

Glaucoma Surgical Management

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Disclosure

- Sanofi Speaker
- EyePromise Employee

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"All relevant financial relationships have been mitigated"

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To chop or to drop

- This debate has gone on for long time
- What should occur first?
 - Drop
 - Chop

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Medications first advantages

- Drugs are safer than surgery-
 - Less complications
 - Less discomfort
- Drug effects can reversed or is short acting
- Less expensive in the short run
- Multiple drugs can be combined to achieve successful reduction in IOP
- Better quality of life when compared to surgery first (Lichter et al., Ophthalmology 2001)

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Medications first disadvantages

- May be more expensive in the long run
- Multiple drugs
 - Compliance, adherence and persistence issues
- Chronic drug uses and its effect on future surgical outcomes?
 - Preservatives effect?
 - Inflammation leading to failure of future procedures*
- Increased chances of cataract formation

*Broadway DC et al., Adverse effects of topical antiglaucoma medications: II Arch Ophthalmol 1994

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Surgery first - advantages

- If successful and large drop in IOP may be obtained
- No issues related to patient compliance, adherence and persistence
- Good in situations where obtaining continuous supply of medications is a problem
- May be cheaper long term

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Surgery first - disadvantages

- Outcomes may be variable
- Long term may lose efficacy
- May still require additional topical medications
- Complications may be dire
- Comfort and quality of life may be lower
- Chances of cataract formation is greater than topical medications
- Age- young vs. older individuals

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Race and management options

- Race – white versus individuals with greater pigment
- Individuals with greater pigment- greater risk of post-operative scarring*
 - Medications –first choice
- *Broadway DC et al., Racial differences in the results of glaucoma filtration surgery: are racial differences in conjunctival cell profile important? BJO 1994

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Age and management options

- Younger individuals
 - Accelerated wound healing systems
 - Thick fleshy periocular tissues heals rapidly
- Thus older individuals better suited for surgical options

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Overall mostly it is medications first!

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When is surgery indicated?

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Current practice patterns

- Unacceptable high pressures will inevitably destroy optic nerve tissue
- Safe levels of IOP by any means warranted
 - If these don't work or not sufficient
 - drugs like – prostaglandins
 - reduction in inflow – beta blockers
- Maximal medical therapy
- Consider surgery

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What are MIGS?

- Minimally invasive glaucoma surgeries (microinvasive ?)
- Cardinal features as proposed by Saheb and Ahmed in 2012
 - Ab interno, micro-incisional approach (*note: Some use an ab-externo approach.)
 - Minimal trauma/disruption to normal anatomy and physiology
 - Demonstrable/reliable IOP lowering
 - Extremely high safety profile
 - Rapid post-op recovery, with minimal need for follow-up

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When and how

- MIGS typically require shorter operation time and allow for more rapid recovery.
- MIGS can be combined with/without cataract extraction for patients with mild to moderate glaucoma and cataracts.
- OAG, or other types like exfoliation and pigment dispersion cases
- MIGS may be less effective in lowering IOP than traditional glaucoma surgeries,

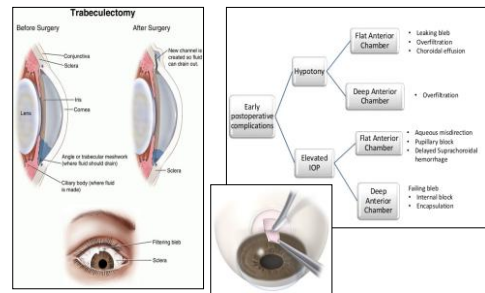
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When and how

- MIGS do fill a gap in the treatment of patients who would benefit from lower IOP but do not warrant the risk of traditional surgery.
- Decrease medication use
- Combined with cataract
- Narrow angles ? Hence cataract surgery

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Why MIGS?



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Systematic Review

The Efficacy and Safety of Minimally Invasive Glaucoma Surgery for Primary Open-Angle Glaucoma: A Systematic Review

Jill Gottehrer¹ and Pinakin Guntant Davey^{2,*}

Highlights

What are the main findings?

- Minimally invasive glaucoma surgeries (MIGS) and implants serve as a safe and effective option to lower intraocular pressure.
- The lowering of intraocular pressure with MIGS is comparable to other invasive procedures and surgeries that are proven in the management of glaucoma.

