National Academy of Medical Sciences (India)
NAMS-AIIMS-PGIMER NAVIGATE CME: OPHTHALMOLOGY SERIES

Surgical Management of Glaucoma

Dr Kavita R Bhatnagar

MBBS, MS (Ophth), PGDHRM, ACME, FAIMER

Professor & Head,

Department of Ophthalmology

AIIMS Jodhpur

No financial interests to disclose

Outline

- Introduction
- Risk categories and management principles
- Management Options
- Surgical Management
  - Indications, Types, Pre-Op Assessment
  - Detailed discussion
    - Filtration Surgery (Trabeculectomy)
    - Glaucoma Drainage Devices (GDD)
    - Minimally Invasive Glaucoma Surgery (MIGS)

Glaucoma

Second leading cause of blindness globally[1]

Leading cause of irreversible blindness globally[1]

Affects >70 million people worldwide[2]

In India, estimated number of cases of glaucoma is 12 million

- Around one fifth of global burden of glaucoma[3]

By year 2040, it is estimated that 111.8 million people will be affected by glaucoma[4]

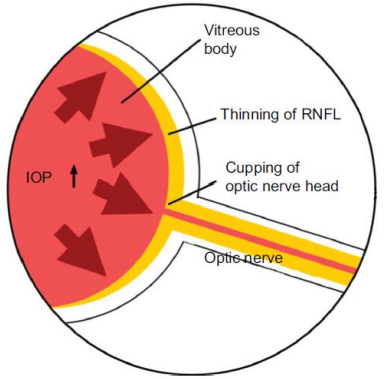
Ref: 1. Neuroprotection in glaucoma. Available [online] at URL: https://eyewiki.aao.org/Neuroprotection_in_Glaucoma. As accessed on 06 Feb 2020; **2.** Weinreb RN, et al. Jama. 2014 May 14;311(18):1901-11; **3.** Saxena R, et al. Indian J Community Med. 2013 Jul-Sep; 38(3): 135–137; **4.** Ran AR, et al. The Lancet Digital Health. 2019 Aug 1;1(4):e172-82.

Glaucoma - a neurodegenerative disorder

Glaucoma is a neurodegenerative disorder[1]

Characterized by[2]

- Retinal ganglion cell (RGC) death
  - Thinning of retinal nerve fibre layer (RNFL)
- Progressive glaucomatous optic neuropathy (GON)
- Glaucomatous visual field defect



Loss of RGC occurs despite IOP reduction[3]

As RGCs cannot regenerate, optic nerve damage is irreversible[1]

In addition to IOP reduction, neuroprotection is an important goal in management of glaucoma (protection of RGC cells)

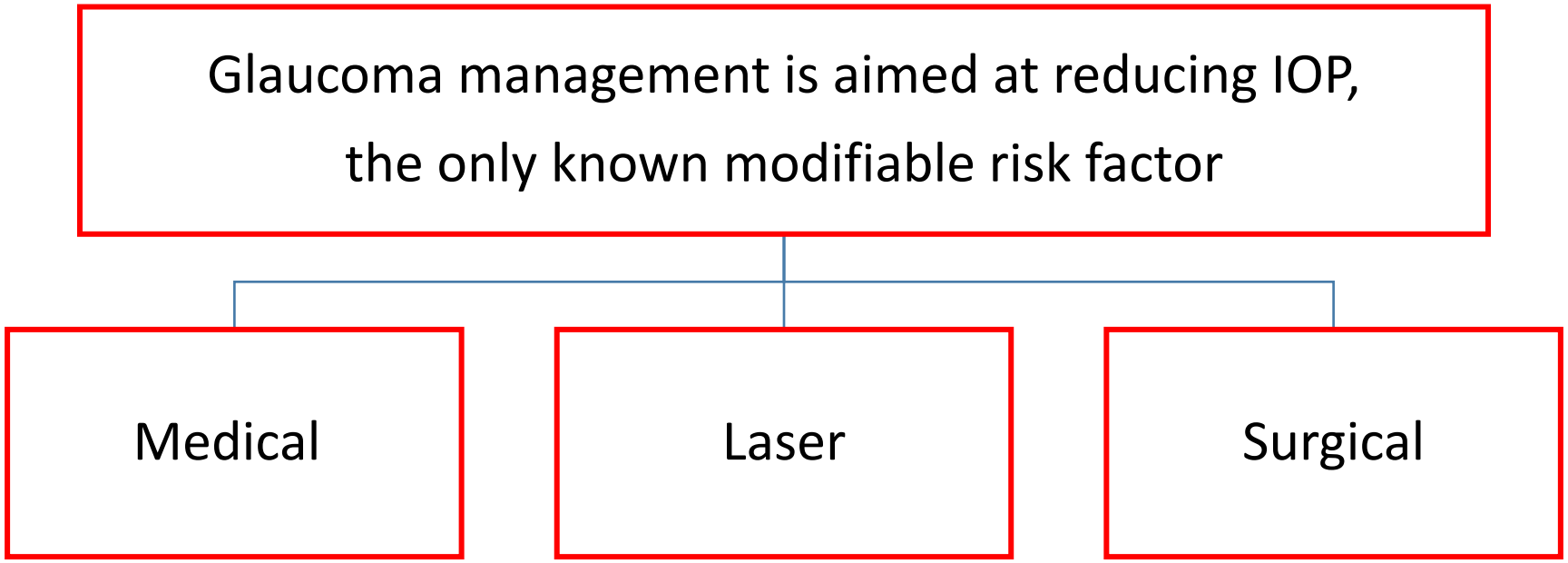
IOP: Intraocular pressure, **RGC:** Retinal ganglion cells, **RNFL:** Retinal nerve fibre layer, **GON:** Glaucomatous optic neuropathy.

Ref: 1. Vasudevan SK, et al. Indian journal of ophthalmology. 2011 Jan;59(Suppl1):S102; **2.** Song W, et al. Drug design, development and therapy. 2015;9:1469; **3.** Doozandeh A, Yazdani S. Journal of ophthalmic & vision research. 2016 Apr;11(2):2092.

Management of Glaucoma

Risk Categories and Management Principles

- Key points:
- Rx indicated when risks of progressive disease outweigh risks & potential side effects of Rx.
- Rx decisions should consider presence of coexisting ocular conditions, patient's life expectancy, general health status, their perceptions & expectations about Rx.
- Rate of disease progression is of fundamental importance.
- Target IOP be recorded & periodically re-evaluated. Status of fellow eye & family history.
- Goal of glaucoma Rx is to maintain patient's visual function and QOL (quality of life) at a sustainable cost.
- The cost can be calculated in terms of inconvenience and side effects as well as financial & social implications for the individual & society.


Glaucoma management is aimed at reducing IOP,
the only known modifiable risk factor
Medical
Laser
Surgical

Goals of Anti - Glaucoma medications

- Prevent further glaucomatous nerve damage
- Preserve the vision related quality of life of the patient such that the patient does not develop functional impairment

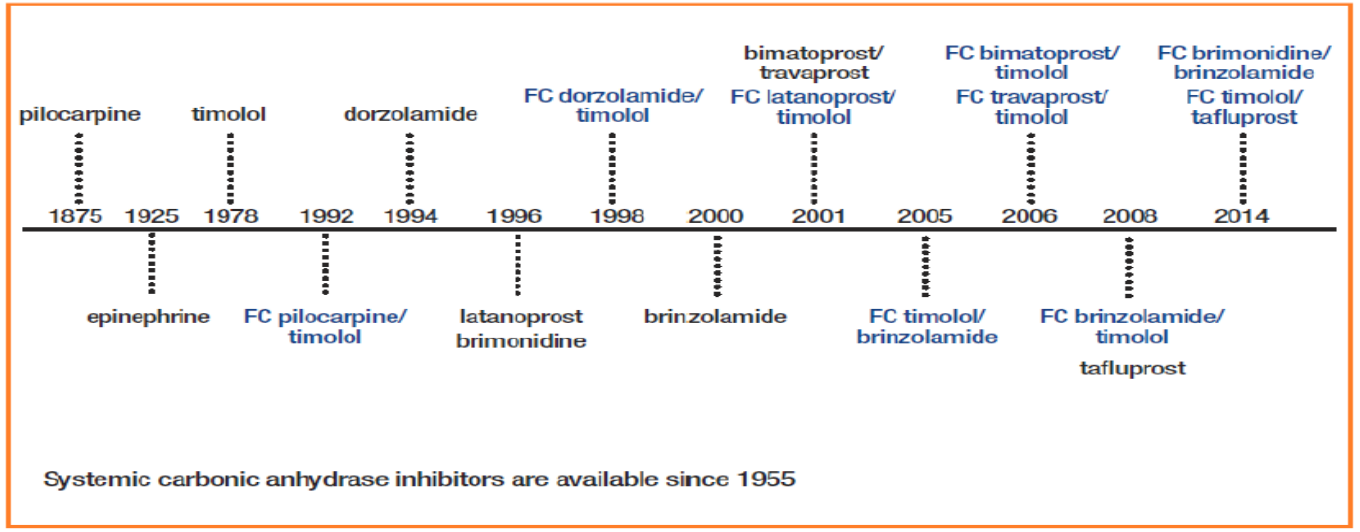


Figure 3.3. IOP lowering molecules and year of first clinical use. FC: fixed combination. In black: monotherapy.

