of these patients is mandatory for monitoring IOP (fluctuations are common in early post-operative periods) and to find out early signs of bleb failure (Figure 11). More aggressive anti-inflammatory therapy in the post-operative period may decrease the bleb failure.[37,45] Topical steroid should be used for longer periods in patients when cataract surgery is done with a bleb. Prolonged use of non-steroidal anti-inflammatory therapy may have a role. Thorough bleb examination is mandatory to pick up imminent signs of bleb failure like corkscrew vessels and encapsulation. If there is vascularisation or fibrosis, sub-conjunctival injection of 5-FU is advocated. A study by Shahid et al[46] showed that there was no significant difference in bleb survival in patients who received 5-FU as compared to patients who did not receive 5-FU post-operatively. Literature has shown variable effects of cataract surgery on a functional bleb and showed that between 65% to 100% of previously functioning bleb would still function successfully after 1 year.[37]

# 11. Long-term trabeculectomy outcomes - overview of success rates, failures, complications

Trabeculectomy has generally been considered the gold standard procedure among all glaucoma surgical procedures.[47] During the last 3-4 decades, studies have confirmed the effectiveness of this procedure on a short and long-term basis. The reported success rate varies from 65% to 85%. Success rates vary with various factors like age, ethnicity, and type of glaucoma.[48,49] Previous studies have reported a lower success rate in Africans and African-Americans than Caucasians.[50-52] Study by Sihota et al[53] showed that 10 years qualified success rate of trabeculectomy without the use of anti-metabolite in Asians is not different from those reported from the Caucasian population.

Fibrosis of sub-conjunctival tissue leads to scarring and failure of bleb and a decrease in the long-term success of trabeculectomy.[54,55] Anti-metabolites like MMC and 5-FU significantly decrease the post-operative subconjunctival scarring. Studies have shown that adjunctive use of anti-metabolite has improved the long-term success rate of trabeculectomy. A study by Scott et al[56] showed that primary trabeculectomy with the use of intra-operative MMC lowered the IOP by 30% or more in 86% and 78% at 1 and 2 years respectively. A study done by Casson et al[57] showed 80.9% of eyes had an IOP of less than 21 mm Hg without medical treatment at the end of three years post-trabeculectomy with 0.02% MMC application. Their study had a 67% and 90% probability of IOP being less than 21 mm Hg at the end of five years using Kaplan Meir life table analysis. Studies have shown that the use of MMC was associated with significantly lower post-operative IOP and higher long-term success as compared to 5-FU.[58] However, the use of MMC and 5-FU during surgery has increased the risk of bleb-related complications like thin avascular cystic bleb, hypotony, maculopathy, blebitis, and bleb-related endophthalmitis.

Nevertheless, trabeculectomy is still considered a gold standard procedure though, it is not free of complications.[59-61] Olayanju et al[1] reported that the 20-year cumulative chances of early, late, or any complications were 19.7%, 26.0%, and 45.0% respectively. The cumulative probabilities of vision-threatening complications during 20 years were 2.0% for blebitis and 5.0% for endophthalmitis.[1]

**Table 1: A review of the various studies showing the success rate and complications following trabeculectomy**

| No. | Name of the study | Success rate | Hypotony | Hyphaema | Bullous choroidal detachment | Subsequent cataract extraction | Second trab/tube |
|---|---|---|---|---|---|---|---|
| 1 | *Tran DH et al[62] N= 88* | *80.9% at 1 year* | *59% (2% needed revision for hypotony)* | *-* | *10%* | *13%* | *28%* |
| 2 | *Shen CC et al[63] N= 20* | *65% at 1 year, 55% at 2 years* | *10%(early) Late leak in 5%* | *40%* | *-* | *-* | *-* |
| 3 | *Wilson MR et al[64] N= 64* | *68.1% at 41 -52 months* | *9.4% (wound leak) Flat AC (15.6%)* | *10.90%* | | *17.18%* | |
| 4 | *Pakravan M et al[65] N= 15* | *40%* | | | *Choroidal effusion (26.66%), drainage is done in all* | | |
| 5 | *Casson R et al[57] N=20, 21 eyes* | *80.9% at 3 years* | *1/21 (4.7%) Hypotonous maculopathy reversed after bleb revision* | *-* | *-* | *7/21 (33.3%)* | *2/21 (9.5%)* |
| 6 | *TVT study[66] N=212 Tube ; 107, Trab ;105* | *Probability of failure at 5 years : 46.9 %* | *12 of 105 (11.42) (wound leak)* | *Vit. Hmg : 1 (0.95%)* | *Supra choroidal Hmg.: 3 (2.85%)* | *43%* | *29% at 5 years* |



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# Section 3 Surgical Videos - Overview

## I. Trabeculectomy module – The beginning

**Abstract**

Trabeculectomy is the gold standard surgery for glaucoma to lower eye pressure. For the surgery to be successful, an extensive preoperative workup is required. After patient evaluation and diagnosis, indications for surgery are considered. A thorough pre-operative evaluation involving both ophthalmic and systemic history is done. Vision assessment pre-operatively forms the foremost step. A detailed slit-lamp evaluation with IOP assessment, gonioscopy and fundus examination is done. Visual fields are mandatory prior to surgery.

Next comes the informed consent. A clear communication to the patient and the family that preservation of vision as the main goal is crucial to moderate any expectations of surgery. Consent form should be in patient's language so as to clearly convey the benefit to risk ratio in surgical decision making.

Facilitating pre-operative treatment to reverse or minimize risk factors and determine the type and dosage of antifibrotic therapy and post-operative bleb modulation to be prioritized. Surgical instrument's maintainance and sterilization is of utmost importance. Block room preparation with intravenous mannitol and subtenons block is important. Lastly pre-operative steroids to reduce ocular inflammation and post-operative regime of 3-months followed meticulously owe in making a successful outcome of trabeculectomy surgery.

Video 1 discusses indications, basic examination (ophthalmic and systemic), risk factors of failure, medications, instruments and preparation needed for trabeculectomy surgery.

## II. Pre-operative evaluation & planning surgical modifications

**Abstract**

Meticulous pre-operative evaluation of patients undergoing glaucoma surgery is imperative for a successful outcome. Infections of the ocular adnexa need to be treated prior to trabeculectomy to prevent endophthalmitis. Syringing to check for a patent nasolacrimal duct and conjunctival swab should done in all functionally one eyed patients prior to surgery. Patients with coexisting lens changes and glaucoma should be carefully evaluated to determine influence of each on visual function to decide on need for trabeculectomy versus combined phacotrabeculectomy. In case of previous intraocular surgeries, it is important to identify areas of mobile conjunctiva to plan surgical site. The ocular surface should also be carefully examined for signs of medication allergy or surface inflammation due to chronic topical therapy. The decision to discontinue anticoagulation/ antiplatelet therapy prior to glaucoma surgery is individualised based on a patient's risk profile and carried out in conjunction with the physician. Additional modifications like subtenon anaesthesia where feasible, avoiding intraoperative hypotony by using preplaced sutures and anterior chamber infusion maybe considered. The type of glaucoma is an important factor for planning modifications in the surgical procedure. Key factors which need consideration in order to modify surgical technique and minimize intra- and post-operative complications while dealing with uveitic eyes, neovascular glaucoma, angle closure glaucoma, Sturge Weber syndrome, nanophthalmos, high myopes and re-trabeculectomy are illustrated in this video.

## III. Surgical Anatomy

**Abstract**

While performing trabeculectomy, the surgeon needs to be aware of the surgical landmarks at the limbus for the correct placement of the incision. The limbus is a blue gray border zone separating cornea, conjunctiva, sclera, and uvea. It is defined differently by the ophthalmic surgeon, pathologists and histologists. The anterior border of the limbus is the conjunctival insertion on the cornea. The posterior border of the limbus is the junction of the translucent limbal zone with the white sclera which corresponds internally to the scleral spur. During trabeculectomy, as the conjunctival and scleral flaps are dissected, the borders of the limbus become more well defined. This video explains the surgical anatomy of the limbus, and corresponding internal landmarks during various stages of trabeculectomy along with the applied anatomy.

## IV. Trabeculectomy Surgery

**1- Trabeculectomy technique**

Trabeculectomy can be performed under topical or peribulbar anesthesia. General anesthesia is reserved for children or unco-operative patients.

After painting and draping, speculum is applied which provides maximum exposure of the eye and also which does not exert pressure on the globe.

A traction suture rotates the globe downwards, providing optimum exposure of the superior sulcus and limbus. Traction can be achieved by superior rectus bridle suture or corneal traction suture. In superior rectus bridle suture technique, a closed Dastoor forceps is slid into the superior fornix where it is opened and pressed firmly on the globe and the superior rectus tendon is grasped. A bridle suture of 4-0 silk on a tapered needle is placed under the tendon, the suture is then drawn superiorly and clamped to the drape. Care must be taken to avoid conjunctival tear or hemorrhage during maneuvers.

In corneal traction suture, a 5-0 mersilk on a spatulated side cutting needle is passed through the cornea approximately 1 mm from the limbus for 3-5 mm half the depth of cornea and is centered directly anterior to the intended site of scleral flap. Gentle traction on the suture can be done, to check for its integrity, prior to clamping the suture to the inferior drape.

Coming to the conjunctival incision, the surgical management of conjunctiva in trabeculectomy is crucial to the long-term surgical outcome. The conjunctiva should be handled carefully to avoid creation of a tear or a buttonhole.

The conjunctival flap may be either fornix-based or limbus-based. In fornix-based conjunctival incision, with a non-toothed forceps, limbal peritomy of the conjunctiva and tenon's together is performed with Westcott scissors for about 2-3 clock hours in the intended quadrant. Dissection is carried out to remove tenon's attachment to episclera both posteriorly and to the sides of peritomy, to create a potential space for aqueous filtration. Gentle cautery of the bleeding vessels is done with wet field cautery.

In limbus-based conjunctival incision, the conjunctiva is incised 8-10 mm from the limbus. Using Westcott scissors, the conjunctiva is separated from the tenon's by undermining in all directions. Then, the incision on the tenon's is made parallel to the conjunctival incision, about 2-3 mm more posteriorly. The tenon's capsule is dissected free from the episclera anteriorly till the limbus.

When we compare limbus-based and fornix-based incisions, Limbus-based flaps cause formation of scar tissue at the conjunctival incision resulting in localized, high blebs. They rarely leak and consume more time to close. Fornix-based flaps take less time and result in more diffuse and low blebs. They may leak in the early post-operative phase.

