Minimally Invasive Glaucoma Surgery Workshop

Robert P Wooldridge, OD, FAAO

1

Disclosure

- Speakers Bureau for Alcon, Allergan, Biotissue, Centervue, Glaukos, Ivantis, Oculus, Optovue, Synemed, Telscreen

2

MIGS Concept

- Intervene earlier in disease and lower IOP to reduce morbidity of progression
- Reduce the need for more aggressive surgical options while preserving that option
- Reduce medication burden
- Some procedures limited to use in conjunction with cataract surgery
  - Some are not restricted to use with CE

3

Minimally Invasive Glaucoma Surgery (MIGS)

- Bypass trabecular meshwork or use suprachoroidal approach
- Usually performed in conjunction with cataract surgery
- More effective in lowering IOP than Phaco alone
- Easier for surgeon and patient than trabeculectomy though less effective
- May reduce or eliminate dependence on meds

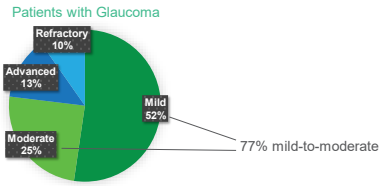
4

MIGS: Micro-Invasive Glaucoma Surgery

- Ab-interno approach
  - Clear corneal micro-incision (<2.0mm)
  - Conjunctival sparing
- Minimally traumatic
  - Negligible disruption of normal anatomy/physiology
- Reduce the need for more aggressive surgical options while preserving that option
- Reduce medication burden

5

MILD-TO-MODERATE GLAUCOMA PREDOMINATES



Paradigm Shift to Surgical Options Earlier

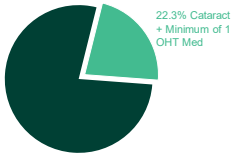
1. Data on file, Glaukos Corporation.

6

CONCOMITANT CATARACT & GLAUCOMA PATIENTS – US

Significant treatment opportunity with more than 1 in 5 eyes with cataracts on OHT medication

4.3M US Cataract Procedures



Market Scope 2019 and Medicare Administrative Claims Data (Carrier 5% SAF) 2007-2010.

7

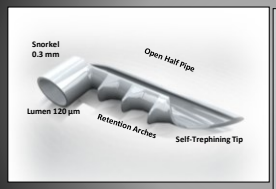
iStent® (Glaukos) Indication For Use

The iStent Trabecular Micro-Bypass Stent is indicated for use in conjunction with cataract surgery for the reduction of intraocular pressure (IOP) in adult patients with mild to moderate open-angle glaucoma currently treated with ocular hypotensive medication

8

Specifications

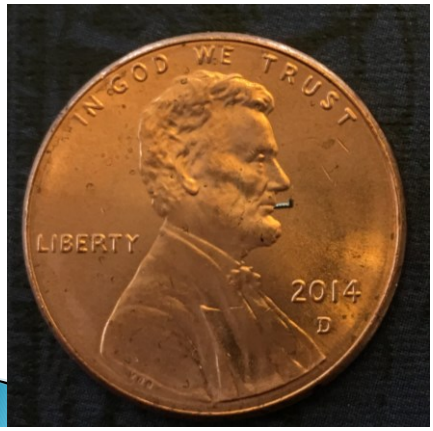
iStent is the smallest medical device known to be implanted in the human body and weighs just 60 µg



ACTUAL SIZE

- **Dimensions are customized for a natural fit within the 270 µm canal space**

9



10

Specifications

11

Therapeutic Objectives

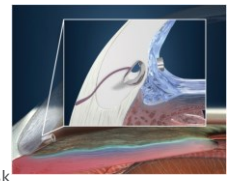
Designed to be used in conjunction with cataract surgery to safely and effectively reduce IOP while facilitating the eye's natural outflow in mild to moderate OAG patients.