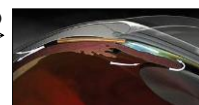
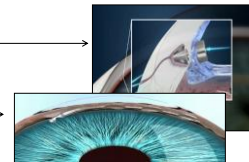
What is the implication of the main finding?

- The healthcare system may benefit from the widespread use of MIGS, as the training needed is minimal and the recovery time post-surgery is as short as that for cataract extraction.
- It is obvious that MIGS are going to remain important in the foreseeable future, and healthcare systems will need to invest resources in studying their long-term safety and efficacy.

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MIGS Treatments

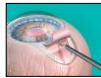
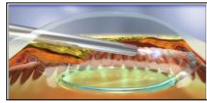
- Increase Trabecular Outflow
 - iStent and iStent inject
 - Trabectome
 - Kahook Blade
 - Hydrus Microstent
- Increase Uveoscleral Outflow
 - Cypass (withdrawn)



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MIGS Treatments

- Reduce Aqueous Production
 - Endoscopic photocoagulation ECP
- Subconjunctival Filtration
 - Xen Gel Stent
- Ab Externo
 - Inn Focus (not approved)
 - Ahmed Shunt



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Physiological considerations

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Resistance to outflow and channels

- The highest point of resistance in the conventional outflow pathway is believed to be in the **juxtacanalicular component** of the trabecular meshwork
 - Distal components of conventional outflow also offer resistance.
- Location
- The nasal quadrant is the most common site for Schlemm canal surgery due to
 1. its easy access through clear corneal temporal incisions.
 2. This site also coincides with the area of the highest concentration of collector channels.

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Stress tests for success

- Provocative testing can assist in identifying the location of unobstructed collector channels and aqueous veins.
 1. Blood reflux with provocative gonioscopy
 2. Episcleral vein filling with fluorescein tracer can be helpful in identifying unobstructed collector channels.

The level of blood reflux and vein filling correlates with post-operative IOP.
- High-resolution imaging using SD OCT can provide a noninvasive method used spectral domain ocular coherence tomography (OCT) to noninvasively assess Schlemm's canal and collector channels and the intrascleral venous plexus

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Other Modifications

- Other modifications to increase conventional outflow
 1. The number of inserted devices,
 2. the length of a device
 3. the width of a trabecular meshwork incision

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Is cataract surgery a "Glaucoma treatment" ?

- Lowers IOP – Normals, POAG, OHT, Angle closure
- Opens and deepens Anterior Chamber
- Trabecular meshwork changes due to phaco energy?
- Trabecular aspiration
- IOP is indeed declined... not as much as one would expect
- IOP high then the drop in pressure is high
- If anatomically narrow or blocked then the phaco indeed helps

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Cataract surgery and IOP reduction

Patient Type	Expected IOP Reduction	Duration in months
Normal eye	1–3 mmHg	24–36
Ocular hypertension	2–4 mmHg	24
POAG	2–4 mmHg	Up to 24
Pseudoexfoliation glaucoma	4–6 mmHg	12
Angle-closure glaucoma	5–8 mmHg	Up to 24

For additional reading scan Qr code



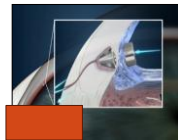
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Trabecular outflow devices

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Istent Inject

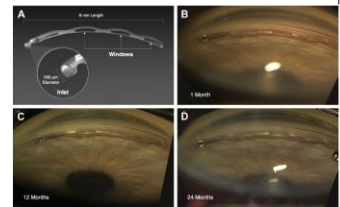
- Apical head (230 microns in width) connected to a narrow thorax that is attached to a wider flange.
- The head is inserted directly into the canal without the necessity to adjust the angle for implantation.
- It resides within the canal and contains 4 inlets for fluid passage.
- The 23-gauge stainless steel injector contains **2 stents for implantation**



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Hydrus Microstent

- The Hydrus device is Crescent-shaped scaffold that is open posteriorly
- "intracanalicular scaffold" for Schlemm's canal and a bypass of the TM
- nickel-titanium alloy (nitinol)
- Contains three windows along its 8mm length.
- With or without phacoemulsification
- One quadrant of Schlemm's

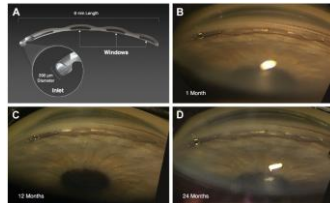


Ophthalmology 2019;126:29-37

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Hydrus Microstent

- The device is implanted through the trabecular meshwork using a manual inserter.
- The device is designed for ab interno placement through the TM into the Schlemm's canal.
- The inlet segment of the device resides in the AC, while the remaining length of the stent dilates and scaffolds a quadrant of the Schlemm's.
- Preclinical studies suggest that Schlemm's canal scaffolding over a quadrant provides access to multiple collector channels.



