

# MIGS MIGS AND MORE MIGS

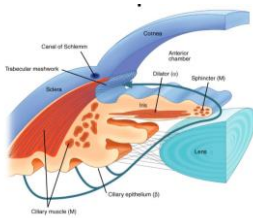
Pinakin Davey OD, PHD, FAAO  
Professor, Western University of Health Sciences



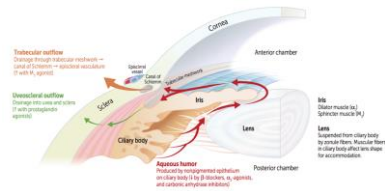
## OUTLINE

- Review of Anatomy
- Review of devices and various considerations
- Research around the devices and success

## PRODUCTION



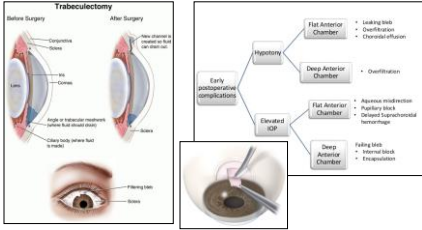
## DRAINAGE



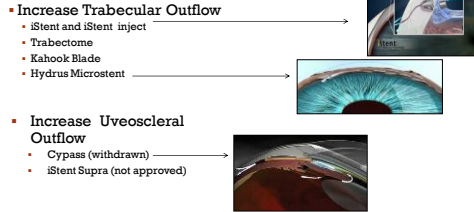
## WHAT ARE MIGS?

- 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
- 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,
- 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

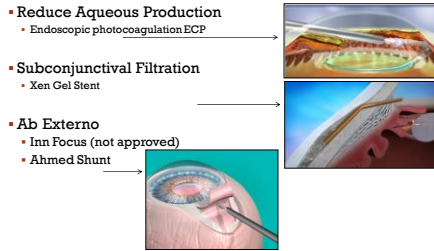
### WHY MIGS?



### MIGS TREATMENTS

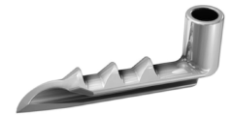


### MIGS TREATMENTS



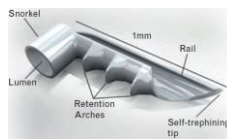
### ISTENT

- First implant 2005
- Heparin-coated, non-ferromagnetic titanium stent; 1.0 mm x 0.3 mm.
- Ab interno insertion into Schlemm's canal
- The iStent (or trabecular microbypass stent) direct channel into Schlemm canal and the subsequent collector channels.
- Safe with MRI testing up to 3 tesla



### ISTENT –FIRST GENERATION

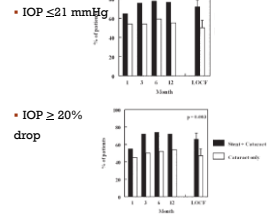
- 26-gauge disposable insertion instrument
- right or left-handed model
- The heparin coating helps to prevent blockage or fibrosis
- Three retention arches ensure that the device will be held in place
- It is 1.0 mm in length,
- 0.33 mm in height,
- weight of 60 mg.
- The snorkel has a length of 0.25 mm and bore diameter of 120 micro meter.



### Randomized Evaluation of the Trabecular Micro-Bypass Stent with Phacoemulsification in Patients with Glaucoma and Cataract

Thomas W. Safranek, MD,<sup>1</sup> L. Joe Roth, MD,<sup>2</sup> Jeffrey M. Walsh, PhD,<sup>1,2</sup> Ning Ding, PhD,<sup>2</sup> Amy Ellen Camperson, BS,<sup>2</sup> for the US Stent Study Group<sup>1,2</sup>

- Primary endpoint unmedicated IOP  $\leq 21$  mmHg at 1 year
- > 72% of treatment eyes versus 50% of control eyes
- Secondary endpoint unmedicated 20% reduction in IOP
- > 66% percent of treatment eyes versus 48% of control eyes