- **Lowers IOP while helping to reduce medication burden**
- **Decrease risk of IOP fluctuations associated with non-adherence to prescription medication regimens**
- **Avoid serious complications associated with end-stage filtration and shunt procedures**
- **Spare the conjunctiva and safely preserve future treatment options**
- **Minimizes risks of hypotony and bleb related complications**

12

iStent Surgical Procedure

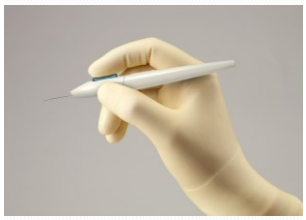
- Placed in the eye during cataract surgery
- The complete procedure is typically accomplished in 15 to 20 minutes per eye
- iStent has an overall safety profile similar to cataract surgery
- The natural episcleral back pressure of 8 to 11 mm Hg, minimizes the risk of hypotony[1,2]



1. Rosenquist R, Epstein D, Melamed S, et al. Outflow resistance of enucleated human eyes at two different perfusion pressures and different extents of trabeculotomy. *Curr Eye Res* 1989;8:1233-40.
2. Samuelson TW, Katz LJ, Wells JM, Duh Y-J, Giamporcaro JE. Randomized evaluation of the trabecular micro-bypass stent with phacoemulsification in patients with glaucoma and cataract. Ophthalmology 2011;118:459-467

13

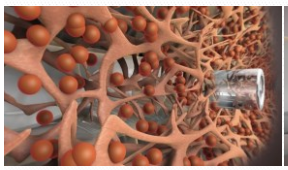
Injector System



Single Use Disposable

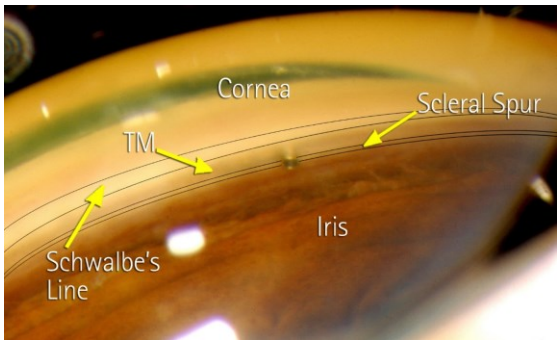
Pre-loaded

14



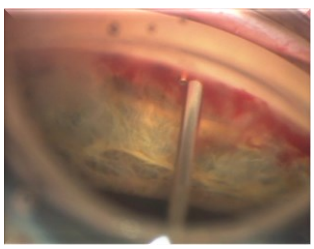
Snorkel in TM

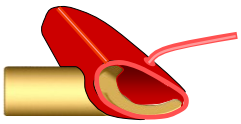
15

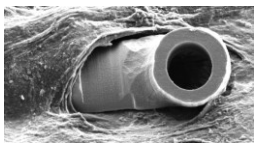


16

Surgical Procedure







- **Rails are seated against scleral wall of Schlemm's canal**
- **Snorkel sits parallel to the iris plane**

17

THE iStent *inject* W TRABECULAR MICRO-BYPASS

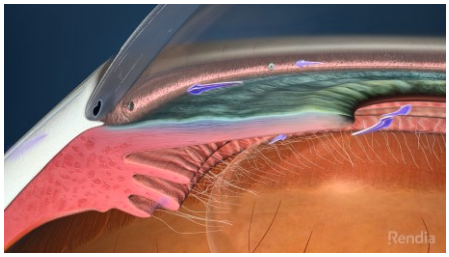
For patients with cataracts and glaucoma, iStent *inject* W is:

- FDA approved therapy for the treatment of elevated IOP in adult patients with mild-to-moderate primary open-angle glaucoma in conjunction with cataract surgery
- An *ab interno*, micro-bypass system designed to restore natural physiological outflow **through two openings** through the trabecular meshwork
- Built on a proven platform of technology with an excellent safety profile

18

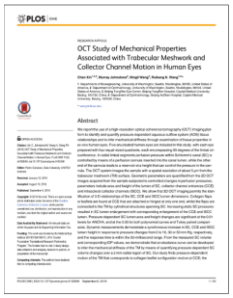
RESTORE THE PATHWAY FOR NATURAL OUTFLOW

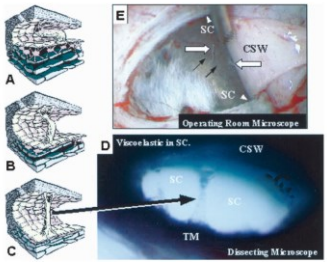
iStent *inject* W creates two patent bypass pathways through the trabecular meshwork, resulting in multi-directional flow through Schlemm's canal