European Glaucoma Society. *Terminology and Guidelines for Glaucoma*. 4th ed. Savona, Italy; 2014,

Dada T et al. Journal of Current Glaucoma Practice. 2009; 3(3): 13-17

Medical Management

- **Topical:**
  - Beta-blockers
    - Timolol- 0.5%
    - Betaxolol 0.5%
    - Levobunalol- 0.5%
  - Topical carbonic anhydrase inhibitor
    - Dorzolamide- 2%
  - Alpha adrenergic
    - Brimonidine -0.15%

Medical Management (contd)

- Prostaglandins
  - Latanprost -0.005%

- Systemic:
- Carbonic anhydrase inhibitor
  - Acetazolamide 250 mg tablets, qid

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Quality of life in medically and surgically treated glaucoma patients

Author(s)

[1] Kavita R Bhatnagar MS Ophthalmology
Ophthalmology, All India Institute of Medical Sciences, Jodhpur, AIIMS Road, Jodhpur-342005, -India
rajankavita12@gmail.com
Contribution: Concepts, Design, Definition of intellectual content, Literature search, Clinical studies, Experimental studies, Data acquisition, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing and review

[2] Tapasya Rajpurohit MS Ophthalmology
Ophthalmology, AIIMS Jodhpur, Department Of Ophthalmology, AIIMS Jodhpur, Jodhpur-342005, -India
rptapasya@gmail.com
Contribution: Concepts, Design, Definition of intellectual content, Literature search, Clinical studies, Experimental studies, Data acquisition, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing and review

[3] Jyoti Shakrawal MD Ophthalmology

Manuscript Acceptance Certificate

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by ***Kavita R Bhatnagar, Tapasya Rajpurohit, Jyoti Shakrawal, Kirti Jaisingh, Seema Meena, Nikhil Agrawal, Manogya Jain*** *has been peer-reviewed and accepted for publication in*

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We appreciate the contribution.

Samiran Panda

Dr. Samiran Panda
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Original Article

Ocular surface changes in primary open-angle glaucoma on anti-glaucoma medications versus treatment-naïve patients

Krati Srivastava, Kavita R Bhatnagar, Jyoti Shakrawal, Manjari Tandon, Kirti Jaisingh, Latika Pandey, Falguni Roy

Purpose: To examine the ocular surface disease in primary open-angle glaucoma (POAG) patients already on treatment versus POAG patients without treatment. **Methods:** A prospective cohort study was conducted on 120 eyes of 60 POAG patients: 60 treatment-naïve eyes (group I) and 60 eyes already on topical anti-glaucoma medications (AGMs) (group II). All patients had filled out the Ocular Surface Disease Index (OSDI) questionnaire and underwent a comprehensive glaucoma workup. Tear break-up time (TBUT) test, Schirmer's test (type I), corneal sensitivity, anterior segment-optical coherence tomography (AS-OCT), and corneal and conjunctival staining were done at day 1, 1 month, 3 months, 6 months, and 12 months follow-up. **Results:** On presentation, TBUT, Schirmer's test, tear meniscus height (TMH), and tear meniscus depth (TMD) were significantly higher in group I compared to group II. No significant difference was noted in OSDI score, corneal sensitivity, and tear meniscus area (TMA) between the groups on presentation. Both, lissamine green and rose bengal staining, had higher grades in group II compared to group I. Worsening of ocular surface disease was noted in both groups on follow-up. OSDI score, TBUT, Schirmer's test, TMH, and TMD had better values in group I in comparison to group II on follow-up. **Conclusion:** The study has identified glaucoma patients on AGMs to be more affected by dry eye disease (DED) compared to treatment-naive glaucoma patients. We found statistically significant differences in values of TBUT, Schirmer tests, lissamine and rose bengal staining, and AS-OCT parameters at baseline and 3, 6, and 12 months follow-up. OSDI scores showed significant differences at 6 and 12 months of follow-up. We recommend consideration of evaluation and management of DED/ocular surface disease in glaucoma patients on topical AGMs, particularly multiple drugs and doses.

Key words: AS-OCT, ocular surface disease, OSDI, primary open-angle glaucoma, treatment-naïve

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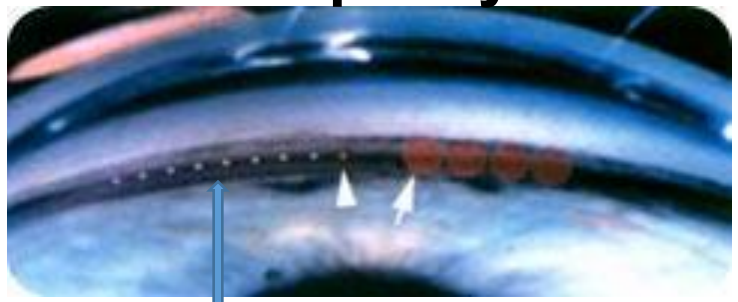
Quick Response Code:

Lasers in Glaucoma

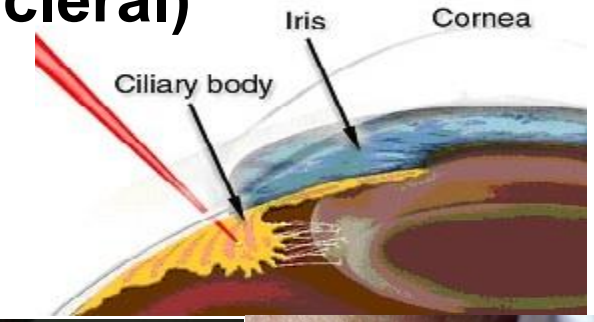
Argon Laser Trabeculoplasty

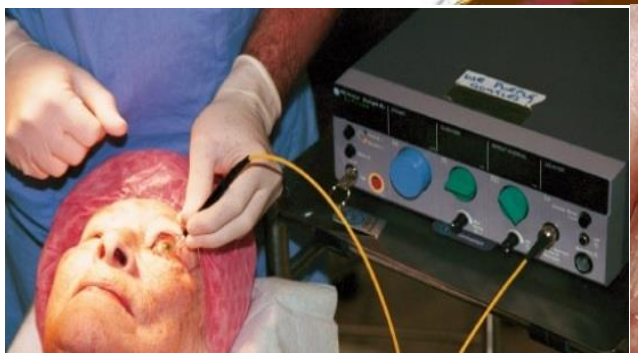


Trabecular Meshwork

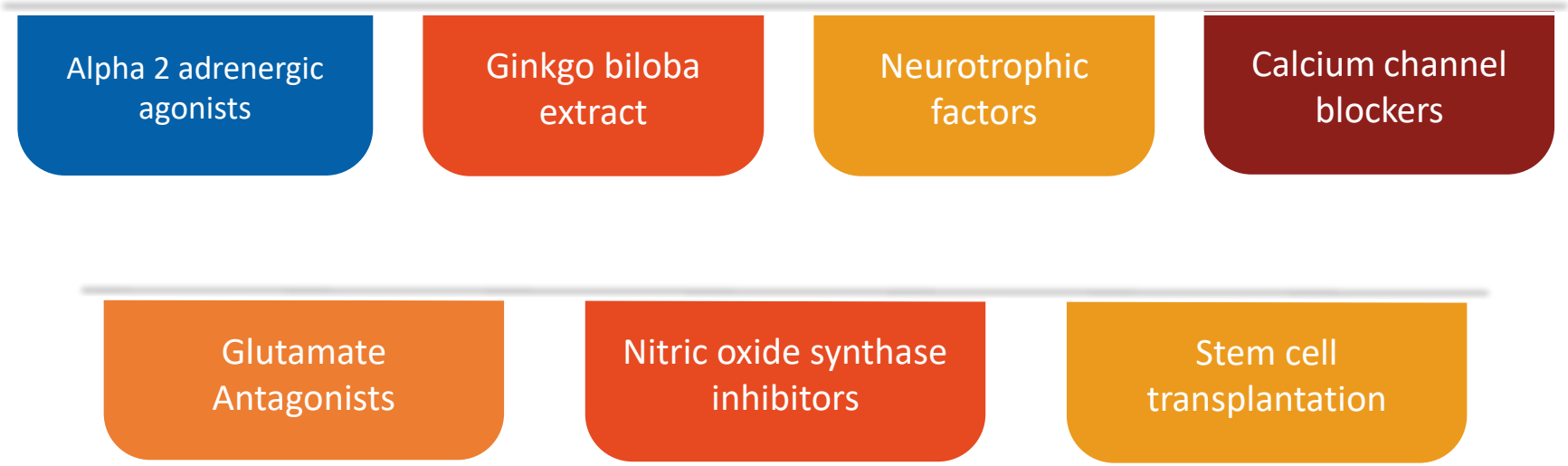
- ❖ Burns- 360 degree
- ❖ Shrinks collagen
- ❖ Opens inter-trab spaces
- ❖ Aqueous outflow improves

Cyclo-destructive procedure (Trans-scleral)





Experimental Neuroprotective strategies



*Experimental: Not approved for glaucoma

Ref: Doozandeh A, Yazdani S. Journal of ophthalmic & vision research. 2016 Apr;11(2):2092.