Coming to the use of anti-metabolites, the episcleral surface is the major site of fibrosis in trabeculectomy. Anti-metabolites like 5-FU and MMC interfere with DNA replication and decrease post-operative subconjunctival fibrosis. MMC is the most commonly used anti-metabolite intra-operatively.

Merocel sponges soaked with 0.2 to 0.4 mg/ml of MMC are placed between the sclera and conjunctival flap for 1-3 minutes. Avoid contact of sponge with the conjunctival edges. Sponges are removed after the planned exposure time and the area is copiously irrigated with 15- 45ml of balanced salt solution. The forceps used to handle Mitomycin is immediately removed from the operating field to avoid contamination.

The scleral flap may be fashioned rectangular or triangular. There is no correlation between the shape and the size of the scleral flap to the post-operative IOP control. The size of the

flap should be 3-4 mm.

Here a depth blade of 300 Q thickness is used to make the scleral groove. The edges of the flap are cut ½ to 2/3rds of scleral thickness, taking care to keep the blade perpendicular to the scleral surface and the sides of the flap are extended 1-2mm short of the limbus to facilitate posterior aqueous flow. Then the apex of the flap is gently lifted and with a 15 no. blade, the flap is dissected from the underlying sclera. Uniform thickness of the scleral flap along its entire course is ensured by cutting only the stretched intervening scleral fibres. The dissection is carried till the corneal blue line. A forward dissection into the clear cornea would ensure that the trabeculectomy stoma is well anterior to the scleral spur and ciliary body.

A paracentesis is made prior to creating the trabeculectomy stoma. A paracentesis helps in providing entry for fluid into the anterior chamber (AC) at any stage of the procedure

- For AC wash in case of hyphema or pigment debris
- It also provides fluid to assess the flow after the scleral flap closure
- And also reformation of the anterior chamber during the early post-operative days in case of shallow AC

Paracentesis is made in the peripheral cornea, obliquely, parallel to the iris surface avoiding contact with the iris or the lens. Releasing the superior rectus bridle or corneal traction suture before paracentesis entry will help in avoiding sudden shallowing of the anterior chamber.

The trabeculectomy ostium can be created using a Kelly Descemet's punch or by using blade and Vannas scissors.

The posterior edge of the scleral flap is held gently and pulled towards the pupil. With a 15 degree blade, a cut is made at the anterior margin of the flap from one end of the flap to the other. A Kelly Descemet's punch is used to create the ostium. The punch will create an ostium of 0.75 mm with each bite. Holding the punch perpendicular to the scleral surface will reduce shelving of the stoma. Two to three punches create an adequate opening of about 1.5 mm for aqueous flow and avoid blockage. At least 0.5 mm of the scleral bed is left from the margins of the stoma, so that the stoma is not exposed during closure.

The peripheral iridectomy (PI) serves two purpose.

- It prevents the obstruction of the ostium by iris and also helps in
- Preventing pupillary block

The PI should be directly done under the ostium and slightly larger than the ostium.

The iris grasped anteriorly through the ostium holding only the anterior iris stroma so as to not hold the iris root or the ciliary body. The forceps is then withdrawn, tenting the iris stroma. With a curved Vannas scissors, keeping the two arms of the forceps radial, the sides of the ostium are gently pressed and the iris is cut. The iris is repositioned with a stream of balanced salt solution and gently massaging over the scleral flap.

The scleral flap is then sutured with fixed and releasable sutures with 10-0 nylon suture. The fixed suture can be placed at the apex or at the base.

Here, a fixed suture is shown which is taken at the base. Releasable sutures help in titrating the IOP in the post-operative period. Here a modified Kolker's technique of taking releasable suture is shown. The first bite is through the cornea for 3-4 mm, it is brought out 2-3 mm anterior to the limbus. The second bite is through the clear cornea into the scleral flap and from the scleral flap edge to the intact sclera. A 4 throw is performed with the tail end of the suture to tie the loop, adjusted to the desired tension and the tail end is cut. The corneal end of the suture is cut flush with the cornea to keep it buried. A second releasable suture is taken in the similar fashion.

Here, another technique of releasable suture, the modified Rootman's U-shaped suture is shown, where a reverse bite from the sclera to the limbus is taken and then from the cornea to the scleral flap is taken. And then a 4 throw is performed as similar to the modified Kolker's technique. Fluid flow through the flap can be assessed through the paracentesis. A slow egress of fluid is desirable.

Coming to the conjunctival suturing, the conjunctiva is reapproximated to the limbus with a 10-0 nylon or vicryl suture. Though there are many techniques for conjunctival closure, it is important that the closure is watertight.

Here, two methods of conjunctival closure are shown-

In edge purse-string suture, the wing suture is taken with a 10-0 nylon suture. The needle is passed through partial thickness of the cornea to the limbus, adjacent to the conjunctival opening. Then the needle is passed through the conjunctiva from inside and conjunctival purse-string sutures are taken till the extent of free conjunctiva is involved in the suture. The final bite is taken from the conjunctival edge to the cornea, both the ends are tied in 3-1-1 knot to secure the wound and the knot is buried. Similar procedure is repeated on the other side, to keep the conjunctiva taut at the limbus. Additional horizontal mattress suture can be taken if necessary and buried. Burying the sutures prevents foreign body sensation in the post-operative period.

Interlocking suture can be taken with 10-0 vicryl or nylon suture. Here the first bite is through the episclera close to the conjunctival opening, and the second bite is taken with the free end of the conjunctiva pulled tighter over the limbus. The two ends are tied in a knot. Then the conjunctiva is closed with interlocking sutures keeping a tight hold of the previous suture. The suturing is extended till the edge of the conjunctival opening. This is tied with the first suture's free end tightly to cause hooding of the interlocking sutures. Additional suture may be taken on the other end if necessary for watertight closure.

At the end of the surgery, paracentesis is hydrated to look for formation of bleb and water tightness of the conjunctival closure. Vigorous hydration should be avoided to prevent sutures from getting loose or cut.

Povidone Iodine drops is applied generously followed by prednisolone eye drops at the end of the procedure. Here, Povidone iodine acts as an antiseptic and steroid drops aid in suppression of inflammation. Subconjunctival steroid injections like dexamethasone can also be given. However routinely used subconjunctival antibiotic, Gentamycin should be avoided as it can cause fibrosis of the bleb. Cycloplegics like homatropine or atropine eye drops may be applied before patching the eye in eyes with angle closure disease.

A good surgical technique, gentle handling of tissues with meticulous conjunctival closure helps in long term success of the trabeculectomy surgery and avoids complications.

**2- Trabeculectomy – Step by Step**

**Abstract**

This video demonstrates step by step approach and various modifications of trabeculectomy. Limbal and fornix based trabeculectomy techniques have been shown. Technique of limited deep sclerectomy for augmentation of trabeculectomy has been demonstrated. Multiple techniques of releasable sutures and peritomy closure to prevent shallow anterior chamber in post-operative period have been compiled.

**3- Trabeculectomy- Intra-operative complications**

**Abstract**

The aim of this video is to analyse each complication and its management. Conjunctival button holes can occur during opening and closure of the conjunctival flap. They occur due to improper conjunctival handling. Gentle handling of conjunctiva is recommended. Conjunctival buttonholes should be identified and managed immediately as they can cause wound leak in post-operative period affecting the surgical outcome. Excessive cauterization can cause shrinkage of the scleral flap. Damage to the scleral flap can occur during flap construction or during sclerotomy. Flap tear can occur in a superficial flap whereas a premature entry can occur in deeply dissected flap. Partial or total flap amputation can also happen. If this occurs in the initial stage, its preferable to change the trabeculectomy site. If it occurs later, horizontal mattress 10-0 nylon suture can be used to suture the flap. A donor scleral patch graft can also be used. Alternatively, a partial thickness flap from adjacent sclera can be used for closure. Intra-operative vitreous loss can occur if the ostium is made too posteriorly in white zone. Ensure that the vitreous is cleared from the ostium by using an automated vitrectomy. Bleeding can occur during the conjunctival flap dissection, scleral flap dissection, sclerostomy or iridectomy. Irrigation or application of pressure stops the

bleeding. A small hyphema is usually self-limiting. Sometimes drainage via an anterior chamber paracentesis is required. Suprachoroidal hemorrhage is a rare complication, and measures must be taken to prevent it in high risk eyes.

**4- Releasable Suture Techniques**

**Abstract**

Releasable sutures are really helpful in early post-operative period of trabeculectomy:

1. **Prevents post operative shallow anterior chamber**
2. **Titration of IOP**
3. **Hypotony related complications like choroidal detachment or suprachoroidal hemorrhage**

Different techniques and commonly practiced releasable sutures are

1. **Modified Wilsons technique (Cornea to Sclera):** Simple and most widely used (mattres type) releasable suture. 10-0 MFN is first passed from clear cornea to edge at the base of the scleral flap underneath the limbus. Then in second step, the same suture is passed in continuous box manner adjacent to base of the intact sclera to clear cornea and knot is tied and buried.
2. **Modified Wilsons technique (Sclera to Cornea):** Same as method described earlier, but the 10-0 MFN is first passed from scleral side towards cornea.
3. **Modified Cohen and Osher technique:** Simple and widely used. Here, 10-0 MFN is initially passed cornea to cornea at partial thickness depth from cornea to base of the scleral flap underneath the limbus. In second step, same suture passed from edge of the scleral flap to adjacent intact scleral margin after leaving a loop over the scleral flap. The needle end of the suture tied with the loop over the scleral flap as a loose end.
4. **Johnstone method of releasable suture:** Technique is little complex and passed in two steps. MFN suture (10-0)is passed in a mattress manner from intact sclera to scleral flap raised end and tied. In second step, 10-0 MFN with needles on both the ends is passed on both sides of the scleral flap, from corneal to intact scleral margin. The left suture end is passed underneath the suture over the scleral flap margin and tied with the right suture end and knot is buried.
5. **Accordion method of releasable suture:** First the 10-0 MFN is passed through the mid distal edge of scleral flap internal to external. It is then passed through mid left edge of the flap, external to internal. Suture is then passed twice through clear cornea at the limbus creating a u shaped loop. The suture is then passed through mid right edge of the scleral flap, internal to external followed by passage through mid distal edge of the flap, external to internal. The free suture ends are tied after securing the scleral flap with corner 10-0 MFN sutures.

These releasable sutures are removed within 6-8 weeks of post-operative period with ease on slit-lamp examination based on the post-operative bleb vascularization, IOP and astigmatism.