19

AQUEOUS OUTFLOW AS A MECHANICAL PUMP

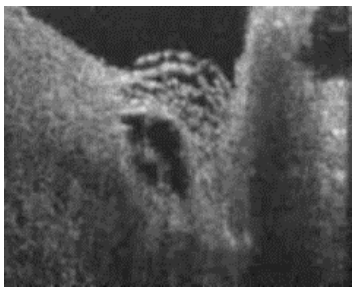

OCT Study of Mechanical Properties Associated with Trabecular Meshwork and Collector Channel Motion in Human Eyes



Murray A. Johnstone, MD

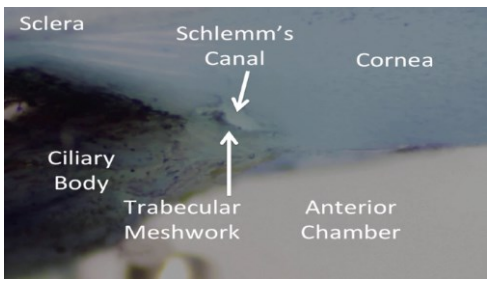
20

PULSE-DEPENDENT COLLECTOR CHANNEL MOTION VIDEO



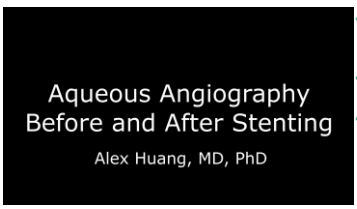
21

TRABECULAR MESHWORK PULSE-INDUCED MOTION VIDEO



22

AQUEOUS ANGIOGRAPHY VIDEO



- Immediate and more expansive flow post iStent *inject* implantation
- Arcs of flow that can span 5-6 clock hours
- May re-establish flow in previously dormant outflow channels

23

Pre-operative Considerations

- iStent Candidate
  - Mild to moderate open angle glaucoma (no more severe than a mean deviation of -12dB)
  - Visually significant cataract is present on examination
  - Patient desires to reduce dependence on glaucoma medications

Any patient with cataracts being treated for mild to moderate open angle glaucoma with medications may be a potential candidate for an iStent[1]

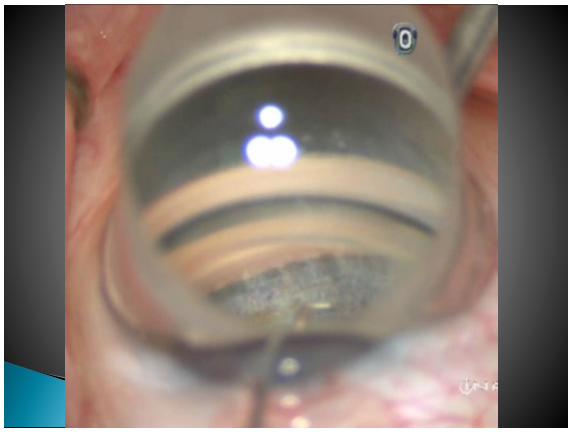
[1] See Directions for Use for a complete list of Contraindications and Precautions

24

iStent Pre-op Care

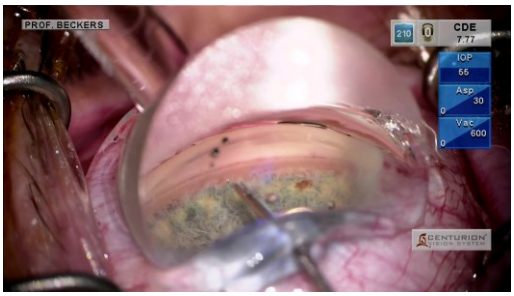
- Review risks and benefits of possible medical and surgical treatment options
- Do NOT promise that the patient will be able to stop some or all of their glaucoma medications
- Continue current glaucoma medications through day of surgery
- Confirm patient's VF, ONP and OCT are up to date
- Gonioscopy – evaluating for synechia, iris processes, narrow anatomical angles, angle recession or any other abnormalities of the angle structure that may interfere with placement of the iStent