Surgical Management of Glaucoma

General Principles

- The goal of surgical Rx is to achieve long term lowering of IOP to the individual target with the aim to minimizing risk of further optic nerve damage. The decision to perform glaucoma surgery and type of surgical procedure must be carefully chosen after a comprehensive risk-benefit analysis for each case individual to maximize chances of success & minimize complications.
- Factors affecting the threshold for surgical intervention are following
  - Estimation of risk of progression
  - Physical quality of life
  - Life expectancy of the patient

Types of Glaucoma Surgery

- Penetrating Filtering Surgeries: Trabeculectomy
- Non-penetrating: Deep sclerectomy, Visco-canalostomy
- Aqueous Shunt Implants: Ahmed, Baerveldt
- MIGS (Minimally Invasive)

Pre-operative assessment

- Proper history taking and comprehensive examination and Refraction
- Pre-operative medication
- It is advisable to stop Pilocarpine as it increases post-operative inflammation
- It is recommended to stop PG one week before surgery as they increase the risk of CME
- Anticoagulants should be stopped three days prior to surgery
- Ocular surface- Meibomitis, blepharitis, any allergies, and associated ocular diseases

Risk factors for surgical failure

Trabeculectomy

- Trabeculectomy, a guarded filteration procedure remains the '**gold standard**' for long lasting intraocular pressure reduction in uncontrolled glaucoma.

Indications

- Patients with failed maximal tolerated medical therapy or failed laser surgery or poor candidates for medical management or laser with any of the following-
- Progressive glaucomatous damage to optic nerve,
- Documented glaucomatous visual fields loss (progression),
- Intolerable side-effects of Glaucoma medication,
- Lack of compliance with Glaucoma medication,
- Poor candidate for follow up, especially in remote areas with poor access to healthcare (ethical dilemma)

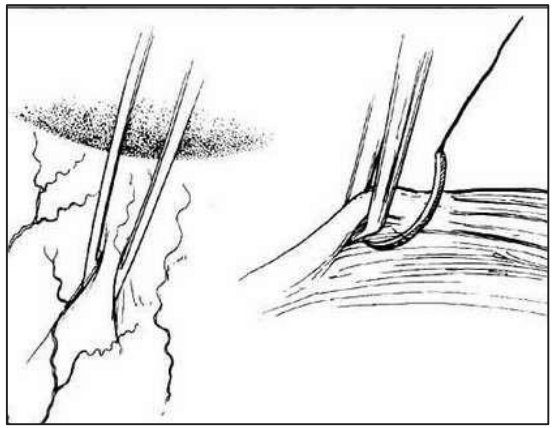
Surgical Procedure

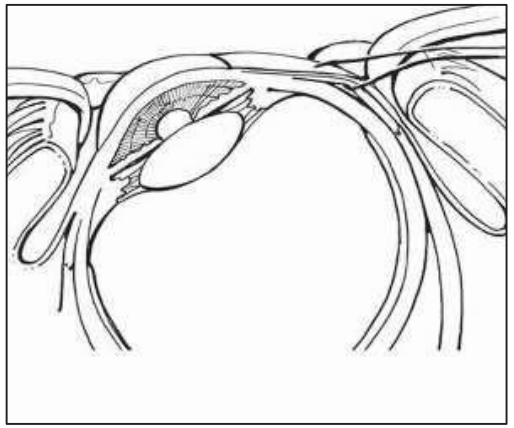
- Local anaesthesia: Retro-bulbar injection, peribulbar injection, subtenon, subconjunctival or topical anaesthesia

- Sedation: paediatric, non-cooperative adults

Traction sutures

- **Superior rectus traction (or bridle) suture**



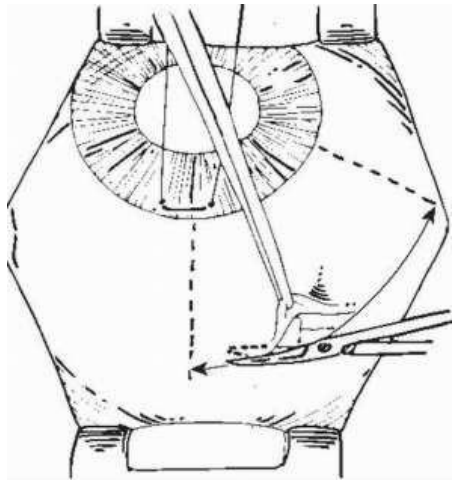


- Superior rectus is grasped with forceps through the conjunctiva 10-15mm behind the limbus and a 4-0 silk suture is passed around the muscle and attached to the head of the surgical drape.
- Complications: subconjunctival hemorrhage, conjunctival defects, scleral perforation postoperative ptosis

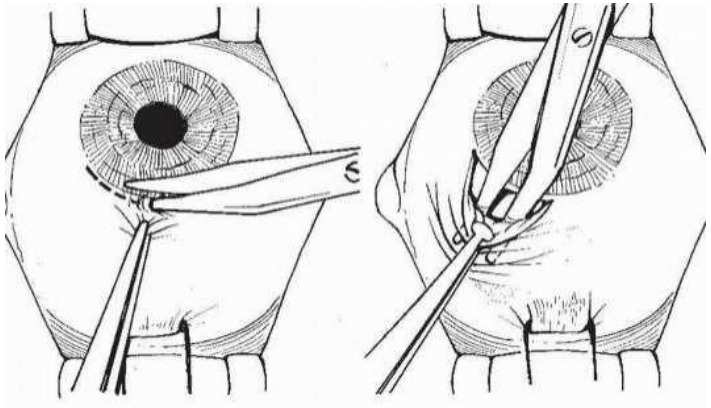
Conjunctival flap

Two types of conjunctival flap: as per surgeons preference

- **Limbal based**
  - incision deep in fornix with base at limbus

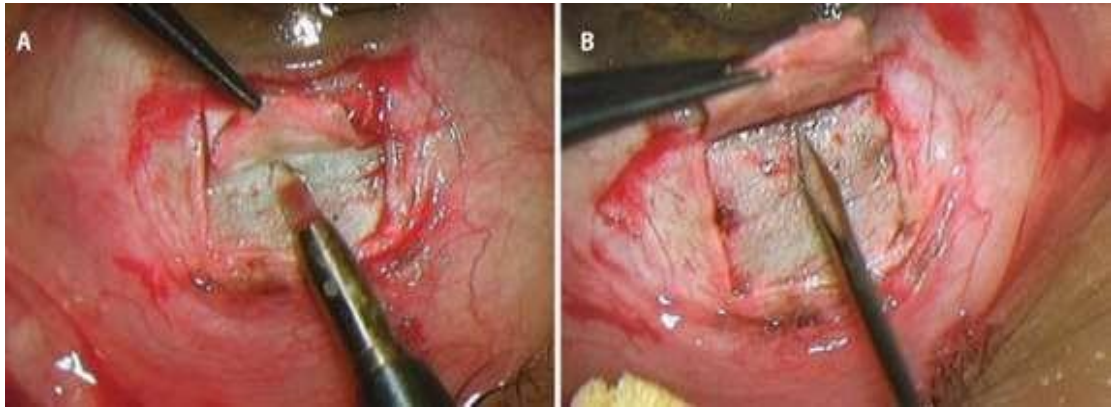


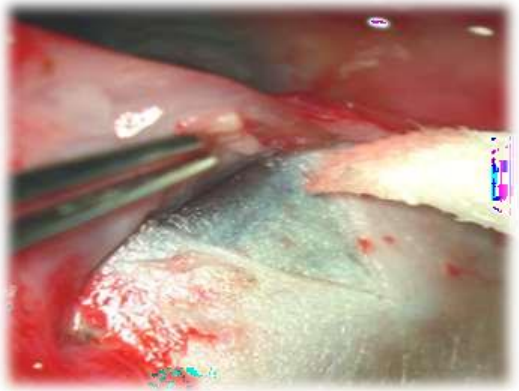
- **Fornix based conjunctival flap (FBCF)**
  - incision at limbus with base at fornix



Scleral flap dissection

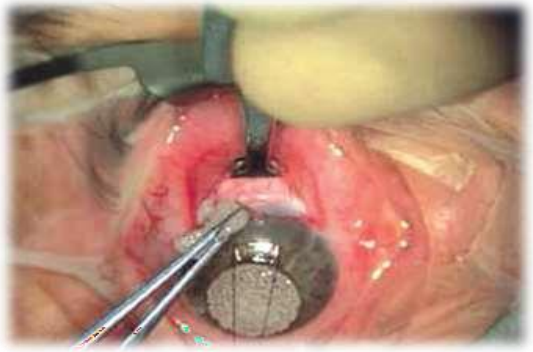
- Provide resistance to aqueous outflow and prevent hypotony
- Act as a safety valve to minimize IOP fluctuations
- Technique:
  - Thickness should be ½ to 2/3rd of scleral thickness
  - Lamellar dissection anteriorly just into clear cornea
  - Can be rectangular (3x3-4mm), triangular,or trapezoid shape