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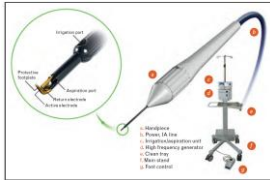
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Hydrus

- Indication with cataract surgery in OAG
 - Contraindicated in angle closure, traumatic, malignant, ac anomalies
 - Monitor the patient postoperatively for proper maintenance of intraocular pressure.
 - The safety and effectiveness not established in young patients <21 years
 - Significant prior trauma,
 - Chronic inflammations, secondary glaucoma, prior incisional surgery, ALT
- eyes with abnormal anterior segment, eyes with chronic inflammation
- The safety and effectiveness of use of more than a single Hydrus Microstent has not been established.

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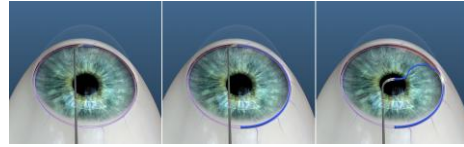
Trabectome



- The Trabectome removes a strip of trabecular meshwork and inner wall of Schlemm's canal using high frequency electrocautery.
- Up to 180 degree
- The 19.5-gauge handpiece incorporates an insulated footplate that enters Schlemm's canal through the trabecular meshwork.
- An irrigation port keeps the anterior chamber formed and dissipates heat, and an aspiration port is adjacent to the cautery electrode

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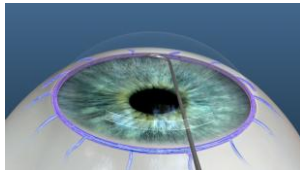
Trab 360 (SightSciences)



- TRAB 360 is a disposable, non-powered device used to perform an ab interno 360° trabeculotomy.
- The TRAB 360 device consists of a cannula, from which a flexible nylon-like trabeculotomy is advanced into Schlemm's canal for 180 degrees
- After the trabeculotomy is created, the trabeculotomy can be retracted once and then advanced into the remainder of Schlemm's canal in the opposite direction for up to a total of 360 degrees.

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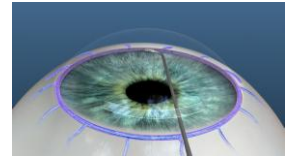
Ab interno Canaloplasty



- Ab interno canaloplasty (ABiC) increases aqueous outflow through cannulation of Schlemm's canal with an illuminated microcatheter (iTrack, Ellex)
- An ophthalmic viscosurgical device is injected to viscodilate Schlemm's canal and the proximal collector channels.
- It has been theorized that viscodilation may also create microperforations within the TM to aid in aqueous outflow.

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Ab interno Canaloplasty



- As the viscoelastic is injected, blanching of episcleral vessels, which is indicative of a patent collecting system, serves as an indirect indicator of success.
- Indications for ABiC include mild to moderate OAG when maximal medical management and laser trabeculoplasty have failed.
- Ab Externo approach is also possible

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Contraindications

- Required anticoagulation, bleeding diatheses, angle closure, obscured angle structures, severe endothelial compromise, or intraocular lens instability.
- Relative contraindications include previous corneal transplant and an inability to elevate patient's head 30° during the first postoperative week.

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Sub conjunctival Filtration

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Selective Laser Trabeculoplasty (SLT)

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ALT versus SLT

- Unlike ALT SLT does not scar
- Autopsy specimens – confirm no coagulative damage after SLT
- Ultrastructural measurements show
 - Crackling of intracytoplasmic pigment granules
 - Disruption of trabecular endothelial cells
- In-vitro studies pulsed laser
 - longer than 1 microsecond – non selective damage of pigmented cells
 - 10 nanosecond to <1 microsecond – no collateral damage

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Mechanisms of action SLT

- 5-8 fold increase in monocytes and macrophages in TM
 - after treatment with SLT
- Hypothesis
 - Injury via laser causes releasing of chemoattractant
 - This in turn recruits monocytes that are transformed into macrophages
 - Macrophages clear pigment granules and exit via Schlemm's canal