Ophthalmology 2011;118:459–467 © 2011

## RESEARCH ARTICLE

## iStent with Phacoemulsification versus Phacoemulsification Alone for Patients with Glaucoma and Cataract: A Meta-Analysis

Monali S. Mahajan<sup>1</sup>, Mehta<sup>2,3</sup>, Yaminis Iordanous<sup>4</sup>, Yifeng Nancy Chen<sup>5</sup>, Wen Wendy Wang<sup>6</sup>, Sergio Serrano<sup>7</sup>, John Costello<sup>8</sup>, Cindy M. L. Hutnik<sup>9</sup>

- Meta-analysis of 32 publications
- Sample size 2495
- Phaco vs Phaco with 1 stent vs Phaco with 2 stents



- Percentage reduction in IOP from baseline
- Phaco A 4% IOP reduction (IOPR%) procedure
- Phaco + 1 iStent 9%
- Phaco + 2 iStents implants 27%

## SO WHAT HAPPENS 2 YEAR PERIOD

- Craven ER, Cataract surgery with trabecular micro-bypass stent implantation in patients with mild-to-moderate open-angle glaucoma and cataract: two-year follow-up. *J Cataract Refract Surg.* 2012;38:1339e45
- Significant difference between treatment and control group
- Control group- Phaco only IOP was increased
- Treatment group Stent with Phaco IOP remained stable

PLOS ONE | DOI:10.1371/journal.pone.0131770 July 6, 2015

## 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



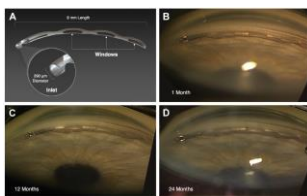
## ISTENT SUPRA (NOT AVAILABLE)

- heparin-coated polyethersulfone and a titanium sleeve.
- Ab interno implantation into the suprachoroidal space
- Not available



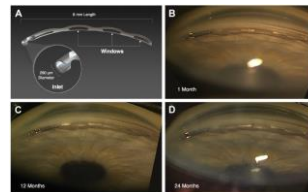
## HYDRUS MICROSTENT

- 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



## 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.



*Ophthalmology* 2019;126:29-37

*Ophthalmology* 2019;126:29-37

### A Schlemm Canal Microstent for Intraocular Pressure Reduction in Primary Open-Angle Glaucoma and Cataract

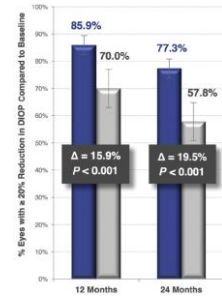
#### The HORIZON Study

- 1 day, 1 week, and 1, 3, 6, 12, 18, and 24 months postoperatively.
- Primary end point
- proportion of subjects demonstrating a  $\geq 20\%$  reduction in unmedicated modified diurnal IOP (MDIOP)
- Secondary endpoint
- change in mean MDIOP from baseline at 24 months
- 369 eyes Hydrus Micro Stent (HMS) group
- 187 eye control (no stent)

Ophthalmology 2019;126:29-37

### HORIZON RESULTS

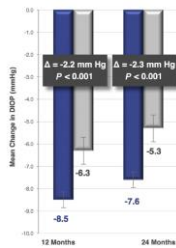
- At 12 month and 24 months, unmedicated modified diurnal IOP was reduced by 20%
- Modified Diurnal Intraocular Pressure
- $4 \pm 1$  hours apart between 8AM and 4PM (ANSI Z80.27 guidance for MIGS investigational studies)



Ophthalmology 2019;126:29-37

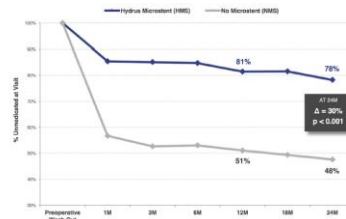
### HORIZON RESULTS MODIFIED DIURNAL IOP