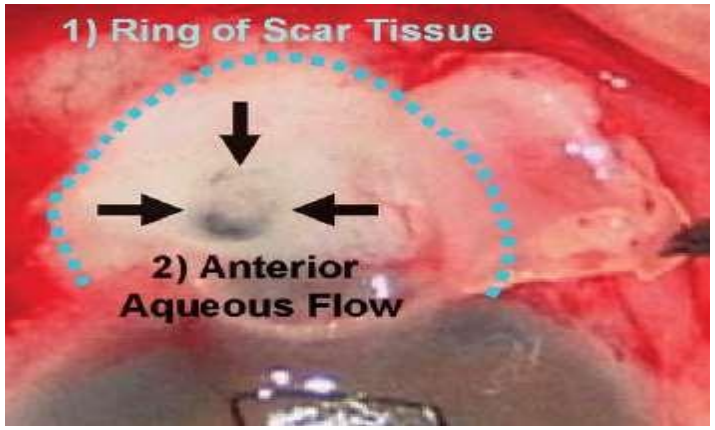
Antimetabolites

MITOMYCIN-C	5-FLUOROURACIL
An alkaloid, synthesized by Streptomyces caespitosus	A pyrimidine analogue
Affects fibroblast proliferation by cross-linking DNA	Blocks DNA synthesis by inhibiting thymidylate synthesis
0.2 to 0.5 mg/ml upto 5 mins	50mg/ml for 5 mins
Soaked sponges are placed beneath the conjunctival flap	Intra-op: sponges soaked Post-op: 0.1ml of 25-50 mg/ml (2.5-5mg) subconjunctival injection daily for 7-14 days



Delivering the anti-fibrotic agent

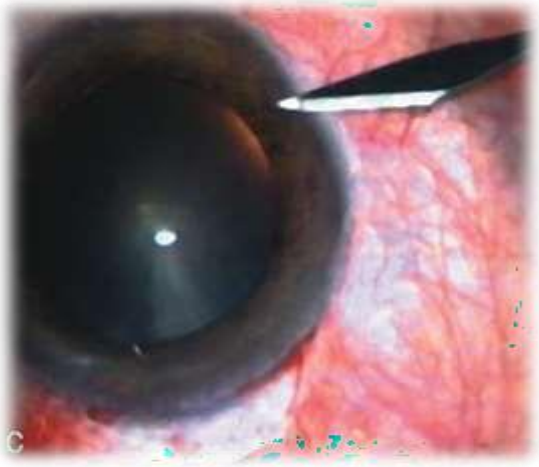
- Cellulose sponge soaked in antimetabolite is placed under dissected tenon's capsule for 2-3 mins followed by thorough irrigation with BSS.
- Cover largest area possible for more diffuse non-cystic bleb and prevent posterior limiting scar ('ring of steel')



AC Paracentesis

An oblique paracentesis in inferior cornea allows fine control of the AC.

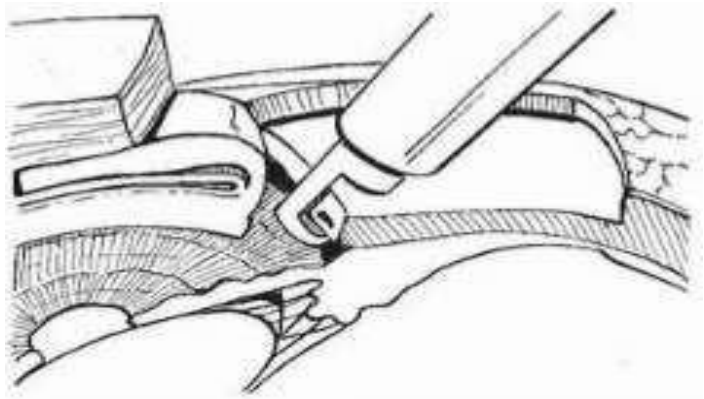
- IOP titration after tying the scleral flap sutures
- Reformation (or decompression) of AC intra or post operatively- BSS or viscoelastics
- Control and washout of AC hemorrhage



Sclerostomy

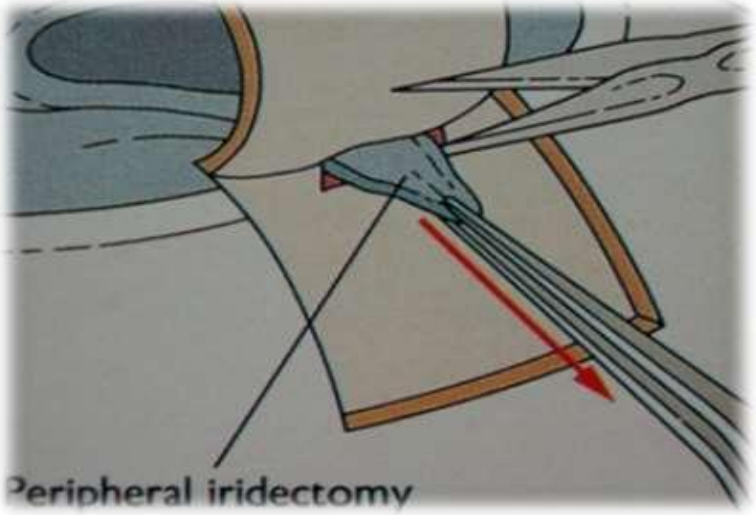
Anterior corneoscleral entry into AC- reduces risk of iris incarceration and bleeding from iris root and ciliary body

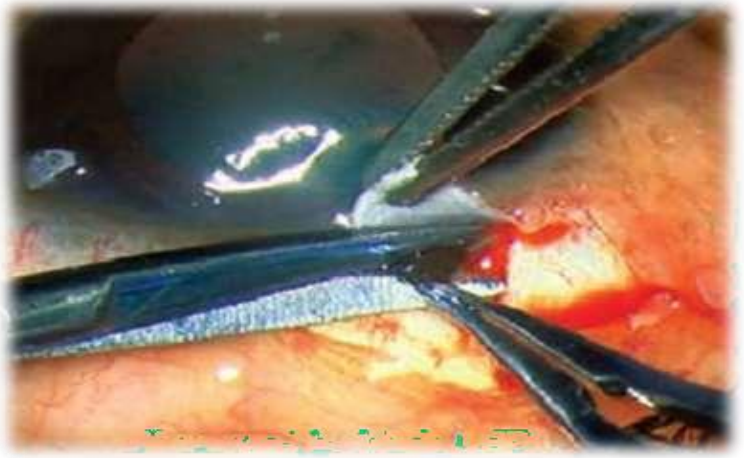
- Punch sclerostomy- Khaw/ Kelly descement membrane punch
- Manual block removal
- Size: 0.5-1.0 mm



Peripheral Iridectomy

- Broad based PI is a routine part of all standard filtering procedures
- Performed from sclerostomy site with extent beyond it's margins to avoid obstruction of sclerostomy by peripheral iris