Alvarado and Murphy Outflow obstruction in pigmentary and primary open angle glaucoma Arch Ophthalmol 1992

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Pre-operative considerations

- Alpha 2 agonists preoperative (Brimonidine or Apraclonidine)
 - Helps reduce post-operative spikes
- Untreated eyes- timolol may also work
- Topical anesthetic before procedure

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SLT -procedure

- Frequency doubled Q-switched Nd:YAG laser
 - 532 nm
 - Pulse 3 nanosecond
 - Spot size 400 micro meter
- Beam focused over pigmented TM
- Standard therapy 50-100 adjacent non-overlapping spots over 180-360 degrees
- Power 0.8mJ (0.2 to 1.7mJ)
- Heavily pigmented eyes – lower power
- Endpoint- tiny “champagne” bubbles

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Selective Laser trabeculoplasty

- Selectively targets melanin pigment of TM
- More safe compared to ALT (because lower power)
- Equally effective as ALT
- Can be repeated if first attempt is not effective

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Post-operative considerations

- Anti-inflammatory medications –post SLT prophylaxis
 - NSAID or steroids
 - Does not give added benefit in lowering IOP
- No robust evidence in suggesting use or not to use anti-inflammatory agents post SLT

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Primary Selective Laser Trabeculoplasty for Open-Angle Glaucoma and Ocular Hypertension

Clinical Outcomes, Predictors of Success, and Safety from the Laser in Glaucoma and Ocular Hypertension Trial

- A total of 611 eyes (195 OHT and 416 OAG) of 355 patients received SLT, and 622 eyes (185 OHT and 437 OAG) of 362 patients received topical medication at baseline.
- At 36 months, 536 eyes (87.7% of 611 eyes) of 314 patients (88.5% of 355 patients) were available for analysis.
- Some **74.6% of eyes (400 eyes) treated with primary SLT achieved drop-free disease-control at 36 months; 58.2% (312 eyes) after single SLT.**
- Six eyes of 6 patients experienced immediate post-laser IOP spike (>5 mmHg from pretreatment IOP) with 1 eye requiring treatment.

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Primary Selective Laser Trabeculoplasty for Open-Angle Glaucoma and Ocular Hypertension

Clinical Outcomes, Predictors of Success, and Safety from the Laser in Glaucoma and Ocular Hypertension Trial

- Conclusions: Primary SLT achieved comparable early absolute IOP-lowering in OHT and OAG eyes compared to medications.
- Drop-free disease-control was achieved in approximately 75% eyes at 36 months after 1 or 2 SLTs, the majority of these after single SLT.
- These analyses are exploratory but support primary SLT to be effective and safe in treatment-naïve OAG and OHT eyes.

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tvst

Article

Automated Direct Selective Laser Trabeculoplasty: First Prospective Clinical Trial

Mordechai Goldenfeld¹, Michael Belkin², Masha Dobkin-Belkman³, Zachary Sacks¹, Sharon Blum Meirovitch¹, Noa Geffen^{4,5}, Ari Leshno^{4,5}, and Alon Skat^{1,4}

Clinical science



Direct selective laser trabeculoplasty in open angle glaucoma study design: a multicentre, randomised, controlled, investigator-masked trial (GLAUrious)

120 shots over 2 seconds of the limbus
1.4–1.8 mJ
400 micron 3ns



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Trabeculectomy

Pre-operative preparations

- Medications to stop (1-2 weeks) prior to surgery
 - Eg. Anticoagulants and nonsteroidal anti-inflammatory agents
- Evaluation of conjunctival health
 - Avoid area of previous surgery
 - History of topical medications

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Normal conjunctival response to wound healing

- Classic features of acute inflammation
- Hemorrhage on site
 - Releases plasma proteins and blood cells
- Increase in local blood flow and vascular permeability
 - Additionally activation of migration of leukocytes
- Activated inflammatory cells
 - Secrete several cytokines and growth factors are secreted
 - Growth factors in turn recruit fibroblasts
 - This in turn leads to healing and scarring
 - In absence of further injury- apoptosis of t-lymphocytes and fibroblasts

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Trabeculectomy

- Creates a fistula that allows aqueous from anterior chamber to subtenons space
- Fistula guarded by scleral flap
- The belb should not be fully vascularized neither completely avascular
- Mytomycin C (alkylating agent) or other antimetabolites (example 5-fluorouracil) prevents scarring and failure

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