**5- Limited deep sclerectomy augmented trabeculectomy**

**Abstract**

In this video we are discussing surgical technique of deep sclerectomy. After making partial thickness flap, another partial thickness scleral flap of approximately 2x1mm dimension is made in the scleral bed. This deep sclerectomy creates space for aqueous pool. Aqueous accumulated in this space keeps scleral flap separated from scleral bed and prevents closing. This new technique improved surgical outcome by creating intrascleral aqueous lake leading to better IOP control than trabeculectomy alone.

**6- Management of premature entry into anterior chamber**

**Abstract**

This video presents management of premature entry into anterior chamber while raising scleral flap. Note the stretched and thinned out limbus superiorly. After localized peritomy



and cauterization, scleral flap was raised with the help of crescent blade. While blade was being advanced towards the cornea sudden egress of fluid and shallowing of anterior chamber was noted. Side entry was made in cornea followed by air injection to form the anterior chamber. Iridectomy was then done from the same entry and scleral incision was then closed with 10-0 MFN. Peritomy was closed with vicryl suture.

**7- Management of vitreous prolapse from ostium**

**Abstract**

Corneal traction suture is applied to rotate eye downwards to facilitate trabeculectomy. Excessive traction if applied, results in increased IOP which can lead iris and even vitreous prolapse from scleral ostium. Here we present a surgical video where excessive tractional force from corneal stay suture resulted in proplase of vitreous from ostium. It was then managed by loosening the traction suture and localized vitrectomy of the prolapsed vitreous. Rest of the steps were the same as any normal surgery.

**8-Trypan blue-assisted assessment of bleb functioning and bleb leak**

**Abstract**

Scleral flap, if sutured too tightly can result in failure of trabeculectomy surgery. Part 1 of the video demonstrates the technique of checking the functioning of sutured scleral flap. Trypan blue dye is poured over sutured scleral flap site and fluid is simultaneously injected in anterior chamber through a side entry. Free flow of fluid should be observed from the edges of scleral flap.

Meticulous peritomy closure is essential to avoid post operative hypotony and shallow anterior chamber. The completeness of closure can also be checked with the help of trypan blue. Dye is slowly poured over peritomy edges and simultaneously fluid is injected into anterior chamber through side entry. No leak should be observed from a meticulously closed bleb. Suturing should be revised if leak is observed.

**9-Combined phaco- trabeculectomy**

**Abstract**

This video presents the technique of combined phaco-trabeculectomy. Combined surgery might be warranted by presence of significant cataract compromising visual acuity or when surgeon feels that thick lens might result in shallow anterior chamber in post-operative period. Usually phaco precedes trabeculectomy when performed together.

A single site or twin site phaco-trabeculectomy can be done. In single site technique, after lifting the scleral flap in the superior sclera, an entry made at the corneal end of flap is used as the main port for phaco probe insertion. In twin site technique, first peritomy and scleral flap preparation is done in superior sclera. Phaco is then done with surgeon sitting temporally using standard clear corneal incisions. This is followed by creation of an ostium at the scleral flap bed. Rest of the steps are the same as any standard trabeculectomy surgery.

**10-Trabeculectomy combined with Manual Small Incision Cataract Surgery**

**Abstract**

This video demonstrates the technique of trabeculectomy combined with manual small incision cataract surgery (MSICS).

First part of the video demonstrates how trabeculectomy can be done with a standard scleral tunnel made for MSICS. Peritomy is followed by formation of a scleral tunnel for MSICS. Rest of the steps proceed as a normal MSICS. After lens implantation, a small trabeculectomy ostium is made with blade or Kelly's Descemet punch. This is followed by peripheral iridotomy. Scleral tunnel is then closed with 10-0 MFN sutures. Finally, peritomy is meticulous closed with vicryl sutures.

Second part of the video demonstrates the technique of combined surgery using scleral flap

method. Here a triangular scleral flap is raised just like in any trabeculectomy. Important thing to note is that the size of flap is larger than what is normally made in trabeculectomy, as the same will be used to deliver cataractous lens and insertion of intraocular lens.

## V. Trabeculectomy post-operative management

### 1-Trabeculectomy- Post-operative modifications

**Abstract**

The early post-operative period following trabeculectomy is vital to identify early signs of bleb failure. An intra-operative tight closure of the scleral flap is usually recommended to avoid hypotony. In the early post-operative period, the IOP can be titrated by digital massage, removal of releasable sutures and argon laser suture lysis. In case of a flat bleb with raised IOP, a tight scleral flap closure is one of the most probable cause. In such cases a gonioscopy is mandatory to rule out any obstruction of the ostium with iris tissue, blood or vitreous. A digital ocular massage may be the simplest methods to re-establish filtration by overcoming any resistance to aqueous outflow. Subconjunctival 5-FU may be required in case of vascularization of the bleb. The removal of a releasable suture is a simple and cost effective way to enhance filtration through the scleral flap edge. It can be done on the slit-lamp and helps in achieving the desired IOP. The optimum timing of removal would be within the first 3 weeks of surgery. Although, it has few limitations such as wind-shield wiper effect, inability to release the knot, and hypotony. The Hoskins or Mandelkorn lens used in Argon laser suture lysis helps to blanch the conjunctiva magnify and clearly visualize the suture. Suturelysis can be effective up to 3 months post-trabeculectomy when augmented with MMC. The drawbacks include hypotony, shallow anterior chamber and inability to visualize or cut the suture. This video gives an overview of post-operative management after trabeculectomy surgery.

### 2-Anterior chamber reformation

**Abstract**

Shallow anterior chamber is a frequently encountered complication of trabeculectomy. It is more commonly encountered in angle closure than open angle glaucoma. Anterior chamber reformation can be done by injecting air or even viscoelastic agents into the anterior chamber with the help of a 26 gauge needle. This video demonstrates the technique of anterior chamber reformation in a case of shallow anterior chamber post-trabeculectomy.

## VI. Post-operative considerations and Rescue Operations

### 1-Good bleb

**Abstract**

This video describes characteristics of good bleb and anterior chamber after trabeculectomy surgery.

### 2- Anterior chamber reformation on slit-lamp

**Abstract**

The basic mechanism of all glaucoma filtering surgeries is to create a fistula for aqueous outflow, bypassing the conventional strained drainage pathway. Hence, post-operative shallow anterior chamber with low IOP is not uncommon. Conservative management with cycloplegics is the first-line, along with targeted treatment for the specific cause. However, the resultant shallow anterior chamber, if severe may require urgent surgical intervention.

Anterior chamber (AC) reformation is most commonly done as a short procedure under the operating microscope in surgical theatre. A few patients may require reformation more than once, and this needs repeated operating room (OR) visits, increasing the costs both to the patient and the facility. To circumvent this, we initiated a safe AC reformation technique as an office procedure under the slit-lamp biomicroscope using sterile filtered air. This could be a convenient procedure in routine glaucoma practice, allaying both the physician's and the patients' anxiety over repeated OR visits.

The patient is pre-treated with topical cycloplegics to cause maximum posterior shift of the iris-lens diaphragm. The procedure is explained to the patient and a written informed consent is taken. He/she is seated comfortably in front of a slit-lamp biomicroscope and one drop of 0.5% topical proparacaine is applied to the eye to be treated. The surgeon after surgical hand scrubbing, wears a sterile glove in the dominant hand. Under sterile aseptic conditions, a two- or five-ml syringe is opened and offered to the surgeon. An air filter is attached onto the syringe and 2 ml of sterile air is drawn into it. The air filter is then disassembled, and a 26- or 30-gauge needle is attached.

The patient is asked to then place his chin on the chin rest. The assistant retracts the patient's upper lid to avoid inadvertent closure. The surgeon adjusts the slit-lamp for right focus using his/her non-dominant hand. With the patient looking straight in primary gaze, the needle is inserted vertically inferior to superior through the peripheral thick cornea with bevel- up, to minimize the chances of inadvertent lens injury. This ensures formation of a long peripheral tunnel, avoiding sudden forceful entry into the AC. Once the entire corneal thickness has been penetrated, entry into AC is heralded by a sudden loss of resistance. If the corneal penetration is tedious due to hypotony and resultant loss of turgor, a Lim's forceps is used to gently grasp the opposite limbal conjunctiva and provide outward traction so as to provide counter-traction to the hypotonous globe, easing penetration. Once full thickness entry is achieved, the required amount of sterile air is gradually injected into the anterior chamber to reform the depth. The needle is then withdrawn, and betadine soaked sterile cotton swab stick is placed on the entry site for a few seconds to prevent air leak. Topical antibiotic is then applied.

### 3- Malignant glaucoma management

**Abstract**

Malignant glaucoma following trabeculectomy is not uncommon and is a vision-threatening complication. Risk factors are eyes with preexisting shallow anterior chamber, angle-closure glaucoma, short axial length (<21 mm), female gender, and malignant glaucoma in the fellow eye. It is caused by the posterior diversion of the aqueous into the vitreous cavity. Aqueous misdirected posteriorly into the vitreous cavity-causing simultaneous flattening of central and peripheral anterior chamber despite patent peripheral iridectomy (PI) and forward rotation of the ciliary processes detected by ultrasound biomicroscope. Before making a diagnosis one should rule out pupillary block.

IOP may normal or high. The initial management includes aqueous suppressants and strong cycloplegics. If medical therapy fails, surgical treatment is indicated. In pseudophakic or aphakic eyes, laser hyaloidotomy with posterior capsulotomy can be tried. Surgical treatment includes vitreous aspiration, pars plana vitrectomy, or pars plana vitrectomy with zonulectomy and iridectomy. Long-term cycloplegics are needed even after the reversal of misdirection.

### 4- Bleb Massage

**Abstract**

A gentle massage at the slit-lamp usually restores outflow and reduces the IOP. The idea is to open up the scleral flap momentarily and allow egress of fluid from the anterior chamber to the sub-tenon's space. This is also important to maintain the patency of the bleb and avoid early scarring of the conjunctiva to sclera which would result in an early bleb failure.

Here, we demonstrate the technique of bleb massage on slit-lamp.

Ask the patient to look down and through the lid gently push the area adjacent to the scleral

flap. Fish mouthing tends to open up the scleral flap and subsequently egress of aqueous in sub-tenon's space and bleb formation.

### 5- Bleb massage and 5-FU injection

#### Abstract

Early healing due to post-operative inflammation is usually seen in the first 7-10 days. At this time, a gentle massage to re-establish flow followed by injection of 5-FU for its anti-mitotic properties to inhibit fibrosis.  Five mg in 0.1 ml is given in the subconjunctival space but away from the bleb.

Ask the patient to look down and through the lid gently push the area adjacent to the scleral flap. Fish mouthing tend to open up the scleral flap and subsequently egress of aqueous in sub-tenon's space and bleb formation. Injection of of 5-FU (5 mg in 0.1 ml) is injected in the subconjunctival plane posteriorly away from the bleb.