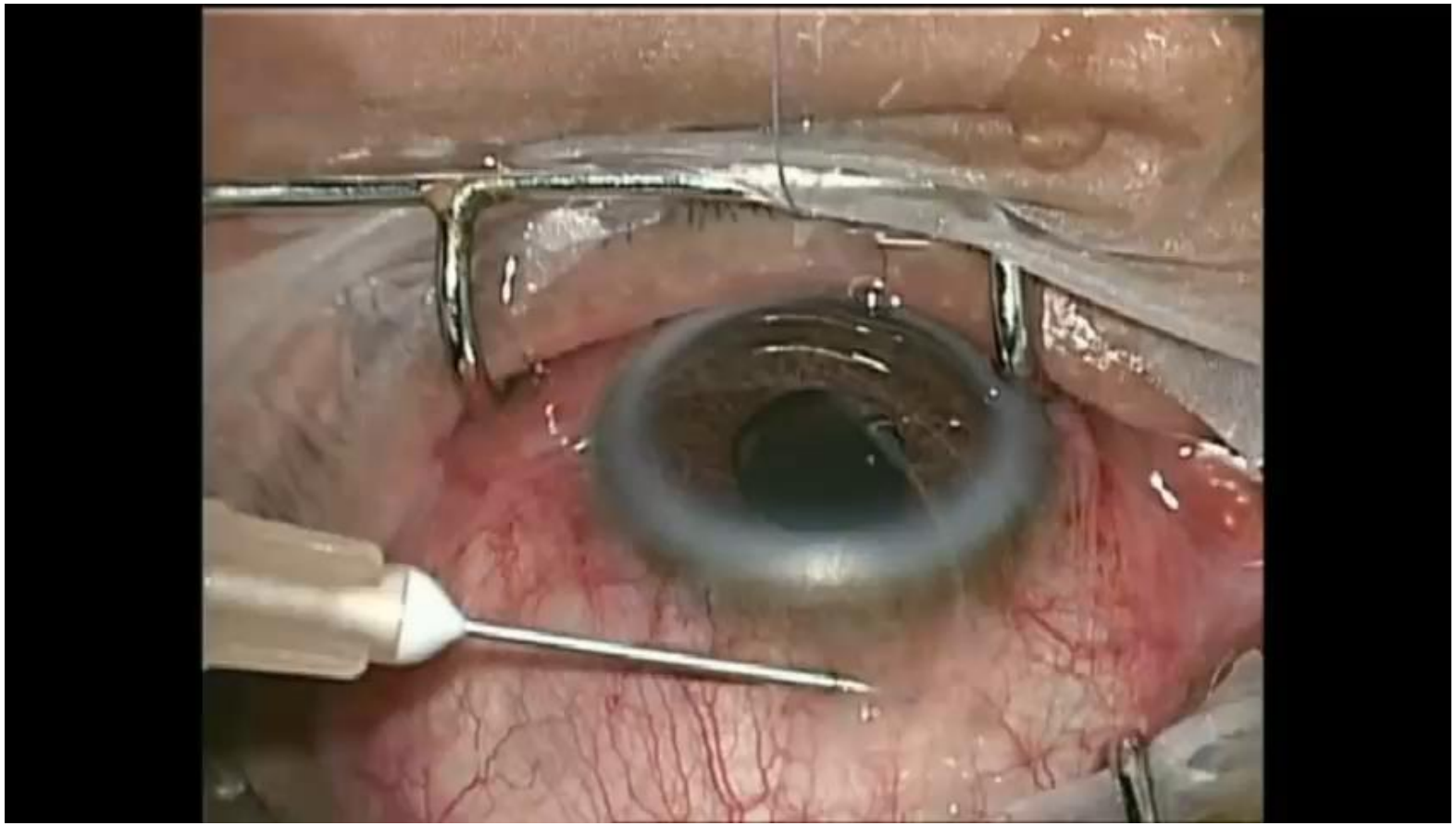


Closure of the wound

- Approximation of scleral flap with 10-0 nylon that achieves mild to moderate resistance to aqueous flow maintaining optimal AC depth.
- Adequate flow resistance can be tested by injecting BSS into AC via paracentesis.
- Some prefer two loose sutures at the posterior corners to promote filtration around the margins of the flap.
- Others prefer tighter sutures to prevent hypotony and a flat AC and lyse the sutures postoperatively with an argon or diode laser if needed.
- Releasable sutures are an alternative to suture lysis.
- Conjunctival closure must be water tight.

May use cycloplegic eye drops at the end of surgery to relax the ciliary processes and prevent the chance of a very shallow anterior chamber.

Trabeculectomy Video



Factors affecting efficacy of trabeculectomy

Efficacy is dependent on:

- ❖Tendency for subconjunctival fibrosis
- ❖Presence of releasable sutures
- ❖If scleral canal opening is small, TM removal is in small area

Efficacy decreases with:

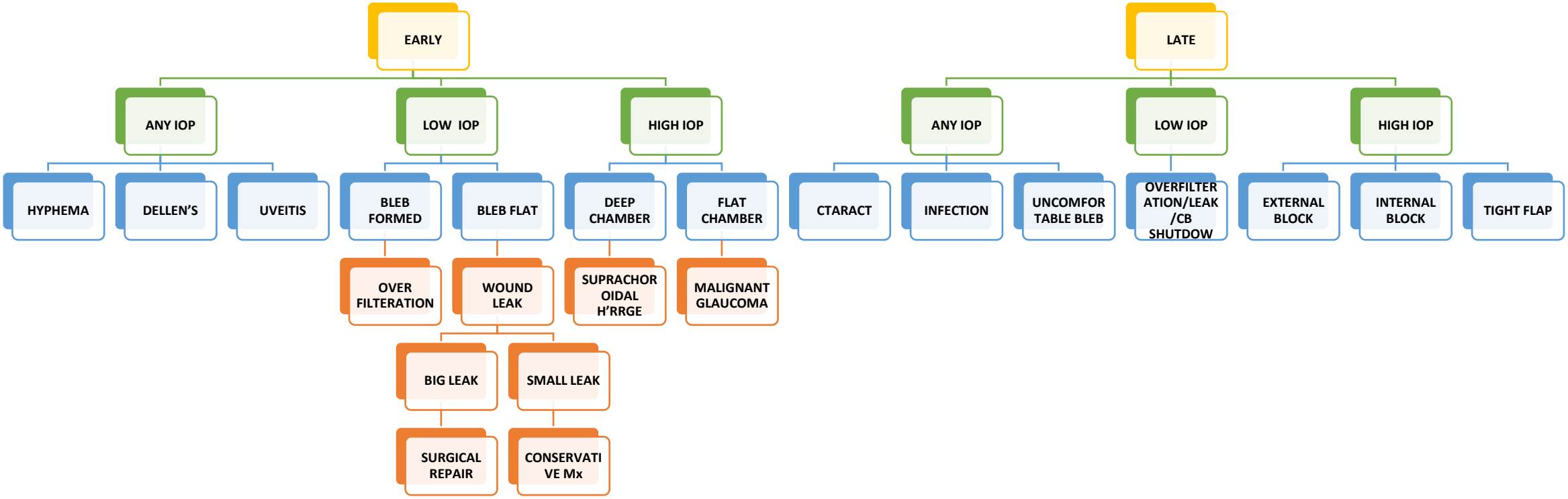
- ❖Increased sub-conjunctival fibrosis
- ❖Repeat surgery or previous ocular surgery
- ❖Younger age
- ❖Uveitic and neovascular glaucoma
- ❖High myopia
- ❖Nanophthalmos and aphakia

Efficacy increases with:

- ❖Use of antifibrotic agents: MMC, 5 FU
- ❖Removal of releasable sutures

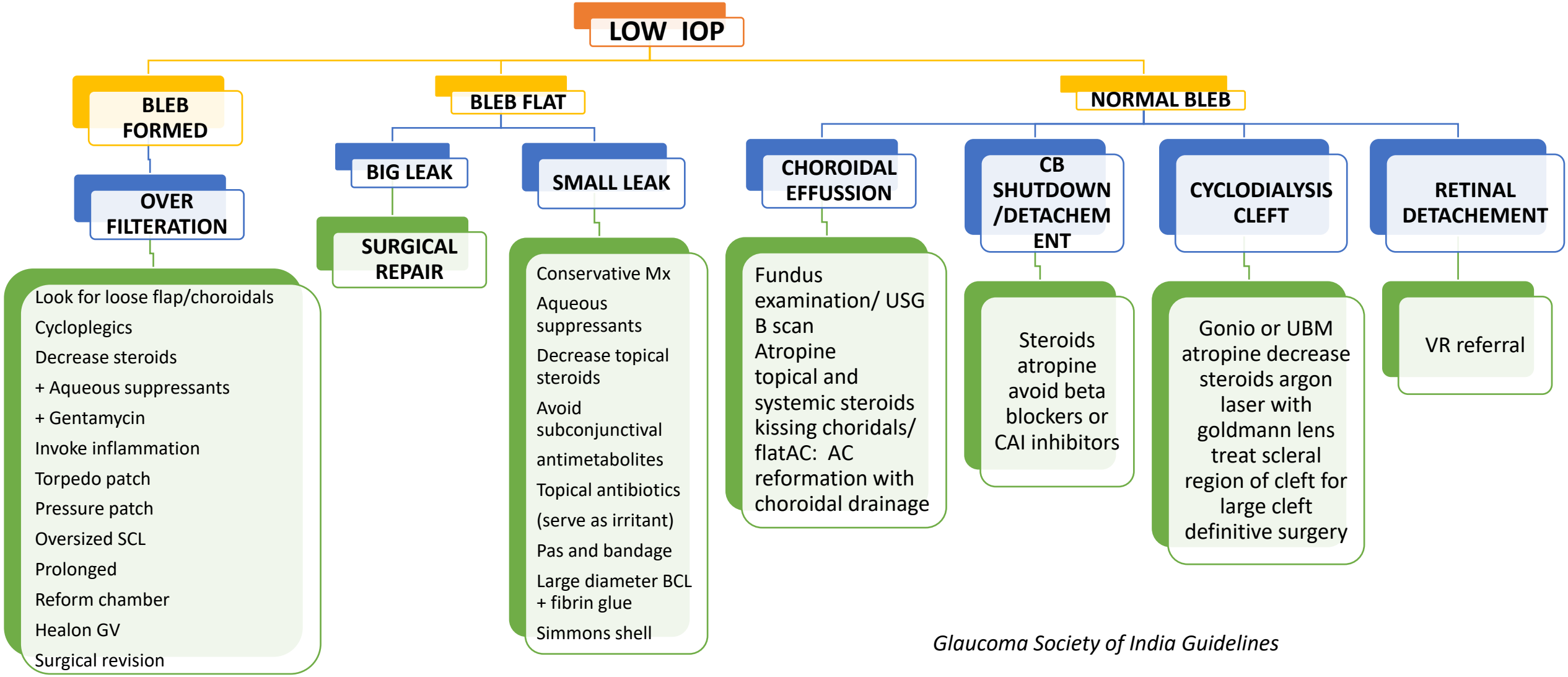
Complications of trabeculectomy

Post-operative complications (Overview)