- The modified diurnal IOP reduction in 24-month unmedicated MDIOP



Ophthalmology 2019;126:29-37

### HORIZON MEDICATIONS FREE SUBJECTS



Ophthalmology 2019;126:29-37

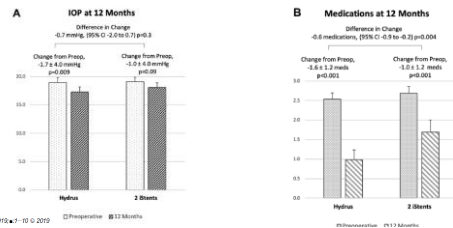
### A Prospective Randomized Trial Comparing Hydrus and iStent Microinvasive Glaucoma Surgery Implants for Standalone Treatment of Open-Angle Glaucoma

#### The COMPARE Study

- N= 152 eyes of 152 individuals
- 1:1 randomization
- Hydrus Versus 2 iStents

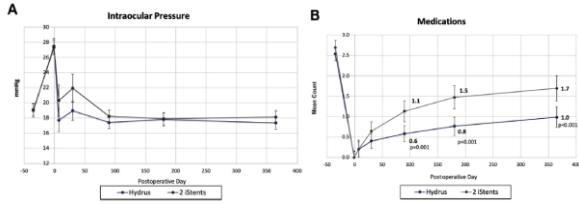
Ophthalmology 2019; 1-10 © 2019

### THE COMPARE STUDY RESULTS



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### THE COMPARE STUDY RESULTS



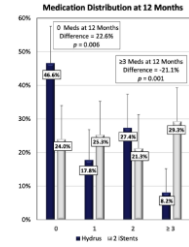
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### THE COMPARE STUDY RESULTS

Table 2. Medicated Mean Intraocular Pressure and Stratified Distribution

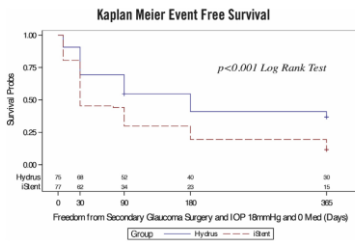
	Preoperative	12 Months	P Value*
<b>Hydrus</b>			
N	75	73	—
Mean (SD) IOP, mmHg	19(2.2)	17.3(1.7)	0.009
% ≥21 mmHg	25.3	8.2	0.008
% ≤18 mmHg	74.7	91.8	0.008
% ≤14 mmHg	41.3	68.4	0.006
% ≤10 mmHg	17.3	24.7	0.31
<b>2-Istent</b>			
N	77	75	—
Mean (SD) IOP, mmHg	19.1(2.6)	18.1(3.7)	0.10
% ≥21 mmHg	27.3	16.0	0.12
% ≤18 mmHg	72.7	84.0	0.12
% ≤14 mmHg	44.2	57.3	0.11
% ≤10 mmHg	14.5	20.0	0.51

IOP = intraocular pressure; SD = standard deviation.  
\*P value, within-group preoperative vs. 12 months.



Ophthalmology 2019;131:1-10 © 2019

### THE COMPARE STUDY RESULTS



- Failure was defined as
  - any secondary glaucoma surgery, intraocular pressure (IOP) >18 mmHg,
  - or use of hypotensive medications on 2 consecutive visits after the 1-month follow-up visit.

Ophthalmology 2019;131:1-10 © 2019

### HYDRUS MICROSTENT HAS ADVANTAGE OVER 2-ISTENT TRABECULAR BYPASS -1 YEAR

- Medication use was reduced by a greater margin or eliminated completely more frequently in the Hydrus group (46.6% vs. 24.0%, P = 0.006)
- Among eyes without medications, Hydrus achieved an IOP 18 mmHg more often (30.1% vs. 9.3%, P < 0.001).
- At 12 months, mean IOP was reduced in the Hydrus group concurrently with elimination of 1.6 medications; in the 2-Istent group IOP was maintained at preoperative levels concurrently with reduction of 1.0 medication.