### 6- Blood in the bleb

#### Abstract

A similar procedure to video 5 may be needed if an accumulation of blood occurs at the scleral flap site, as the presence of blood puts it at risk of fibrosis and thus failure. Injection 5-FU (5 mg in 0.1 mL) is of value in such cases.

### 7- Releasable suture removal followed by bleb massage and 5-FU injection

#### Abstract

A flat bleb may need the removal of a releasable suture followed by a bleb massage to allow the passage of fluid from beneath the flap into the subconjunctival space. Simultaneous injection of 5-FU (5mg in 0.1 mL) should also be given at a site away from the bleb if there is a presence of cork-screwing of vessels.

### 8- Laser suture-lysis

#### Abstract

Removal of sutures in the absence of releasable sutures can also be done by using the laser. Argon laser the most commonly used laser for this purpose, also double frequency Nd-YAG laser can be used. The suture to be lysed should be taught and focussed with Hoskins lens.

This video demonstrates the procedure of Nd-YAG assisted laser suture-lysis. The eye is anesthetised with the proparacaine 0.5% eye drops. With the help of Hoskins lens (120D), eye is stabilized and the flap suture to be lysed is focused. Magnification is adjusted according to the need. With energy of 2-2.5mJ, spot size of 50-100 microns and duration 20-100 milliseconds, 1-3 application are needed for desired effect.

Post-procedure antibiotics are instilled and with slight massage, bleb formation can be seen.

This procedure should be preferably done after 48 hours of the surgery to avoid excessive filtration and post-operative hypotony.

### 9- Management of blood clots at the scleral ostium

#### Abstract

Scleral ostium blockage is an uncommon occurrence in the early post-operative period. Post-operative presentation will be raised IOP with deep anterior chambers. Reasons of blockage can be iris tissue, vitreous, blood clot and silicone oil in a previously operated vitreoretinal surgery.

Post-operative day one with evidence of blood at the bleb site or anterior chamber with high IOP with regular pupils is suspicious of ostium blockage with the blood clot. A simple bleb massage can dislodge the blood clots which can be seen as a trickle of hyphema in the anterior chamber.



Alternatively, a tissue plasminogen activator can be injected at the bleb site under sterile condition or an anterior chamber wash can be done.

### 10- Surgical retrieval of clogged iris at scleral ostium

#### Abstract

This video demonstrates the surgical retrieval of clogged iris at the scleral ostium. This patient presented with post-operative raised IOP with distorted pupil. Gonioscopy was suggestive of ostium occlusion by the iris tissue. Patient was cleaned and draped under topical anesthesia. MVR entry is made and anterior chamber is formed with viscoelastic. With the help of sinsky, iris tissue is swiped at the ostium site. As the blockage is relieved the bleb is formed and the pupil becomes circular. Surgical enlargement of the peripheral iridotomy is done. Anterior chamber wash is done with BSS and MVR site is hydrated.

In the post-operative period, the iris may plug the sclerostomy ostium and cause blockage of aqueous outflow. Surgically enlarging the iridectomy usually is all that is needed. Sometimes a vigorous massage may also result in the iris blocking the sclerostomy, surgical revision is usually needed in this case also.

### 11- Bleb needling

#### Abstract

#### High bleb phase

In the first 6-8 weeks after trabeculectomy, elevated IOP associated with a high bleb develops in some patients. It may be managed by aqueous suppressants and a short course of steroids.

#### Encysted Bleb

When a high bleb persists, it may get localized and fibrosis around the edges makes it less amenable to medical treatment.  Often requires needling revision to repair it and to restore IOP control.

Needling is a simple procedure which can be done both on slit-lamp and under microscope. Indication includes encysted bleb, late bleb failures etc. We normally use a bent 26G needle for the procedure. Needling can be used to break fibrotic bands formed between the floor and scleral flap and between conjunctiva and scleral flap by varying the depth of manipulation.

After topical anesthesia with 0.5% proparacaine, a bent 26 G needle mounted on a syringe is introduced from the edge of the bleb while the patient is asked to look away. BSS is injected in sub-tenons space and gently spread with the help of a swab stick. The needle is then passed in the deeper plane and slowly moved in a swiping motion to break the adhesion in subconjunctival plane and sub-scleral plane. A diffuse bleb formation can be noticed. Care must be taken not to disrupt the walls of the existing bleb. It is then slowly retracted and injection of 5-FU is given away from the bleb.

Sometimes gentle massage will result in bleb formation and subsequently lowering of IOP.

### 12- Bleb Excision

#### Abstract

The late bleb leak is usually due to thin-walled bleb and the leak may be focal or diffuse. The reported incidence of late bleb leak ranges from 1.8-to 10%. Preventive strategies include the avoidance of thin scleral flaps and an adequate titration of the use of anti-fibrotic agents, and avoiding excessive exposure to the anti-fibrotic agent. Bleb leak can be detected by Seidel's test: A Fluorescein strip is gently applied over the bleb and the eye should be examined under a cobalt blue filter. A leaky bleb shows the flow of unstained aqueous surrounded by dark green colored tear film.

A focal leak can be managed conservatively with an aqueous suppressant, broad-spectrum

antibiotics, and a soft contact lens. If the leak is large or not responding to conservative therapy then bleb closure can be tried with cyanoacrylate glue, fibrin glue, or injection of autologous blood. Other definitive option is excision of necrotic bleb and advancement of the conjunctiva to the limbus. The scleral bed should be inspected and a donor patch graft can be used if there is scleral necrosis

This technique demonstrates the technique of bleb excision and conjunctival advancement. Bleb margins were delineated and peritomy is done in the surrounding conjunctiva. Bleeding vessels were cauterized. Adequate posterior conjunctiva prepared for advancement with the help of Vannas scissors. The avascular bleb is then excised with the help of vannas scissors. The dissected surrounding conjunctiva is then advanced on to the scleral bed and sutured at the limbus with the help of 6-0 Vicryl. Inferiorly, subconjunctival gentamycin+ dexamethasone injection is given.

### 13- Management of over filtering bleb


**Abstract**

This video demonstrates the steps of surgical revision with closure of the scleral flap combined with external compression suture.

After doing localized peritomy at the posterior margin of the bleb and careful dissection, the triangular scleral fap is identified. A single interrupted 10-0 nylon suture is placed at one of the margins of the bleb. The peritomy is then closed with 8-0 vicryl continuous sutures.

On the other margin of the scleral flap, a box shaped single (10-0 nylon) external compression suture is applied starting at the scleral end, coming out at the corneal end. And finally tying the knot with the free end of the suture at the scleral end.


### 14- Bleb needling and blebotomy


**Abstract**

Late onset-tenon fibrosis can be managed by sub-tenon's needling may be done either on the slit-lamp or in the operating room depending upon the anticipation of combining the procedure with a subscleral approach.

The procedure of blebotomy involves the use of 1.2 mm sized MVR blade. At the posterior margin of the bleb the MVR is passed in the subconjunctival and sub-tenons space. A careful dissection is carried out with slow horizontal sweeping motions to break the adhesions at these plane. Also, dissection is done between the scleral flap and the scleral bed. A successful dissection will lead to shallowing of anterior chamber and formation of bleb.

This can be combined with peripheral injection of 5-FU to delay the fibrosis in the post-operative period.


### 15- Ab interno bleb revision


**Abstract**

Sub-scleral release of fibrosis may be a little tricky owing to the blind nature of the procedure and the possibility of injury to underlying structures with the sharp needle. External bleb repair is a more invasive surgery requiring conjunctival dissection and reopening of the scleral flap. A newer procedure an ab-interno sub-scleral revision technique has been described, and it appears to be a less invasive procedure with a more controlled and predictable approach. A gonioscopy is mandatory to document an open sclerostomy since the spatula will enter the subscleral space through this opening.

Pre-surgery preparation for ab-interno bleb revision

- Office-based slit-lamp procedure, to be done 5 days before surgery.
- Subconjunctival injection of anti-metabolite agent MMC 0.1 mg/ml (0.1 ml) injected in sub-tenon plane using a 30 G needle and 1 ml syringe, in the region of the failed bleb. The injection is then spread using a cotton swab.




Under aseptic conditions, two side ports are made at 2 o'clock and 6 o'clock position, followed by injection of pilocarpine. Anterior chamber is formed with viscoelastic and gonioscopy is performed to visualize the sclerostomy site. The Grover- Fellman sclerostomy internal bleb revision spatula (Epsilon USA) is then introduced from the inferior side port and under visualization through a gonioprism, is passed through the sclerostomy site. With gentle horizontal swaying motion, a blunt dissection is carried out beneath the scleral flap. The spatula is then further advanced carefully in a similar fashion to break the fibrotic adhesion between the sclera and the tenons posteriorly. This re-establishes the free flow of aqueous through the sclerostomy in the sub-tenons space, thus seen as formation of a bleb.

### 16- Overhanging bleb


**Abstract**

Overhanging bleb and intracorneal dissecting of a drainage bleb are late complications that lead to astigmatism and dysesthesia. The management is surgical in the form of blunt dissection of overhanging bleb from the cornea and followed by bleb excision at the limbus. The dissecting bleb requires excision and refashioning of the bleb. This video demonstrates management of overhanging bleb.


### 17- Limited external bleb revision


**Abstract**

Limited posterior bleb revision is also an effective procedure in scarred blebs involving limited dissection at the bleb site through a posterior fornical small conjunctival incision. It is more invasive than a blebotomy. The external bleb revision can be augment with anti-metabolite like MMC.

This video demonstrates the technique of limited posterior external bleb revision.

Following all aseptic conditions localized peritomy is done at around 10 mm from the limbus at the posterior margin of the bleb. A gentle dissection is done in the sub-tenons plane all around the bleb. Careful dissection is done at the bleb site. Mitomycin C (0.02%) is applied with the help of merocel sponges for two and a half minutes in the dissected plane. A through BSS wash is given. The previous scleral flap is identified and with the help of blunt dissection adhesions between the scleral flap and scleral bed are meticulously released, until the egress of aqueous is seen. Through a side port, BSS is injected in the anterior chamber to confirm the patency. The peritomy is closed with the help of 8-0 vicryl continuous sutures.


### 18- Repeat trabeculectomy


**Abstract**

Repeat trabeculectomy can also be performed in previously failed needling or external bleb revision. With the advent of drainage implants, number of repeat trabeculectomy has decreased significantly. Repeat trabeculectomy has a lower success rate than the first, concerning IOP and medication reduction.