Glaucoma Society of India Guidelines

Early Post-operative complications



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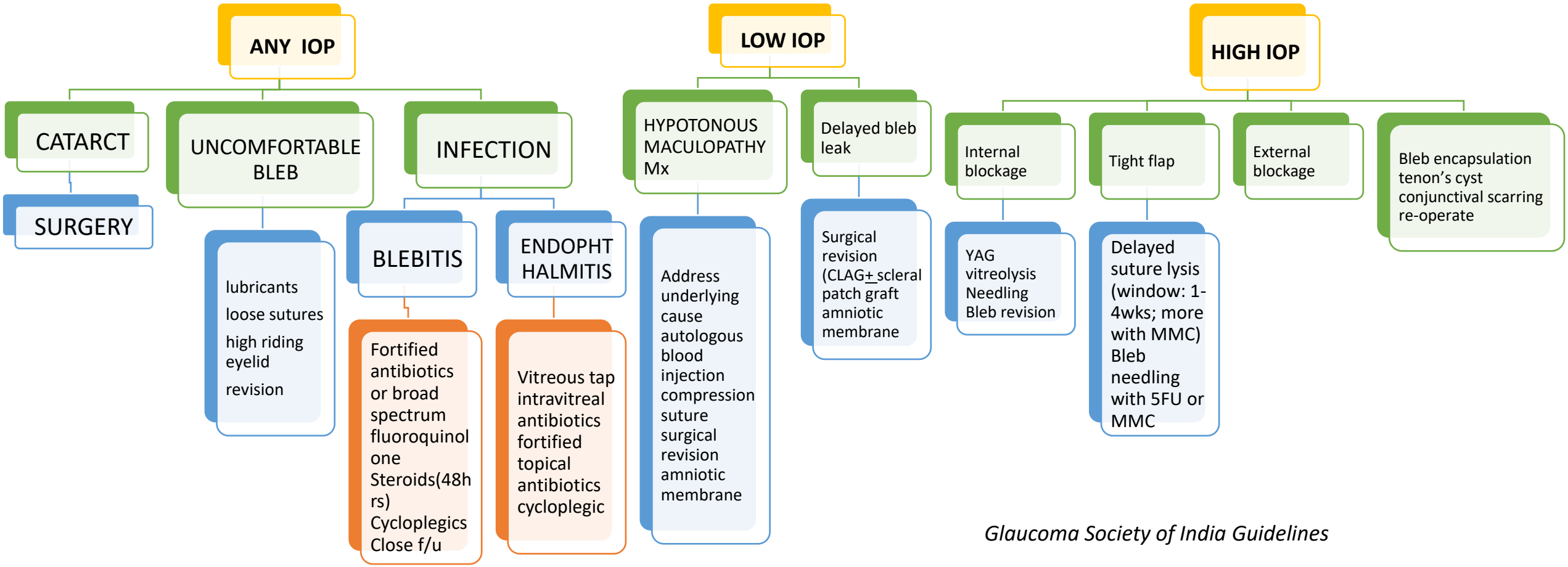
Late Post-operative complications



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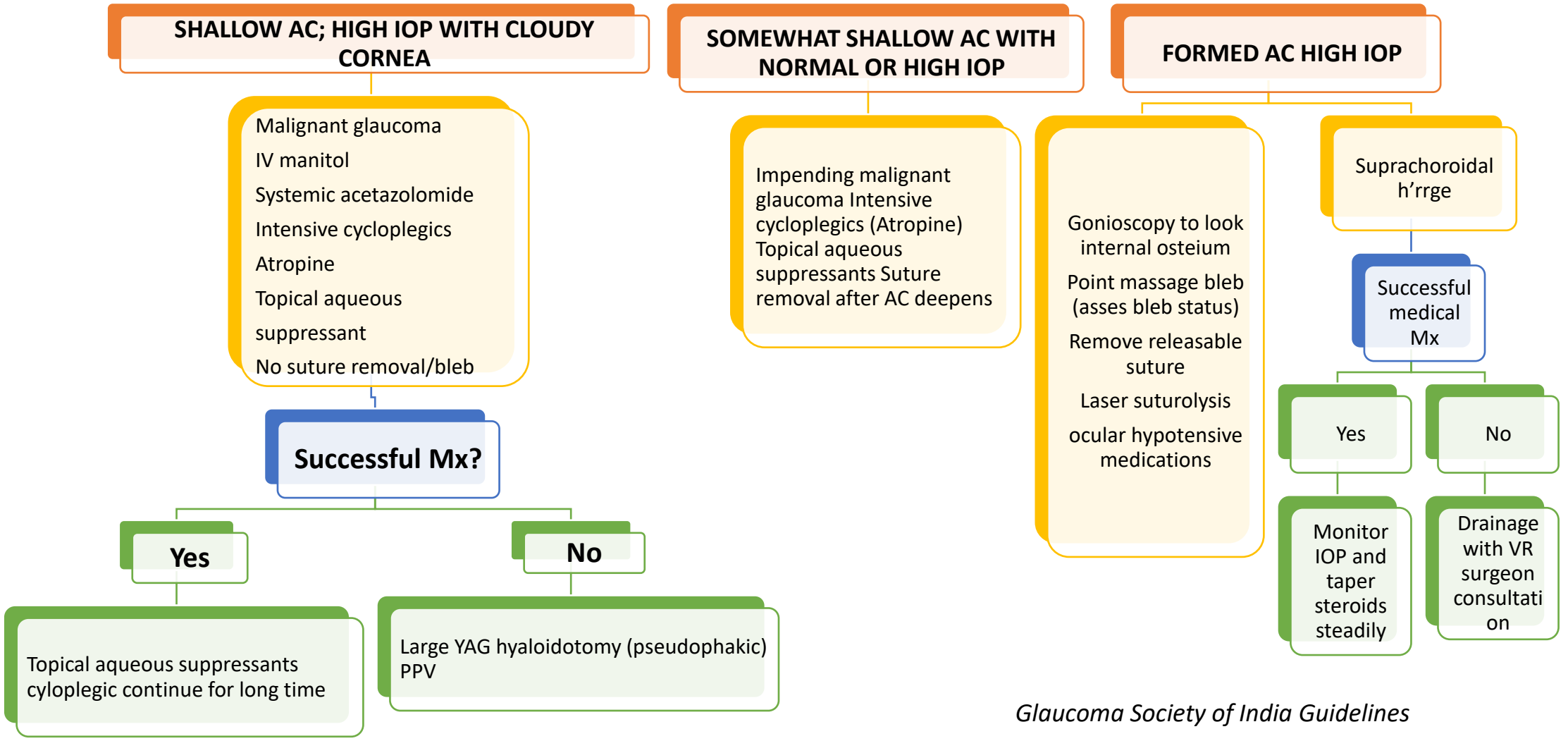
Post-operative high IOP



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Glaucoma Drainage Devices

Indications

- Eyes with severe conjunctival scarring : traumatic, chemical, or inflammatory
- Previously failed Glaucoma filtration surgery esp with anti-Metabolites
- Neovascular Glaucoma
- Uveitic Glaucoma
- Traumatic Glaucoma
- Previous intraocular surgeries with scarring
- Aphakic or pseudophakic Glaucoma
- Refractory congenital or developmental Glaucoma
- Sturge-Weber syndrome

Materials used

Most commonly used materials are

- Silicone
  - Baerveldt, Krupin, Ahmed
- Polypropylene (causes more inflammation)
  - Ahmed, Molteno
- Hydroxyapatite
- Expandable polytetrafluoroethylene

Increase vascularisation of the fibrous capsule increasing the efficacy and functional lifetime of the implant.

Implant designs

- Open tube designs
  - Molteno
  - Baerveldt
  - Schocket
- Flow restricted designs
  - Ahmed
  - Krupin

Flow Restricted Drainage devices

- **Ahmed Glaucoma valve**
- Most commonly used valved implant
- Implant design – silicon tube connected to silicon sheathed valve held by a polypropylene body

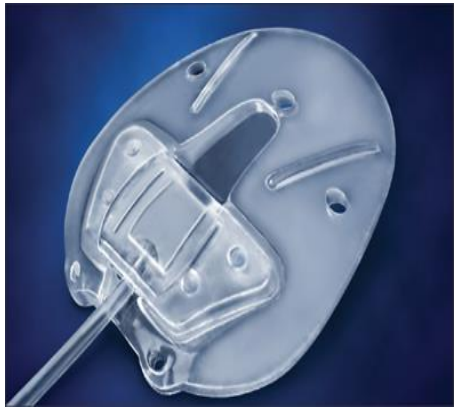
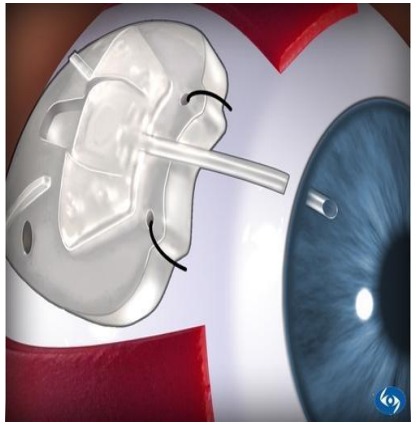


Table 1 Ahmed glaucoma valve implant available models

Type	Model	Size (mm^2)	Material (plate)
Single plate	S2	184	Polypropylene
Pediatric size	S3	96	Polypropylene
Double plate	B1	364	Polypropylene
Single plate	FP7	184	Silicone
Pediatric size	FP8	96	Silicone
Double plate	FX1	364	Silicone
Single plate	M4	160	Polyethylene
Pars plana	PS2	184	Polypropylene
Pars plana (pediatric)	PS3	96	Polypropylene
Pars plana	PC7	184	Silicone
Pars plana (pediatric)	PC8	96	Silicone



Surgical procedure: Valved GDD

- Supero temporal 90° fornix based conjunctival incision, posterior dissection, and radial relaxing incision.
- Corneal or limbus sutures enable surgical exposure
- Prime AGV with balance salt solution using a 26 gauge cannula
- Suture plate 8 to 10 mm posteriorly from the limbus using non-absorbable sutures.
- Cut the tube bevel up to a length approximately1 to 2 mm in the anterior chamber.
- Anterior chamber paracentesis using a 23 gauge needle and insert tube through needle track.
- Suture scleral or corneal patch graft to cover the tube close to the limbus.
- Suture fornix based flap over the implanted tube shunt.