- 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 foilplate 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

### Prospective randomized controlled trial of phaco-trabectome versus phaco-trabeculectomy in patients with open angle glaucoma

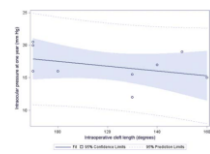
Jessica L.M. Ting, MD, Christopher J. Rudnisky, MD, MPH, Karim F. Damji, MD, MBA

- Small sample RCT.

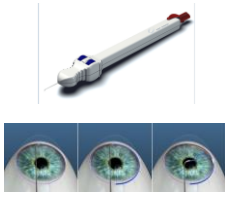
Table 3—Change in Intraocular Pressure

Variable	phaco-ATT	phaco-Trab	p Value
<b>Baseline (mm Hg)</b>			
Mean ± SD	20.0 ± 5.3 n = 10	23.1 ± 6.4 n = 9	0.22
<b>6 months (mm Hg)</b>			
Mean ± SD	17.5 ± 3.8 n = 9	16.0 ± 6.0 n = 8	0.54
Mean change ± SD	-2.8 ± 3.2	-7.4 ± 9.7	0.54
All target IOP, n (%)	2 (22.2%)	5 (62.5%)	0.09
<b>12 months (mm Hg)</b>			
Mean ± SD	16.8 ± 2.7 n = 9	17.1 ± 5.0 n = 8	0.57
Mean change ± SD	-2.7 ± 5.3	-6.4 ± 8.7	0.35
All target IOP, n (%)	4 (44.4%)	5 (62.5%)	0.48

phaco-ATT: Trabectome combined with cataract surgery; phaco-Trab: trabeculectomy with miotimoxol. C combined with cataract surgery. IOP, intraocular pressure.  
\*At 6 and 12 months, 2 phaco-ATT and 2 phaco-Trab patients required ≥1 glaucoma medication to maintain target intraocular pressure.



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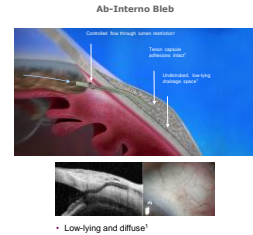


## TRAB 360 (SIGHTSCIENCES)

- 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 trabeculotome is advanced into Schlemm's canal for 180 degrees
- After the trabeculotomy is created, the trabeculotome 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.

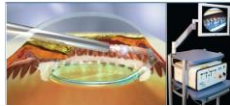
## XEN GEL STENT

- A glaucoma implant designed to reduce intraocular pressure in eyes suffering from refractory glaucoma
- 6-mm length, 45-micron inner diameter—about the length of an eyelash
- Composed of gelatin, cross-linked with glutaraldehyde
- Creates a permanent channel through the sclera allowing flow of aqueous humor from the anterior chamber into the subconjunctival space



## ENDOCYCLOPHOTOCOAGULATION (ECP)

- ECP consists of cyclodestruction of the ciliary body epithelium to reduce aqueous production and therefore IOP
- The ECP probe is reusable device, which includes a laser source, camera, and light source.
- The probe directed towards the anterior ciliary processes delivers continuous energy (210 nm wavelength) for successful photocoagulation.
- Localized shrinkage and whitening of the processes
- Through a single corneal incision, approximately 240 to 360 degrees of the ciliary processes can be treated, but more incisions are needed for a 360-degree treatment.
- As expected, the greater the amount of processes treated, the greater the reduction in IOP and need for glaucoma medications.