After passing a superior clear corneal traction suture, BSS is injected in the supero-temporal quadrant to aid in dissection of plane between the conjunctiva and sclera. A fornix-based peritomy is done and posterior dissection is done in sub-tenons space. Bleeding vessel are cauterized. MMC (0.02 %) is applied with the help of merocele sponges sub-conjunctively for two and a half minutes followed by a through wash with BSS. A triangular partial thickness scleral flap is made with the help of crescent knife in the supero-temporal quadrant. Through the side port, pilocarpine is injected in the anterior chamber for pupillary constriction. A full thickness sclerostomy is then made with the help of Kelly Descemet punch and peripheral iridectomy is done with the help of vannas scissors. The scleral flap is apposed to the scleral bed with the help of single 10-0 nylon suture at the apex of the triangular flap. Two releasable sutures are placed on both the side of the flap to titrate the aqueous flow in the post-operative period. The peritomy is the sealed at the limbus with the help of 8-0 vicryl interrupted sutures.

# VII . Special situations

### 1-Trabeculectomy in Neovascular glaucoma

**Abstract**

Neovascular glaucoma (NVG) is an ocular emergency. If not diagnosed and treated early, it's a blinding disease. NVG is a difficult type of glaucoma and is commonly refractory to maximal medical therapy. Trabeculectomy has reasonable success rates in these eyes if new vessels and inflammation have regressed preoperatively. In this video, we present few tips to perform successful trabeculectomy with appropriate modifications.

### 2-Trabeculectomy in Primary angle closure glaucoma and its post-operative care

**Abstract**

A good pre-operative preparation sets stage for a safe surgery. Rapid reduction of IOP can cause serious vision threatening complications. Therefore, good pre-operative IOP control is mandatory for a safer surgery. This can be achieved with pre-operative intravenous mannitol (20% intravenous mannitol, 5ml/kg body weight). A good peribulbar block followed by ocular massage ensures appropriate hypotony. However, in eyes with very advanced damage, periocular anesthesia may compromise the tenuous blood flow to the optic nerve head and precipitate a wipeout syndrome. Such eyes are best operated under general or topical anesthesia.

Steps of trabeculectomy are similar to any other indication. Some of the precautions are to avoid posterior extension of the deep block to prevent injury to the iris root and ciliary body and prevent bleeding. Adequate peripheral iridectomy is performed. To minimize the duration of hypotony following deep block excision, scleral flap suturing should be performed quickly. Alternately pre-placed sutures may be used to hasten the process.

Additional sutures to the scleral flap and reformation of the anterior chamber as deemed necessary to prevent post-operative hypotony is recommended. One cannot emphasize the need for meticulous and water-tight conjunctival closure. Intra-operative cycloplegics (atropine) topically or subconjunctivally helps to initiate cycloplegia, to deepen the anterior chamber and to prevent malignant glaucoma. Topical or subconjunctival steroid helps to decrease the inflammation.

This video shows trabeculectomy in a case of primary angle closure glaucoma.

### 3- Trabeculectomy post-implantable collamer lens

**Abstract**

Phakic intraocular lens implantation for the correction of high myopia is a popular refractive surgery and is increasingly performed in young individuals, with advantages of faster visual recovery, high efficacy and reversibility. It involves placing of an implantable collamer lens (ICL) between the posterior layer of the iris and the crystalline lens, in the ciliary sulcus. The lens has a plate haptic design with central anteriorly vaulted optic to prevent contact with the crystalline lens and the haptics rest in the ciliary sulcus. Although considered a safe procedure, the position of the phakic intraocular lens along with other factors may contribute to complications such as cataract formation, post-operative IOP elevation and endothelial cell loss. The development of secondary glaucoma is a serious complication following phakic posterior chamber implantable collamer lens implantation.

Raised IOP accounts for 4.4% of post-operative complications and is multifactorial. The early post-operative rise in intraocular pressure following ICL implantation is most often transient and is managed conservatively. Although less frequent, prolonged rise in IOP needing long-term anti-glaucoma medications and/or surgical intervention have also been reported.

Understanding the mechanisms of post-operative raised IOP (open angle: Steroid response, pigment dispersion, retained viscoelastic, prexisting juvenile open angle glaucoma, angle closure: pupillary block, non-pupillary block angle closure due to oversized ICL, reversed ICL causing angle closure) is important to plan appropriate treatment and prevent long-term sight threatening complications of glaucoma. The management may vary from medical management to trabeculectomy to explantation of ICL.

In this video, we present two cases, that needed and underwent trabeculectomy appropriate modifications that helped in achieving IOP control. Avoiding intra-operative and post-operative hypotony is of prime importance to prevent complications in these high myopic eyes. Pigment dispersion due to intra-operative manipulation or shallow anterior chamber should be avoided. Slow decompression, anterior chamber reformation, releasable sutures, judicious use of mitomycin C, intra- and post-operative cycloplegia are important in preventing complications in these eyes.

### 4- Trabeculectomy post-penetrating keratoplasty

**Abstract**

Post-penetrating keratoplasty glaucoma (PPKG) is multifactorial in etiology and complicated. Olson and Kaufman identified several other variables that could possibly alter the anterior chamber angle and thus increase the IOP using a mathematical model, including tight suturing, long suture bites, and same-sized donor-recipient trephination.

Strong risk factors for PPKG includes preexisting glaucoma and aphakia, and minor risk factors include pseudophakia, regrafting, and pre-operative diagnosis as bullous keratoplasty and trauma.

The reported incidence varies strikingly as there is no “gold standard” of PPKG diagnosis. The incidence in early and late post-operative period varies between 9-31% and 18-35% respectively.

Pre-operatively, treat pre-existing glaucoma with medications or surgery so that IOP is well controlled before keratoplasty is performed.

It is an interplay between topical anti-glaucoma medications, laser and surgical management to control PPKG. Conventional trabeculectomy success range is 40-50%. Bleb failure is important aspect to handle in early and late post-operative period along with graft survival. The risk factors for bleb failure are

- Limbal and conjunctival scarring
- Inflammation from previous surgery
- Bleb fibrosis and synechiae formation
- Previous chronic ocular and intraocular inflammation

In this video, we are showing patient with past history of blast injury with previous corneal patch graft undergoing keratoplasty and developing intractable glaucoma requiring trabeculectomy with appropriate modifications. A wider dissection of conjunctiva with wide application of mitomycin C, taking care to avoid damage to graft-host junction, avoiding intra-operative AC shallowing and use of releasable suture when needed is of prime importance for a long surviving trabeculectomy in controlling IOP.

### 5- Modified SICS Trabeculectomy suitable for underserved regions

**Abstract**

In underserved regions of the world, health care personnel including doctors, medical equipment and materials are scarce, while patients generally present with advanced stage of cataract and glaucoma. In this scenario, combining trabeculectomy with manual small incision cataract surgery (SICS) is a more practical approach to a one-off intervention over phaco-trabeculectomy. A simple and easy to follow technique of SICS Trabeculectomy is described in this video. The modifications are towards simplification and standardization of the technique. The highlight of this technique is an aggressive filter with a backup releasable suture. Contrary to the classical teaching, this surgical formula can be applied irrespective of the level of pre-operative IOP or the type of glaucoma.

### 6- Trabeculectomy in congenital glaucoma with a very enlarged limbus

**Abstract**

This is a case of an advanced primary congenital glaucoma with a very enlarged limbus. A 6-0 vicryl superior corneal traction suture was used to infraduct the globe, increasing exposure of surgical site. The subconjuctival plane was separated by injecting using a 26 gauge needle and a fornix based conjuctival flap was created. Localised wet field cautery of the bleeding vessels was performed. A partial thickness scleral tunnel was then created by performing a careful dissection of the thin sclera using a crescent blade. The two side edges were cut and a scleral flap was made. A 10- 0 nylon suture was passed at one of the corners of the flap. Air was injected into the anterior chamber through a paracentesis and a sclerostomy was made at the trabeculectomy site. Peripheral iridectomy was then performed to avoid occlusion of the sclerostomy. The scleral flap was secured using two 10-0 nylon fixed sutures at its corners. The overlying conjuctiva was then secured at the limbus using 8-0 vicryl sutures at its two edges and a 10- 0 nylon mattress suture to anchor it at the limbus.

### 7- Trabeculectomy in aphakia

**Abstract**

Glaucoma in aphakia is the second most common secondary glaucoma in children. It is also one of the most challenging glaucomas to manage. The surgical management options include trabeculectomy, goniotomy, glaucoma drainage implants & cyclophotocoagulation.

Trabeculectomy in aphakia has been reported to have a success rate varying between 25% to 62%. The reasons for lower success rate include history of a complicated surgery, presence of conjunctival adhesion, presence of vitreous in the anterior chamber and an increased incidence of post-operative hypotony.

In this video, we explain the theories of mechanism of glaucoma in aphakic eyes and present the pre-operative, intra-operative and post-operative modifications which can help us to minimize the failure rate of trabeculectomy in these eyes. A careful patient selection, pre-operative mannitol, a thorough anterior vitrectomy where applicable, is of prime importance. Slow decompression, adequate sized deep ostium and peripheral iridectomy, releasable sutures, judicious use of mitomycin C, and a frequent post-operative follow-up are important in achieving a good IOP control and minimizing the complications in these eyes.

### 8- Trabeculectomy with Primary Air Injection to Avoid Shallow Anterior Chamber in Weill-Marchesani Syndrome

**Abstract**

Weill-Marchesani syndrome (WMS) is a connective tissue disorder characterized by abnormalities of the lens of the eye, short stature, brachydactyly, joint stiffness, and cardiovascular defects. The ocular problems, typically recognized in childhood, include microspherophakia (small spherical lens), myopia secondary to the abnormal shape of the lens, ectopia lentis (abnormal position of the lens), and glaucoma, which can lead to blindness. Surgical management of glaucoma can include peripheral iridectomy to prevent or relieve pupillary block and trabeculectomy in advanced chronic angle closure glaucoma.

Trabeculectomy in WMS is challenging because the surgical procedure can lead to shallow to flat anterior chamber intra-operatively as the microspherophakic lens moves forward due to weak zonules. To manage the flat anterior chamber in the early post-operative period, surgical reformation of the anterior chamber is required frequently. The present video demonstrates primary air injection at the end of trabeculectomy which helps prevent the development of shallow anterior chamber.