Complications

Common to all filters	Common to all GDDs	Non-valved
• Hyphaema • Hypotony-maculopathy • Shallow flat AC • Choroidal effusion • Bleb encapsulation • Aqueous mis-direction • Endophthalmitis • Loss of Vision	• Conjunct retraction • Tube /plate exposure • Tube endothelial touch • Corneal decompensated • Bullous keratopathy • Tube blocked by iris or clot or vitreous or silicon oil • Tube retraction • Hypertensive phase	• Hypotony • Diplopia

Video of GDD

MIGS

Minimally Invasive Glaucoma Surgeries

MIGS is the term applied to a variety of novel surgical procedures for glaucoma, which can provide a safer alternative to traditional filtration procedures in mild to moderate glaucoma, leaving the conjunctiva untouched for future filtration surgery, if and when required.

MIGS procedures involve

- ❖Minimal invasiveness with Ab interno approach.
- ❖Minimal tissue dissection.
- ❖Higher safety profile.
- ❖Rapid visual recovery.
- ❖IOP lowering to physiological levels.

Indications of MIGS

- Mild to moderate open or closed angle glaucoma requiring cataract surgery.
- Mild to moderate phakic OAG not compliant with medication or progressing despite medical management.
- Mild to moderate pseudophakic open or closed angle glaucoma patients interested in decreasing the number of eyedrops being used to control IOP.

Assessment

- Gonioscopy is required before deciding on any MIGS procedure
- If spur is visible all around without indentation, any MIGS procedure can be attempted alone, regardless of lens status.
- If spur is visible all around only on indentation and the patient is phakic, do not consider MIGS.
- If spur is visible, all around with indentation and the patient has cataract, combine cataract and MIGS.

MIGS- Classification

Suprachoroidal outflow

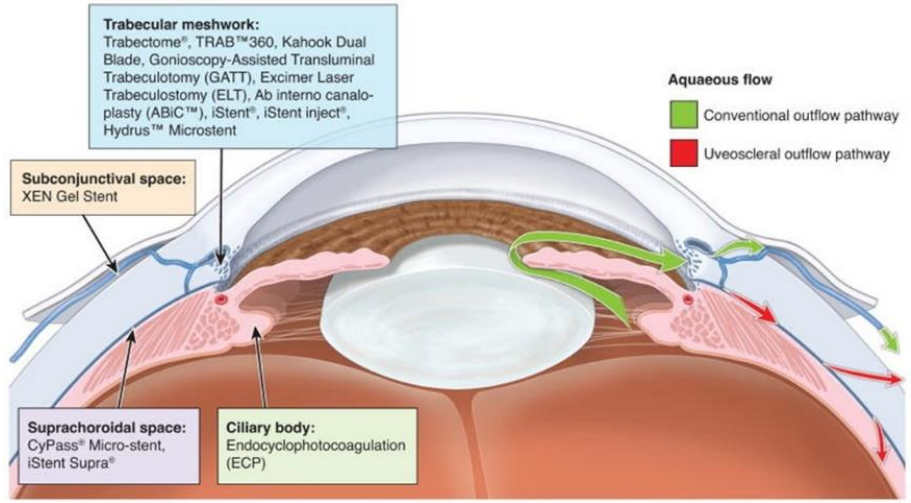
- Cypass
- iStent supra

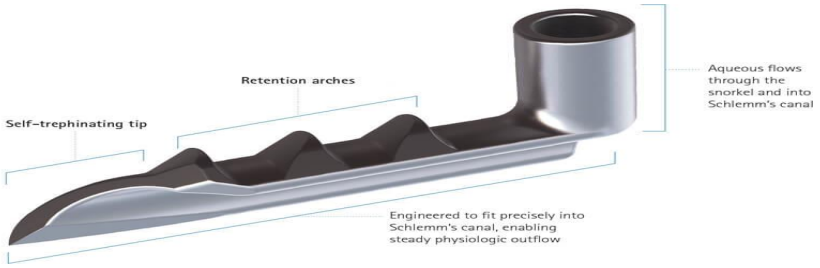
Schlemm's canal outflow

- Trebectome
- iStent
- Hydrus
- High frequency deep sclerotomy
- GATT
- Ab interno canaloplasty

Sub-conjunctival outflow (MIBS)

- XEN implant
- PRESERFLO Microshunt





- ❖Cypass and iStent supra create a pathway for aqueous into the supra choroidal space.
- ❖The XEN implant drains aqueous into the sub conjunctival space.
- ❖The Trebectome and Kahook dual blade, are devices used for ab-interno trabeculectomy.
- ❖The iStent allows aqueous to bypass the TM and drain into schlemm’s canal.
- ❖The Hydrus implant allows aqueous to bypass the TM and also dilates schlemm’s canal.

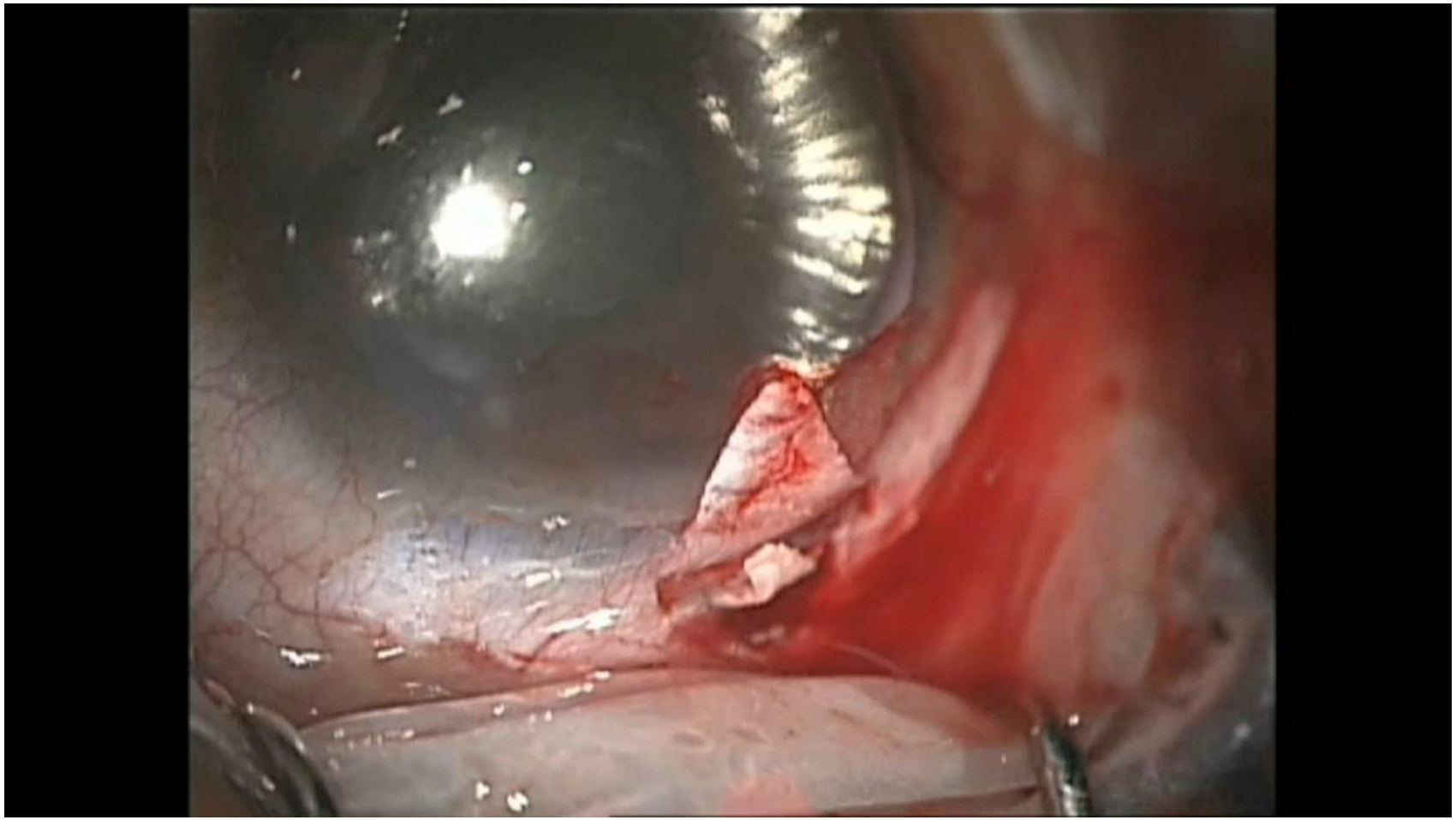
❖GATT uses an illuminated micro-catheter to create a 360° ab-interno trabeculotomy.