25



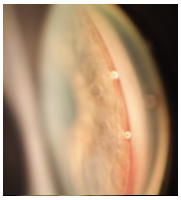
26

iStent *inject* W SURGICAL PROCEDURE

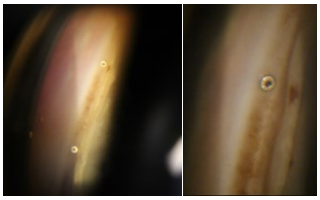


27

POST-OP IMAGES



iStent *inject* W
Courtesy of Dr. Florian Rufer



iStent *inject* – 2-year post-op
Courtesy of Dr. George Reiss

28

iStent *inject* PIVOTAL TRIAL

Study Design

- Prospective, multicenter, 3:1 randomized controlled trial
- iStent *inject* + phaco vs. phaco alone
- Follow-up through 24 months, with baseline and annual washouts
- 505 total subjects randomized

Efficacy Endpoints

- Primary: ≥ 20% reduction in unmedicated DIOP
- Secondary: Mean reduction in unmedicated DIOP

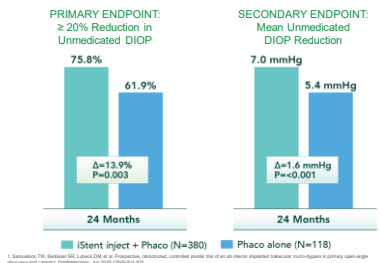
Study met all effectiveness endpoints[1]

High safety profile, similar to cataract surgery alone[1]

1. Samuelson TW, Sarkisian SR, Lubeck DM, et al. Prospective, randomized, controlled pivotal trial of an ab interno implanted trabecular micro-bypass in primary open-angle glaucoma and cataract. Ophthalmology. Jun 2019;126(6):811-821.

29

iStent *inject* PIVOTAL TRIAL
PROVEN EFFICACY[1]

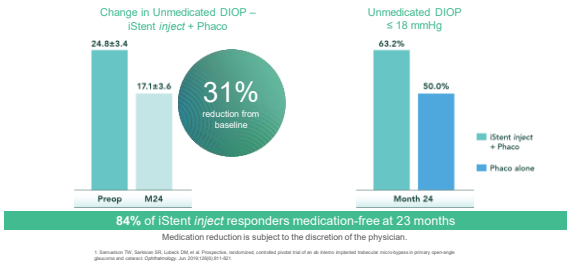


1. Samuelson TW, Sarkisian SR, Lubeck DM, et al. Prospective, randomized, controlled pivotal trial of an ab interno implanted trabecular micro-bypass in primary open-angle glaucoma and cataract. Ophthalmology. Jun 2019;126(6):811-821.

30

iStent *inject* PIVOTAL TRIAL

OTHER OBSERVED DATA[1]

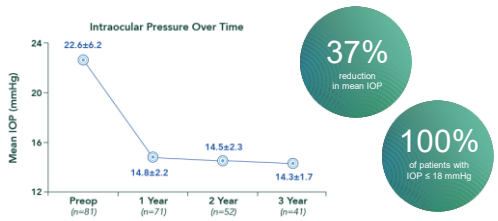


1. Samuelson TW, Sarkisian SR, Lubeck DM, et al. Prospective, randomized, controlled pivotal trial of an ab interno implanted trabecular micro-bypass in primary open-angle glaucoma and cataract. Ophthalmology. Jun 2019;126(6):811-821.

31

HENGERER (3 YEAR)

LONG-TERM IOP REDUCTION AT 3 YEARS[1]

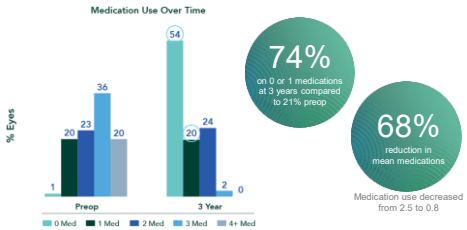


1. Hengerer FH, Auffarth GU, Riffel C, Conrad-Hengerer I. Prospective, non-randomized, 36-month study of second-generation trabecular micro-bypass stents with phacoemulsification in eyes with various types of glaucoma. Ophthalmol Ther. 2018 Dec;7(2):405-415.