At the end of trabeculectomy, the reformation of the anterior chamber is performed with a bent 30-guage needle attached to a 2cc glass syringe. The needle is introduced through the cornea just inside the limbus and is insinuated through the corneal stroma for about 1 mm before piercing the Descemet's membrane and then introduced into the anterior chamber. A small bubble of air injected into the anterior chamber to push the lens-iris diaphragm and to create the space. Extreme care needs to be exercised so as to prevent overfilling the anterior chamber with the air bubble. A clinical tip is the visibility of the margins of the air bubble inside the limbus all around. Subsequently, the needle is withdrawn and a cotton-tip applicator is pressed over the needle track to prevent the escape of air. The rationale for air injection is to mechanically introduce some space between the cornea and the lens which will help maintain the depth of the anterior chamber and slow down the flow of aqueous through the bleb in the immediate post-operative period giving the bleb a chance to seal. The air bubble is gradually replaced by aqueous humor maintaining the anterior chamber depth and subsequently the filtration is resumed. Air injection is a safe and valuable adjunct to prevent shallow anterior chamber following trabeculectomy in cases of WMS.

### 9- Glaucoma surgery in Pregnancy

**Abstract**

Management of elevated IOP during pregnancy differs based on the trimester of pregnancy, the severity of the disease, and risk versus benefit of treatment. Though IOP is known to decrease during pregnancy, some patients develop uncontrolled IOP not amenable to medical treatment and may need laser trabeculoplasty or surgery. If surgery is indicated, it might be safer to perform the same during the second trimester.

Glaucoma surgery during pregnancy has serious risks. Challenges are related to pre-operative planning, anesthetic concerns, intra-operative modifications, and post-operative management.

Altered maternal physiology predisposes pregnant women to hypoxia, hypercapnia, and systemic hypotension, which exposes both mother and fetus to the risk of anesthesia, more so with general anesthesia. Additional challenges include difficult airway management because of gastro-oesophageal reflux and increased risk of aspiration. Placental transfer of anesthetic agents such as narcotics, paralyzing agents, and inhalational agents can cause fetal cardiovascular and central nervous system depression. Topical anesthesia augmented with subconjunctival and anterior subtenon anesthesia causes less systemic absorption of anesthetic drugs, hence it is advisable to limit the drugs to the minimum required dose for effective analgesia.

Supine position in the second and third trimester can cause profound systemic hypotension as the gravid uterus tends to compress the aorta and vena cava. It is advisable to rotate patient's hip, abdomen, and thighs to the left lateral position while maintaining a normal head position for surgery. As chances of gastro-oesophageal reflux are high, a full stomach should be avoided during surgery. It is advisable to defer surgery till the second trimester to prevent potential hazards of teratogenic anesthetic agents on the fetus. However, the risk of surgery also increases substantially as the fetus grows in the second and third trimester.

Avoid MMC or 5-FU, however, because of a high risk of bleb scarring in young patients, a subconjunctival, biodegradable, collagen (Ologen) implant can be used as an adjunct to modulate wound healing and prevent subconjunctival fibrosis.

All topical medications should be prescribed with punctal occlusion and eyelid closure to reduce systemic absorption. Patients should be advised to avoid blinking immediately after instillation of eye drops as blinking can activate the lacrimal pump and increase systemic absorption. However, utmost care and caution should be exercised during punctal occlusion in the early pos-operative period, avoiding additional pressure on the eyeball and taking appropriate hygienic precautions.

### 10- Trabeculectomy in Sturge Weber Syndrome

**Abstract**

Sturge-Weber syndrome (SWS) is a mesodermal phakomatosis characterized by

hemangiomas involving ocular, intracranial and facial cutaneous structures. Glaucoma has been reported in between 30% and 71%. Filtering surgery in patients with SWS carries the risk of massive intraoperative choroidal effusion or expulsive hemorrhage. The choroidal effusions are thought to be secondary to the rapid movement of fluid from the intravascular to the extravascular spaces in the setting of sudden hypotony and increased venous pressure. Sudden onset of intra-operative choroidal effusion has been reported in 10% to 40% of SWS patients undergoing glaucoma filtering surgery or implant. Meticulous pre-operative evaluation to rule out associated choroidal haemangioma is essential to prevent the post-operative complications.

In this video, we present about the challenges of glaucoma surgery in eyes with SWS and describe various pre-operative, intra-operative surgical modifications in these eyes to prevent complications. Avoidance of intra-operative and post-operative hypotony is of prime importance to prevent complications. The appropriate surgical modifications are pre-operative intravenous mannitol injection, general anesthesia, slow and controlled decompression, replacing the flap quickly with the help of preplaced scleral flap sutures, releasable sutures, meticulous wound closure and strong intra- and post-operative cycloplegia. Various other prophylactic techniques described in the literature are use of anterior chamber maintainer, injection of viscoelastic agent, prophylactic sclerectomy and sclerotomy and pre-operative oral propranolol.

### 11- Trabeculectomy in uveitic glaucoma


#### Abstract

Trabeculectomy in uveitic glaucoma has higher risk of failure than normal due to increased incidence of inflammation. This video demonstrates a case of trabeculectomy in medically refractory uveitic glaucoma.

After passing superior rectus bridle suture, limbus based conjunctival peritomy was done at around 8 mm distance from the limbus. Bleeding vessels were cauterized. Dissection was done in sub-tenon space upto the limbus. Scleral bed was prepared and bleeding vessels were cauterized with the help of bipolar cautery. A 4X4 mm sized, 2/3rd thickness scleral flap was created with help of blade breaker which was extended up to grey-white zone of surgical limbus. MMC (0.02%) soaked sponges were placed for 1 min in sub-scleral and 2 mins in subconjunctival plane. Thorough BSS wash was given and scleral bed was dried. Anterior chamber paracentesis was done to lower the IOP to prevent intra-operative complications of sudden lowering of IOP by creating ostium. Ostium was created with the help of MVR and vannas scissors. Adequate surgical iridectomy was made. Scleral flap was fixated with 10-0 MFN suture at both corners. Box shaped (10-0 nylon) two releasable sutures were placed on both the sides of the scleral flap. Conjunctival peritomy was closed with 8-0 Vicryl in continuous manner with a single scleral bite posterior to scleral flap in midway. Anterior chamber was formed after injection of air. Inferiorly subconjunctival gentamycin plus dexamethasone injection was given.


### 12- Trabeculectomy with limited deep sclerectomy


#### Abstract

This is a case of a primary congenital glaucoma. A 6-0 vicryl superior corneal traction suture is used to infraduct the globe. A fornix-based conjunctival peritomy is done. Localized wet field cautery of the bleeding vessels is performed. A partial thickness scleral tunnel is then created by performing a careful dissection using a crescent blade. The two side edges are cut and a scleral flap is made. A deeper sclerotomy is made just above the Schlemm's canal with the help of crescent blade. Air is injected into the anterior chamber through a paracentesis and a sclerostomy is made at the trabeculectomy site. Peripheral iridectomy is then performed to avoid occlusion of the sclerostomy. The scleral flap is secured using two 10-0 nylon fixed sutures at its corners. The overlying conjunctiva is then secured at the limbus using 8-0 vicryl sutures at its two edges and a 10- 0 nylon mattress suture to anchor it at the limbus.




### 13- Primary combined Trabeculotomy-Trabeculectomy with Ologen Implant in Advanced Primary Congenital Glaucoma


#### Abstract

Management of advanced primary congenital glaucoma (PCG) is challenging. However, the prognosis may be improved with the intra-operative use of Ologen implant. In this video, the Ologen implant was used to augment the surgical outcome of primary combined trabeculotomy-trabeculectomy in a 6-month old child with advanced PCG with corneal diameter of 14 mm.

Advanced PCG is usually associated with extreme enlargement of the globe with severe stretching of the limbus leading to difficulty in identification of the anatomical landmarks intra-operatively. The surgical technique involved exploration of Schemm's canal under a partial thickness superficial triangular scleral flap and performing ab-externo trabeculotomy with a metal trabeculotomy probe. This was followed by completion of trabeculectomy and iridectomy in a standard manner. Subsequently, the scleral flap was sutured back with one 10-0 nylon suture at the apex. Finally, Ologen implant was placed over the sclera and conjunctival closure was done with a running suture using 8-o' vicryl. Six months post-operatively, the infant had good IOP control and moderately elevated bleb with typical microcystic changes. The tips and tricks of the surgical technique have been explained in this video.


### 14- Revision trabeculectomy


#### Abstract

In case of failed trabeculectomy with fibrosed encysted bleb, a novel technique of revision trabeculectomy at the previous surgical site can be done.

A small conjunctival nick, 8-10 mm from limbus, just posterior to the bleb is made. Conjunctiva along with the tenons are dissected carefully over the bleb upto the limbus. Mitomycin C is applied in subconjunctival space, to reduce fibrosis in the post-operative period. The previous scleral flap is carefully dissected with help of crescent blade and patency of the previous sclerostomy is confirmed with the help of trypan blue dye. The ostium enlarged with help Kelly's Descemet membrane punch. Anterior chamber is formed with air and balanced salt solution. The scleral flap is not sutured, unlike in conventional trabeculectomy. The conjunctiva is then closed using 8-0 vicryl sutures.

This technique can be used in case of encysted failed bleb, cases where surgeon does not want to use the fresh site for re-trabeculectomy and in cases where no fresh site is left to do re-trabeculectomy.


### 15- Management of hypotony maculopathy due to over filtration using a lamellar transverse scleral flap and collagen implant


#### Abstract

The surgery was carried using an aseptic technique under local anesthesia. A 6-0 vicryl superior corneal traction suture was used to infraduct the globe, increasing exposure of the surgical site. Sub-conjunctival local anesthetic was injected to dissect the plane over the trabeculectomy site and a localized peritomy was then performed. Bleeders were cauterized using wet field cautery. The unhealthy necrotic tissue was removed using a vannas scissor after staining with trypan blue dye. A localised full thickness scleral defect was noted at the bleb site from where we could see the aqueous leaking. A partial thickness lamellar scleral flap was dissected using a crescent blade adjacent to the defect. This transverse scleral flap was then inverted and sutured over the leaking scleral defect using 10-0 nylon sutures. This created a guarded channel for the aqueous drainage. A collagen implant was placed over the site from where the scleral flap was harvested. The conjunctiva was then advanced to cover the trabeculectomy site to close at the limbus using 8-0 vicryl sutures.