❖This procedure can also be accomplished using a 5’0 proline suture called (Suture GATT) as a low cost alternative.

❖Bent Angle Needle Goniotomy (BANG) is another low-cost alternative to GATT.

- *Of the above, most devices and implants are not currently available in India. What is being practiced is Suture GATT, GATT, Ab-interno trabeculectomy(Kahook, BANG) and HFDS.*

GATT SURGERY VIDEO



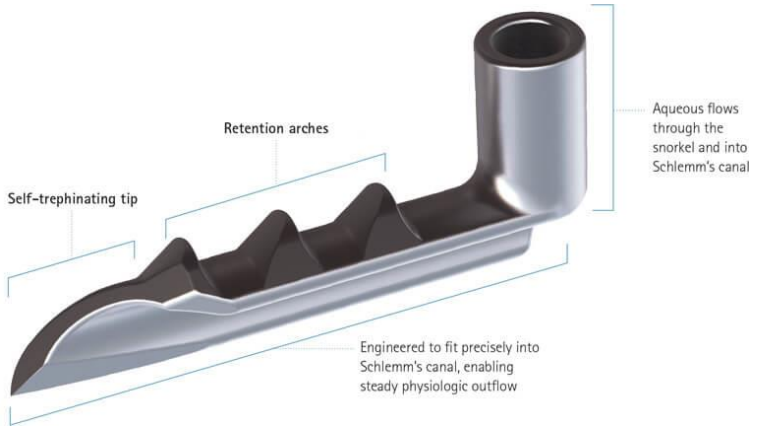
Other devices

Ex-PRESS shunt:

- Made of a stainless steel tube with a barbed end, to anchor it into the trabecular meshwork, through which a stent is placed.
- This is drained underneath a traditional trabeculectomy flap

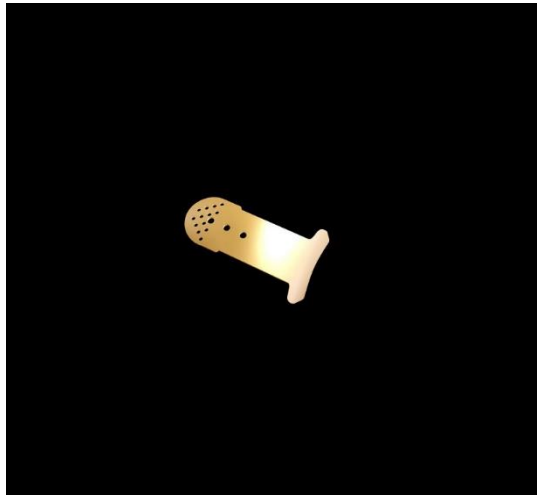
iStent:

- ❖It is a stainless steel stent that is implanted from an ab interno approach.
- ❖The devices traverses the trabecular meshwork and drain aqueous from the AC straight into the Schlemm canal.
- ❖Early studies are showing promising results.



The Solx Gold Shunt

- Made from 24-karat gold and works to connect the anterior chamber and suprachoroidal space
- Pressure in the suprachoroidal space serves as a natural counter pressure to prevent severe postoperative hypotony
- Implanted by using an ab interno approach so, no bleb.



Filtering Surgery vs MIBS vs MIGS

What is the goal of surgery?

- **Trabeculectomy** remains the gold standard for IOP-lowering, and ability to titrate downwards with early postoperative laser-suture lysis
- **MIGS** are less potent but provide a non-bleb and safer option for certain patients, and combine synergistically with cataract surgery with minimal impact to future filtering surgery
- **MIBS** provide similar to slightly less potent IOP-lowering than trabeculectomy, but in a more predictable and more controlled way, with less post-operative intensity and improved bleb morphology.

Key Takeaways

- Tailor surgery to patient and glaucoma type. Decision should consider the risk-benefit ratio.
- Even though decrease in IOP is beneficial for preservation of vision, the risk of vision loss without surgery must outweigh the risk of vision loss due to surgery.
- **Trabeculectomy remains gold standard.**
- Scarring- most common cause of surgical failure in trabeculectomy, therefore risk factors to be evaluated.
- The use of anti-fibrotics is associated with a higher incidence of complications but increases surgical success rates so dose should be titrated based on risk factors & stage of glaucoma.
- Trabeculectomy lowers IOP more than the non-penetrating deep sclerectomy (NPDS) technique. However the complication rate seems to be lower in NPDS.
- In eyes with previous intraocular surgery, there is insufficient evidence that TUBE surgery may be better than standard trabeculectomy.
- MIGS has expanding role.
- Post-op follow-up is crucial.

References & Further Reading

- Glaucoma Society of India Guidelines
- European Glaucoma Society Guidelines
- Shields textbook of Glaucoma 6th edition
- Kanski's Clinical Ophthalmology 9th edition
- AAO Basic and Clinical Science Course 2019-2020 Glaucoma
- Ophthalmic Surgery: Principles and Practice, 4th Edition

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अखिल भारतीय आयुर्विज्ञान संस्थान,जोधपुर
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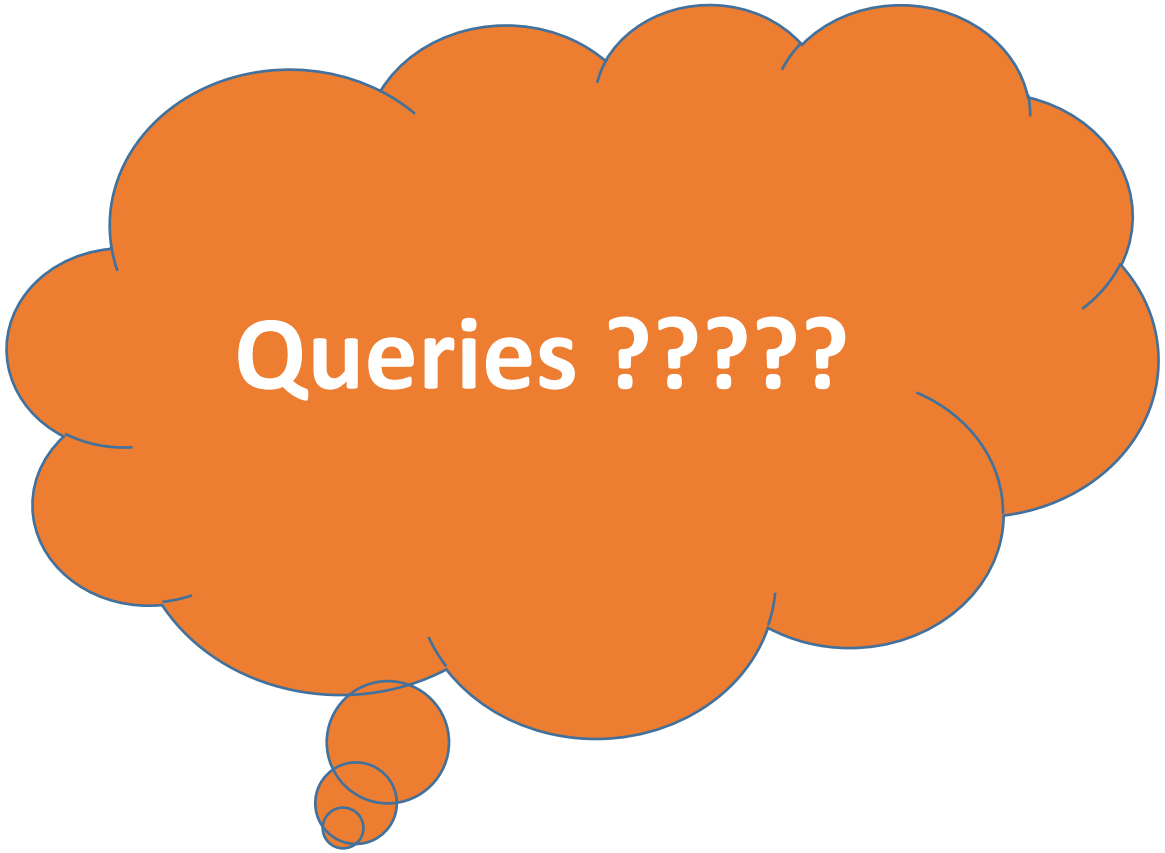
THANK YOU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