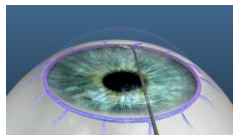


<https://webeye.ophth.uiowa.edu/eforum/tutorials/ezp/>

## EXCIMER LASER TRABECULOSTOMY

- Excimer laser trabeculostomy (ELT) creates small holes in the trabecular meshwork and inner wall of Schlemm's canal
- Energy from a quartz fiberoptic probe connected to a xenon chloride pulsed excimer laser.
- Eight to 10 laser punctures are spaced over 90-degree, with visible whitening of the trabecular meshwork and bubble formation

## AB INTERNO CANALOPLASTY



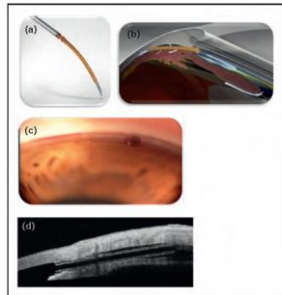
- Ab interno canaloplasty (ABIC) increases aqueous outflow through cannulation of Schlemm's canal with an illuminated microcatheter (iTrack, Ellex)
- An ophthalmic viscosurgical device is injected to viscodilate Schlemm's canal and the proximal collector channels.
- It has been theorized that viscodilation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

## 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.

## CYPASS STENT

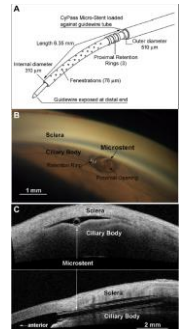
- The CyPass implant is made of polyamide material
- Inserted ab interno into the suprachoroidal space through a manual inserter



## Two-Year COMPASS Trial Results: Supraciliary Microstenting with Phacoemulsification in Patients with Open-Angle Glaucoma and Cataracts

Soren Vold, MD; Ajay K. Ahmed, MD; E. Bruce Coates, MD; Chuhua Minns, MD; Robert Sanger, MD; Mark Packer, MD; Ross H. Brown, MD; Fernando Sanchez, MD, MPH; et al. for the CyPass Study Group

- This RCT demonstrated safe and sustained 2-year reduction in IOP and glaucoma medication use after microinterventional surgical treatment for mild-to-moderate POAG.
- 505 subjects
- 131 were randomized to the control
- 374 were randomized to the microstent group
- Decrease 7.4 mmHg for the microstent group versus 5.4 mmHg in controls (P < 0.001), with 85% of microstent subjects not requiring IOP medications at 24 months



## COMPASS XT RESULTS

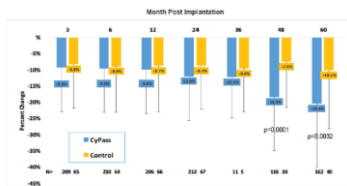


Figure 1. Percentage of change in EOD from baseline.

- 3 year extension trial
- Insisted by FDA during approval
- 282 included 253 completed

Continental Inc.

## COMPASS XT RESULTS CONTINUED

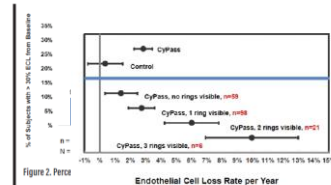
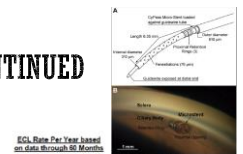


Figure 2. Percent

Figure 3. Annualized ECL at 60 months by device position.



ECL Rate Per Year based on data through 60 Months

Control	2.85%
CyPass, no rings visible, n=93	0.38%
CyPass, 1 ring visible, n=88	1.20%
CyPass, 2 rings visible, n=21	2.74%
CyPass, 3 rings visible, n=6	6.02%
	9.96%