### 16- Management of hypotony maculopathy post-trabeculectomy with scleral patch graft and conjunctival overlay

**Abstract**

Chronic hypotony leading to visual loss is a serious complication associated with trabeculectomy augmented with MMC. This video demonstrates the surgical technique of bleb repair in a 53-year old patient who developed hypotony maculopathy 4 years after trabeculectomy for uncontrolled primary angle closure glaucoma. The patient presented with a complaint of diminution of vision in his right eye and on examination, his best corrected visual acuity (BCVA) in the right eye was 6/18 with an IOP of 4 mmHg. He was found to have a thin cystic bleb with sweating and an associated hypotony maculopathy. Intra-operatively, after local debridement of the unhealthy conjunctival epithelium, the pre-existing bleb was excised and a conjunctival overlay was planned. However, the scleral flap was found to be thinned out and necrotic. An attempt was made to close the scleral flap with 10-0 nylon sutures, however the scleral tissue was very thin and friable and the suture cheese wired through it. After removing the necrosed scleral tissue, the decision was made to augment the area with a scleral patch graft. A partial thickness scleral allograft was fashioned and sutured to the trabeculectomy site using 6-0 vicryl sutures at the four apices. Additionally, 10-0 nylon interrupted sutures were used at the limbus to securely fix the donor sclera anteriorly, so that aqueous could be directed posteriorly. Following this, the fornix-based conjunctival-tenon flap was advanced over the scleral patch graft to cover it completely and hitched using 6-0 vicryl sutures at the edges and additional 10-0 nylon sutures in the centre. Post-operatively, the patient resolution of the hypotony maculopathy and the BCVA improved 6/9 at 2 months follow up with an IOP of 12 mm Hg.

### 17- Intra-operative optical coherence tomography (iOCT) guided glaucoma surgery

**Abstract**

iOCT has proved to be a useful tool in directing many ocular surgeries. It is a non-invasive tool which can provide a cross-sectional view of bleb and its walls. This video demonstrates use of iOCT in needling of failed bleb.

## VIII. Special Techniques for managing post-trabeculectomy complications

### 1- Managing bleb leak with bleb sparing conjunctival epithelial exchange

**Abstract**

This video demonstrates the technique of bleb leak management with bleb sparing conjunctival epithelial exchange in a 40 years old female who had previously undergone trabeculectomy with 0.02% MMC.

After passing superior rectus bridle suture, bleb margins were delineated and cut with curved vannas scissors. Bleeding vessels were cauterized. Adequate posterior conjunctiva prepared for exchange with the help of straight Vannas scissors. Conjunctival bleb epithelium was stained with trypan blue dye and gentle bleb epithelial dissection done with the help of curved Vannas scissors. Posterior conjunctival exchange over bleb was done by fixating mattress sutures with 6-0 vicryl. The conjunctival pocket was repaired end to end with 8-0 vicryl suture. Anterior end of the bleb area was closed with double row of 10-0 MFN sutures. Inferiorly subconjunctival gentamycin plus dexamethasone injection was given.

### 2-Managing bleb leak with bleb sparing conjunctival epithelial exchange with conjunctival pedicle flap

**Abstract**

A 60-years old male who underwent trabeculectomy with 0.02% MMC, in 2010 for primary angle closure glaucoma presented with thin cystic, Seidel's positive bleb (H2VOE2S2) in left eye and was planned for bleb sparing conjunctival epithelial exchange.



After passing superior rectus bridle suture, bleb margins were delineated and cut with curved vannas scissors. Bleeding vessels were cauterized. Adequate posterior conjunctiva prepared for exchange with the help of straight Vannas scissors. Conjunctival bleb epithelium was stained with trypan blue dye and gentle bleb epithelial dissection done with the help of curved Vannas scissors. Posterior conjunctival adhesions were removed and was found inadequate to exchange large area. A pedicle conjunctival flap was dissected from medial conjunctiva. The pedicle flap was then rotated and its limbal margin was sutured to limbal end of the bleb with 6-0 vicryl. The free posterior margin of the flap was closed with anterior conjunctival margin in lip-lip continuous manner with 8-0 vicryl. Anterior flap margin was closed with double row of 10-0 MFN sutures. Medial conjunctival defect was primarily closed with 8-0 vicryl. Inferiorly subconjunctival gentamycin plus dexamethasone injection was given.

### 3- Ciliary staphyloma repair with a donor scleral patch graft

**Abstract**

This video demonstrates ciliary staphyloma repair technique in a patient with previously operated trabeculectomy for angle closure glaucoma.

After passing superior clear corneal traction suture, an anterior chamber maintainer was placed infero-temporally and secured. Fornix-based peritomy was done in the region of staphyloma. The thinned out leaky sclera bed was first repaired with the help of single 10-0 nylon suture. A donor scleral patch of appropriate size was fashioned and sutured at the staphylomatous scleral bed with help of 6-0 vicryl suture. Finally, the surrounding conjunctiva was advanced and sutured over the underlying graft with 8-0 vicryl suture.

### 4- Compression suture for overhanging bleb

**Abstract**

Compression sutures with 9-0 nylon and 10-0 nylon suture can be placed for overhanging blebs. In this video, 10-0 mattress sutures are placed deep through the scleral bed both parallel and radial to the limbus over the overhanging bleb. The sutures can be left to dissolve or removed. This technique is easy to adopt and minimally invasive.

### 5- Cyclodialysis repair post-trabeculectomy

**Abstract**

Surgical repair of cyclodialysis cleft in patient with long standing hypotonic maculopathy following a blunt trauma refractory to medical management is demonstrated in this video.

After injecting viscoelastic device in the anterior chamber cyclodialysis cleft is identified with the help of gonioprism. A localized conjunctival peritomy is done at the identified site. A partial thickness scleral flap is structured with help of a crescent blade followed by exposure of suprachoroidal space through a full thickness sclerotosmy at the scleral bed.

Anterior chamber is formed with air and under direct visualization ciliary body band is reattached to the under surface of sclera using interrupted 10-0 nylon sutures. Mild cryo is applied over the scleral bed to supplement in reattachment. Scleral flap is sutured back and peritomy is closed with 8-0 vicryl sutures.

### 6- Bleb revision using donor scleral patch graft

**Abstract**

The surgery was carried using an aseptic technique under local anesthesia. A 6-0 vicryl superior corneal traction suture was used to infraduct the globe, increasing exposure of surgical site. The conjunctiva over the bleb was stained using trypan blue dye and the epithelium was scraped off using a lamellar dissector and subsequently by using a crescent blade. The thin and necrotic conjunctiva over the bleb is removed using Vannas scissors. A side port entry was then made using a microvitreoretinal (MVR) blade and air was injected into the anterior chamber. The surrounding conjunctiva was undermined and a fornix-based

conjunctival tenon flap was dissected just behind the leaking bleb. Intra-operatively, the scleral flap was found thinned out due to scleral necrosis. The ostium was found to be patent with the extrusion of vitreous at the defect site. Vitrectomy was done at the site. A decision to proceed with a scleral patch graft was made. The exposed trabeculectomy site was measured using a castervijo callipers and from the donor sclera a partial thickness circular scleral allograft was fashioned. The graft was sutured in place using 10 -0 nylon interrupted sutures. The conjunctiva was advanced to close at the limbus using 8-0 vicryl sutures at the two edges and two of 10- 0 nylon circumferential sutures to anchor it at the limbus. BSS was injected into the anterior chamber and the bleb was found to be functional.

### 7- Excision of fibrotic bleb overlying the cornea


#### Abstract

This video demonstrates the technique of excising fibrotic bleb overlying the cornea. Transverse 6-0 vicryl suture is passed over the fibrotic bleb near the limbus. This vicryl suture is used as a torniquet to crush any small vessels and also as demarcation line. The fibrotic bleb overlying the cornea is carefully dissected with the help of crescent knife and blunt dissection. Excision is completed with the help of Vannas scissors.


### 8- Cystic bleb excision and repair with surrounding conjunctival advancement


#### Abstract

This video demonstrates bleb repair of high thin cystic bleb. Under aseptic conditions the conjunctiva around the bleb is dissected and undermined. The inaesthetic bleb is the excised in toto to expose the underlying scleral bed. Few pin point leaky points are seen on the scleral bed, which are repaired with the help of 10-0 nylon suture. Surrounding conjunctiva is then advanced to cover the scleral bed and sutured with the help of 6-0 vicryl wing sutures and 10-0 nylon mattress sutures. At the end, subconjunctival injection of gentamycin and dexamethasone is given.


### 9- Leaky bleb repair using a lamellar transverse scleral flap


#### Abstract

The surgery was carried using an aseptic technique under local anesthesia. A 6-0 vicryl superior corneal traction suture was used to infraduct the globe, increasing exposure of the surgical site. A localized peritomy was then performed around the preexisting bleb. Bleeders were cauterized using wet field cautery. A partial thickness lamellar scleral flap was dissected using a crescent blade adjacent to the defect. The unhealthy necrotic tissue was removed using a vannas scissor after staining with trypan blue dye. A localized full thickness scleral defect was noted at the bleb site from where we could see the aqueous leaking. This transverse scleral flap was then inverted and sutured over the leaking scleral defect using 10 nylon sutures. The conjunctiva was then advanced to cover the trabeculectomy site to close at the limbus using 8-0 vicryl sutures.


### 10- Thin and leaky cystic bleb repair with auto-rotated partial thickness scleral flap and conjunctival pedicle


#### Abstract

This video demonstrates a technique of thin cystic bleb repair using auto-rotated partial thickness scleral flap and conjunctival graft.

After staining the bleb with trypan blue dye, the thin cystic bleb is dissected and non-viable tissue is excised. Defect in scleral bed is noted with visible uveal tissue. Anterior chamber is formed with air. A small partial thickness scleral pedicle flap is structured with the help of crescent knife. The scleral pedicle flap is then rotated and sutured over the defective scleral bed. Localized peritomy is done and adjacent conjunctiva is dissected to cover the scleral bed. Due to the insufficient conjunctiva available for advancement, a conjunctival pedicle is structured from the adjacent area and rotated to cover the deficient area. The free margin of the pedicle is sutured to the adjacent dissected conjunctiva and the donor site is primarily closed with the help of 8-o vicryl.




### 11- Iris prolapse during trabeculectomy


#### Abstract

A 1-year old child of PCG was taken up for trabeculectomy under GA. A fornix-based localized peritomy was done which was followed with partial thickness scleral flap dissection with help of a crescent blade. 0.04% MMC was applied subconjunctival and sub-scleral for 2 mins, followed by thorough wash with BSS. A 10- 0 nylon suture was passed at one of the corners of the flap. Air was injected into the anterior chamber through a paracentesis and a sclerostomy was made at the trabeculectomy site. Iris prolapse was noticed while making the sclerostomy. At this point, a gentle peripheral iridectomy was then performed and with the help of iris repositor iris was prolapsed iris was carefully replaced back into the anterior chamber. Viscoelastic was injected at the sclerostomy site to avoid the iris from prolapsing future and thus to avoid occlusion of the sclerostomy. The scleral flap was secured using two 10- 0 nylon fixed sutures at its corners. Further 8-0 vicryl sutures are applied at the lateral borders of the scleral fap to achieve the desired titration of aqueous outflow. Anterior chamber shallowing is avoided throughout the procedure by injecting air and BSS through the MVR site. The overlying conjunctiva was then secured at the limbus using 10- 0 nylon mattress suture and 8-0 vicryl sutures at its two edges and achieve a water tight wound. A circular pupil at the end is a sign, that no iris is plugging the ostium.