32

HENGERER (3 YEAR)

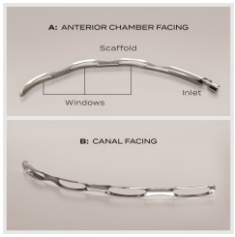
SUSTAINED MEDICATION REDUCTION[1]



1. Hengerer FH, Auffarth GU, Riffel C, Conrad-Hengerer I. Prospective, non-randomized, 36-month study of second-generation trabecular micro-bypass stents with phacoemulsification in eyes with various types of glaucoma. Ophthalmol Ther. 2018 Dec;7(2):405-415.

33

Hydrus® Microstent

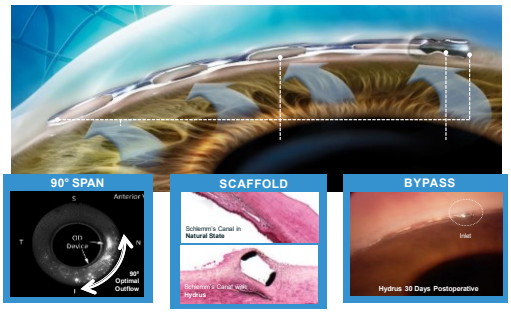


- Flexible, 8 mm
- Nitinol (highly biocompatible material used in cardiovascular stents)
- Contoured to match canal curvature
- Three open windows face anterior chamber
- The canal-facing surface is completely open for unobstructed collector channel access

Hydrus is a registered trademark of Ivantis, Inc.

34

Mechanism of Action



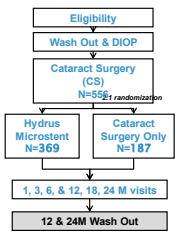
Source: Gong H, Johnstone M, et al. Poster #115 American Glaucoma Society, New York 2012

Source: Heys CL, Toris CB, et al. *Invest Ophthalmol Vis Sci.* 2014;55:1860-1900

Courtesy of Ike Ahmed, MD

35

HORIZON Trial: Study Design[1]



- **Inclusion:** *Mild/moderate* POAG (VF MD >-12dB), cataract, 1-4 medications, no prior glaucoma surgery, ±prior SLT
- **After 4 week wash out:** Mean diurnal IOP 22-34 mmHg
- **Treatment**: 2:1 randomization in the OR to Hydrus or phaco only after successful PC IOL
- **Primary Endpoint**: 20% reduction in washed out diurnal IOP at 24 months
- **Secondary endpoint:** Change in mean washed out diurnal IOP at 24 months
- **Medications:** mean and counts at each visit
- **Statistics:** >90% power for primary endpoint; Intention-to-treat analysis

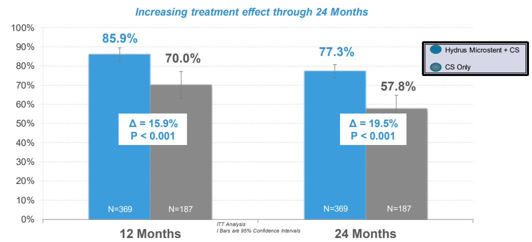
Kuldev Singh, MD, MPH Medical Monitor

1. Samuelson TW, Chang DF, Marquis R, et al. A Schlemm canal microstent for intraocular pressure reduction in primary open-angle glaucoma and cataract: The HORIZON Study. *Ophthalmology* 2019;126:29-37.

36

HORIZON: Primary Endpoint[1]

20% REDUCTION IN WASHED OUT DIOP AT 24 MONTHS



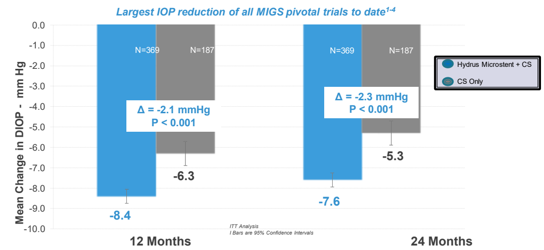
1. Samuelson TW, Chang DF, Marquis R, et al. A Schlemm canal microstent for intraocular pressure reduction in primary open-angle glaucoma and cataract: The HORIZON Study. *Ophthalmology* 2019;126:29-37.