TABLE 1. COMPARISON OF ECL RATES ACROSS MIGS PROCEDURES				
MIGS DEVICE	N	FOLLOW-UP TIME	MEAN % ECL	% WITH ECL >30%
<b>Sclerotomy Canal</b>				
Stent Inject (Glaukos)	505	24 months	13.1% treatment 12.2% control	10.4% treatment 9.5% control
3P		12 months	13.2%	
Hydrex Microstent (Avanti)	556	24 months	14.0% treatment 10.0% control	13.6% treatment 7.2% control
		36 months	15.0% treatment 11.0% control	14.0% treatment 10.2% control
Tuberculosis (Ivantis)	60*	12 months	No change	
Kahook Dual (Bausch & Lomb Medical)	Unknown			
Ab Interno Canaloplasty (Cillo)	Unknown			
Osmol (Sight Sciences)	Unknown			
<b>Supraciliary</b>				
CyPass Micro-Stent (Alcon)	253	60 months	10.4% treatment 7.5% control	27.2% treatment 10.0% control
Stent Supra (Glaukos)	Unknown			
<b>Subconjunctival</b>				
Non Gel Stent (Allergan)	3†	12 months	No change (+3.6%)	
Infocross MicroShunt (Santen)	Unknown			

Key: N = number of patients, ECL = endothelial cell loss, MIGS = microinvasive glaucoma surgery. \*Nishioka et al 2013, †Yee et al 2017

## RISK ASSESSMENT IN PATIENT WITH CYPASS

- Routine gonioscopy is needed
- Contact with Endothelium must be noted.
- Baseline corneal thickness and endothelial cell count is needed
- Note rings visible
- Look for edema or guttata

## CYPASS MICRO-STENT POSITION ADJUSTMENT OR REMOVAL

- "Situations that may merit consideration of CyPass Micro-Stent position adjustment or removal include, but are not limited to: intermittent or persistent **contact** between the CyPass Micro-Stent and the **corneal endothelium**; significant **decrease in endothelial cell density** that appears related to CyPass Micro-Stent positioning or stability; iris-cornea touch; persistent hypotony; persistent uncontrolled uveitis; recurrent or persistent hyphema with IOP elevation above target pressure; or any anatomic or functional clinical sequelae of the anterior or posterior segment that may cause a threat to vision."

## EFFECTIVENESS OF MIGS

MIGS Procedure	Decrease in IOP	Decrease in Medications	Study Type
Stent Micro-Bypass* [7]	4.4 mmHg @ 2 years	0.6 @ 2 years	Randomized controlled trial
Stent Inject [9]	6.1 mmHg @ 1 year	Not available	Prospective, randomized trial
Gonioscopy-assisted transillumination trabeculectomy (GATT)* [10]	4.4 mmHg @ 1 year	1.8 @ 1 year	Retrospective review
Tubectomies* [11]	6.2 mmHg @ 2 years	0.7N @ 2 years	Meta-analysis
TiMAB 360 Trabeculectomy [16]	6.3 mmHg @ 131.5 days**	0.9 @ 131.5 days**	Retrospective review
Ab interno canaliculoplasty* [18]	4.0 mmHg @ 1 year	1.0 @ 1 year	Case-series review
Hydrus Microstent* [20]	3.4 mmHg @ 2 years	1.5 @ 2 years	Randomized controlled trial
CyPass Micro-Stent* [22]	1.4 mmHg @ 2 years	1.2 @ 2 years	Randomized controlled trial
Stent Supra [23-24]	1.8 mmHg @ 2 years	Not available	Prospective, single arm clinical trial
SEN Glaucoma Treatment System [27]	6.2 mmHg @ 1 year	1.8 @ 1 year	Prospective, single arm clinical trial
IntFocus MicroStent* [31]	10.2 mmHg @ 3 years	1.6 @ 3 years	Prospective, single arm clinical trial
Endocyclophotocoagulation* [32]	2.1 mmHg @ 2 years	1.1 @ 2 years	Prospective case-control study

<https://webeye.sph.illinois.edu/eyeforum/tutorial/migs/>

## SUMMARY

- Minimal trauma, high efficacy, high safety profile, and rapid recovery.
- There is an increasing interest and availability of MIGS procedures.
- Important to have good science and long-term follow-up data.
- MIGS devices may offer benefits to our patients with glaucoma
  - > through IOP reduction
  - > reduced need for glaucoma medications
  - > high safety profile.
- MIGS are here to stay for the foreseeable future and its role increasing.