### 12- Trabeculectomy modifications in Malignant glaucoma


#### Abstract

Malignant glaucoma (MG) is a rare sight-threatening complication occurring in 0.6 to 4 % of eyes undergoing filtering surgery for angle closure glaucoma. It is characterized by shallow anterior chamber, with normal to raised IOP in the presence of a patent peripheral iridotomy. It has been postulated that following a surgical intervention, the predisposed eyes develop anterior rotation of the ciliary body with posterior misdirection of aqueous, leading to increase in vitreous volume and subsequent shallowing of the anterior chamber. MG is reported to occur after uncomplicated cataract surgery, needling of a trabeculectomy bleb, retinal detachment surgery, laser iridotomy, laser capsulotomy and laser cyclophotocoagulation. The treatment of malignant glaucoma is aimed at deepening the anterior chamber and reversing the ciliary rotation. Treatment is with topical cycloplegics, laser hyaloidotomy or surgical intervention to convert the eye into a unicameral chamber with pars plana vitrectomy (PPV) withirido-zonulo-hyaloido-vitrectomy (IZHV) by an anterior approach. Eyes with significantly high IOP, trabeculectomy or tube implant is required to control the IOP. When indicated the glaucoma surgery is combined with IZHV with or without PPV.

We present two scenarios where trabeculectomy with IZHV was indicated and performed. The first case is a 56-year-old lady with PACG, developed malignant glaucoma 2 months following an uncomplicated cataract surgery in her left eye. She did not respond to medical treatment and was referred for glaucoma surgery. The IOP was 50 mmHg despite maximum meds, the angles were completely closed and the optic disc showed advanced cupping. In view of long-standing malignant glaucoma with closed angles, trabeculectomy was planned along with IZHV. In this case, pre-operative intravenous mannitol was given. A paracentesis was made inferotemporally for the introduction of a 25 or 23 gauge vitrector. The vitrector was introduced with cutter facing inferiorly and advanced towards the 6 o'clock position, creating a peripheral iridectomy of adequate size. The adequate size of iridectomy opening is essential to place the vitrector in a slightly vertical position and to perform the steps of focal zonulectomy and anterior hyalodotomy at the root of iris. The vitrector is advanced through the anterior hyaloid face, performing an anterior hyaloidotomy with the vitrectomy settings with cut rate of 200-250 cutus/min. The end point for IZHV is to note sufficient deepening of the anterior chamber and formation of a unicameral chamber with adequate communication from posterior to the anterior chamber. Note that one of the key factors for success of this procedure is to have a clear communication between the anterior chamber and the posterior chamber. Note that although capsulectomy was created and anterior

vitrectomy performed through it, on oblique illumination using a light pipe or by retro illumination, we can visualize the incision in the capsule but the capsule is still present, this is likely to close with failure of the procedure or recurrence of malignant glaucoma. If this is identified, care should be taken to excise the capsular flap until a clear communication is visible. Air bubble was used to fill the AC and prevent vitreous prolapse into the AC.

This was followed by conventional fornix based trabeculectomy with a modified frill conjunctival flap that was closed with 10-0 vicryl. Topical and or subconjunctival atropine along with steroids were given. Note a deep anterior chamber and well-formed bleb at the end of the surgery. 3 years post-operative photograph showing well-formed AC, corneal scar temporally, and a good bleb. IOP was maintained at 12 mmHg. RE of the same patient underwent a similar procedure early and see the clear cornea, good bleb and patent IZHV inferiorly.

Second case was a 36-year-old gentleman with angle closure glaucoma, who developed malignant glaucoma following trabeculectomy in his right eye a couple of years ago. Although the IOP was well controlled, the anterior chamber was almost flat. His LE IOP was medically uncontrolled, 39 mmHg despite topical and oral medications. Trabeculectomy was indicated in this eye too. However, with MG in the RE, similar complication is likely to occur in the left eye as well. So we decided to perform Trabeculectomy with MMC with a prophylactic IZHV through the anterior approach. This step is performed either before or after creating a scleral flap, however before the anterior chamber entry is done. This IZHV by an anterior approach can be performed by anterior segment surgeons, which allows postero-anterior aqueous communication, helps in decreasing posterior vitreous pressure and restoring anterior chamber depth, and most importantly helps prevent malignant glaucoma and preserve the crystalline lens. Post-operative 1 week photograph with deep AC, patent IZHV, diffuse bleb. 1 year post-operative bleb photo showing a good bleb, IOP was 14 mmHg.

Subconjunctival atropine along with steroid would help to induce cycloplegia and control inflammation. Post-operatively, topical steroids (Prednisolone acetate 1%) to decrease the inflammation in tapering doses over 4-5 weeks, topical antibiotics for one week and topical cycloplegics (Atropine 1%/ Homatropine 2%) for 2-3 months which is tapered and continued indefinitely.

Although rare, trabeculectomy can be performed with along with IZHV to create postero-anterior communication and to relieve or prevent malignant glaucoma in predisposed pseudophakic or phakic eyes.

### 13- Amniotic membrane graft (AMG) bleb remodeling


#### Abstract

Large avascular blebs need to be repaired especially if they are associated with leaks or have had episodes of bleb-related infections. We describe a new technique of using an amniotic membrane graft that is inserted into the bleb through a small incision, helping to reduce the size of the avascularity, providing support to the bleb, and preventing extraneous infections. Classical revision procedures for these blebs, like conjunctival advancement, have shown good results; however, they are associated with complications, especially in the area where the bleb is large, such as ptosis and trabeculectomy failure. This procedure of intra-bleb AMG introduction is simple with minimal manipulation of the bleb. There is no risk of the AMG extrusion as it is lying under the conjunctiva of the bleb and not over it. The extraneous tissue (of AMG) acts as a spacer to provide support to the area of the bleb that may also have underlying necrosis. The AMG acts as an additional layer of protection against trauma and bleb infections.

A slit incision with a crescent knife adjacent and lateral to the area of the avascular bleb is made. This incision is extended into the bed of the avascular bleb. Then a small AMG is rolled and introduced within the bed of the bleb which remains covered with the overlying conjunctiva of the bleb. The conjunctival incision is sutured with 10-0 vicryl. The patient is prescribed topical antibiotics 4 times a day for 5 days. Post-operatively, bleb morphology improves significantly by 3 months with no evidence of bleb leak or sweating.




### 14- Bleb needling with 5-FU


#### Abstract

Under topical anesthesia, a bent 26 gauge needle on a 1 ml syringe is introduced in the subconjunctival space with the bevel up. Repeated to and fro motion is then done to disrupt the scarred tissue in the sub tenon's space around the bleb. Lateral swiping motion is also performed to release the adhesion around the bleb. The wall of the bleb may be punctured posterior during this to and fro motion to enhance the permeability of the bleb. The scleral flap is then lifted with the needle which is inserted into the anterior chamber to restore the flow. IOP is checked digitally to ensure that adequate aqueous flow through the bleb has been restored. A 30 gauge needle is then introduced from another site to inject 5- FU in the subconjunctival space with copious saline wash to avoid any corneal toxicity.


### 15- Compression sutures post-trabeculectomy


#### Abstract

A transconjunctival technique for compression sutures to treat hypotony in patients with an overfiltering bleb or large overhanging dysesthetic blebs is demonstrated. After topical anesthesia is administered, full-thickness, 10-0 nylon sutures are placed through both conjunctiva and sclera. The sutures are kept as deep and radial as possible, and then tied tightly in the former trabeculectomy site. By compressing the tissue in the immediate area, blood is prevented from entering the anterior chamber and leaks are limited. The sutures can be left to dissolve or removed. They can be left to incorporate into the bleb. This technique is easy to adopt and minimally invasive, and it does not preclude further bleb revision surgery if needed.


### 16- Dellen repair post-trabeculectomy


#### Abstract

This video demonstrates management of a dellen site in a patient post-trabeculectomy. The dellen site is examined by staining with trypan blue dye for any leak and staining defects. Conjunctiva around the bleb is dissected and again with the help of trypan blue dye patency of the sclerostomy site is established. Dellen site is smoothened with the help of crescent knife. The surrounding healthy conjunctiva is then advanced and sutured over the scleral bed with help of 6-0 vicryl.


### 17- Transconjunctival compression suture application for management of over filtering bleb


#### Abstract

This video demonstrates the technique of transconjunctival compression suture application for management of over filtering bleb. Under aseptic conditions, a superior clear corneal traction suture is placed. With the help of 10-0 nylon sutures, interrupted bites are taken starting at the limbal end of the bleb deep enough to pass through the scleral bed, upto the posterior margin of the bleb. Multiple sutures can be taken to cover the whole area of the bleb. At the end of the procedure, subconjunctival injection of antibiotics, steroid and atropine is given.


### 18-Visco-assisted dissection of filtering bleb over cornea


#### Abstract

This video demonstrates an atraumatic visco-assisted technique for dissecting bleb over cornea. After separating edge of bleb tissue over cornea with crescent knife, viscoelastic was injected underneath the tissue. Edge of bleb tissue was held with forecep and gentle dissection was done to separate it till limbus. Bleb tissue was then cut at limbus with Vannas scissor. At the end of procedure, trypan blue dye and fluorescein dye were used to check for leak.

## 19 – Drainage of suprachoroidal hemorrhage


### Abstract

Suprachoroidal haemorrhage is a rare but devastating complication of trabeculectomy. It can occur either intra-operatively (expulsive choroidal haemorrhage) or in the post-operative period (delayed or post-operative suprachoroidal haemorrhage). Appositional suprachoroidal haemorrhage also known as kissing choroidals can also occur after glaucoma surgery. Patient presents with intense pain and decreased vision. Small bleeds can be observed but drainage may be required in cases with high IOP, intolerable pain, flat anterior chamber, retinal detachment, deteriorating vision and central retinal apposition, etc.

Suprachoroidal bleed is drained externally via drainage sclerotomies created in the quadrant(s) of the involved suprachoroidal haemorrhage. The IOP is maintained by continuously injecting a vitreous substitute into the globe. In this video, we present an alternative technique wherein, instead of making sclerotomy with blades, we use a trocar placed at the site of highest choroidal mound to drain blood. Care is taken to insert trocar at an oblique angle and only partially so that it stays in the suprachoroidal space and does not pierce choroid and retina.




## NOTES

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