37

37

HORIZON: Secondary Endpoint[1]

CHANGE IN WASHED OUT DIOP AT 24 MONTHS



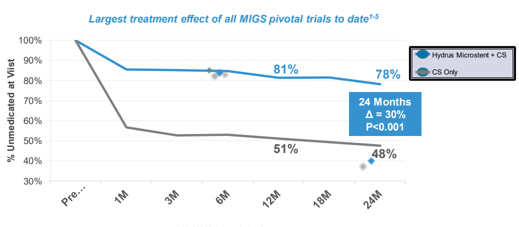
1. Samuelson TW, Chang DF, Marquis R, et al. A Schlemm canal microstent for intraocular pressure reduction in primary open-angle glaucoma and cataract: The HORIZON Study. *Ophthalmology* 2019;126:29-37. 2. Vold S, Ahmed II, Craven ER, et al; CyPass Study Group. Two-Year COMPASS Trial Results: Supraciliary Microstenting with Phacoemulsification in Patients with Open-Angle Glaucoma and Cataracts. *Ophthalmology*. 2016;123(10):2103-2112. 3. US Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED): Glaukos iStent® Trabecular Micro-Bypass Stent. US Food and Drug Administration website. https://www.accessdata.fda.gov/cdrh_docs/pdf8/P080030B.pdf. Published June 25, 2012. 4. US Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED): iStent inject Trabecular Micro-Bypass System. US Food and Drug Administration website. https://www.accessdata.fda.gov/cdrh_docs/pdf17/P170043b.pdf. Published June 21, 2018.

38

38

HORIZON: Medication Free[1]

MEDICATION FREE 0-24 MONTHS

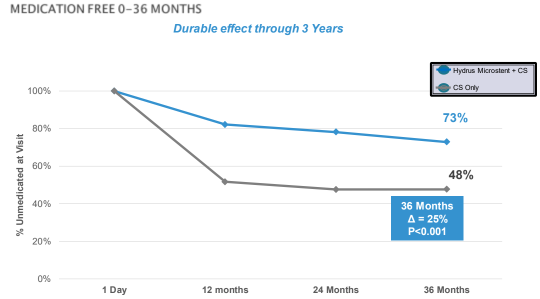


1. Samuelson TW, Chang DF, Marquis R, et al. A Schlemm canal microstent for intraocular pressure reduction in primary open-angle glaucoma and cataract: The HORIZON Study. *Ophthalmology* 2019;126:29-37. 2. Vold S, Ahmed II, Craven ER, et al; CyPass Study Group. Two-Year COMPASS Trial Results: Supraciliary Microstenting with Phacoemulsification in Patients with Open-Angle Glaucoma and Cataracts. *Ophthalmology*. 2016;123(10):2103-2112.
3. US Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED): Glaukos iStent® Trabecular Micro-Bypass Stent. US Food and Drug Administration website. https://www.accessdata.fda.gov/cdrh_docs/pdf8/P080030B.pdf. Published June 25, 2012. 4. US Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED): iStent inject Trabecular Micro-Bypass System. US Food and Drug Administration website. https://www.accessdata.fda.gov/cdrh_docs/pdf17/P170043b.pdf. Published June 21, 2018.

39

HORIZON: Medication Free[1]

MEDICATION FREE 0-36 MONTHS



*Data on File – Ivantis, Inc.

40

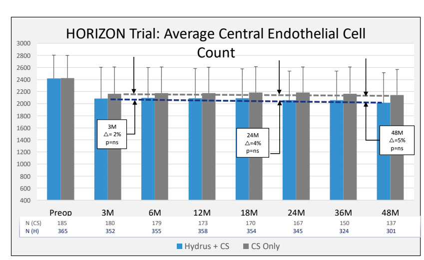
Cumulative Adverse Events through 24 Months[1]

Intraoperative Events	Hydrus MS + CS N=369	CS Only N=187
Device malposition	1.6%	0
Hyphema	1.1%	0
Post Operative Events	**Hydrus MS + CS N=369**	**CS Only N=187**
Incisional glaucoma surgery (Trab/GDD)	0	2.1%
IOP elevation (> 10 mmHg over baseline >30 day follow up)	0.5%	2.7%
Hypotony ≤ 6 mmHg ≥ 1 day	0	0
Uveitis/Iritis requiring steroids	5.6%	3.7%
Layered Hyphema, >2 mm > 1 day	0.5%	0.5%
Laser synechialysis	0.8%	0%
Tissue obstruction/obstructive PAS	3.8%	0%

1. Samuelson TW, Chang DF, Marquis R, et al. A Schlemm canal microstent for intraocular pressure reduction in primary open-angle glaucoma and cataract: The HORIZON Study. *Ophthalmology* 2019;126:29-37.

41

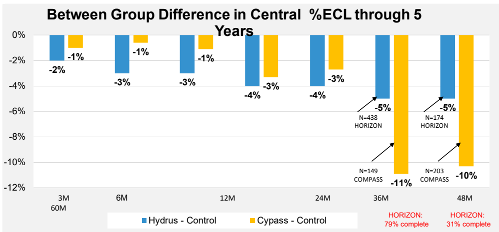
HORIZON: Stable Central ECD*



*Data on File – Ivantis, Inc.

42

Hydrus[1] vs. CyPass[2]: Difference in ECL



1. Data on file – Ivantis, Inc.
2. Lane S. Overview of the results from the 5 yr follow up study of the CyPass ® MicroStent. https://drive.google.com/file/d/1jl1JhJjHXNnYXwJ8BCPb4xNIIsZDtxJ5/view. ESCRS. September 2018.

43

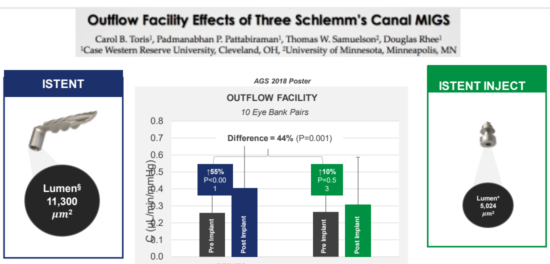
Safety – Stable from Year 2 to 3

Post Operative Events	Cumulative – 2 Years[1]		Cumulative – 3 Years[2]	
	HYDRUS MS (N=369)	CS Only (N=187)	HYDRUS MS (N=369)	CS Only (N=187)
IOP related events –				
IOP elevation (≥ 10 mmHg, >30 days)	0.5%	2.7%	0.8%	2.7%
Hypotony ≤ 6 mmHg ≥ 1 month	0	0	0	0
Loss of BCVA ≥ 2 lines after 3 months	1.4%	1.6%	1.4%	2.7%
Loss of HVF – MD ≥ 2.5 dB	4.3%	5.3%	5.9%	7.4%
Uveitis/Iritis requiring steroids	5.6%	3.7%	5.6%	3.7%
Nickel/allergic reaction	0	-	0	-
Device Obstruction/PAS				
Obstructive	3.8%	0	3.8%	0
Non – obstructive	14.9%	2.1%	16.3%	2.1%
Laser procedures (tissue ablation/SLT)	0.8%	0.5%	1.6%	2.1%

1. Samuelson TW, Chang DF, Marquis R, et al. A Schlemm canal microstent for intraocular pressure reduction in primary open-angle glaucoma and cataract: The HORIZON Study. *Ophthalmology* 2019;126:29-37.
2. Data on file

44

Outflow Comparison: Two iStents and Two iStent *injects*



§ Lumen area calculated based on published data – (Ref. Directions for Use - US Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED): Glaukos iStent® Trabecular Micro-Bypass Stent. US Food and Drug Administration website. https://www.accessdata.fda.gov/cdrh_docs/pdf8/P080030B.pdf. Published June 25, 2012
*Directions for Use - US Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED): iStent inject Trabecular Micro-Bypass System. US Food and Drug Administration website. https://www.accessdata.fda.gov/cdrh_docs/pdf17/P170043b.pdf. Published June 21, 2018)

45

THREE PIVOTAL TRIALS – MIGS + CS
Demographics & Pre Op Status

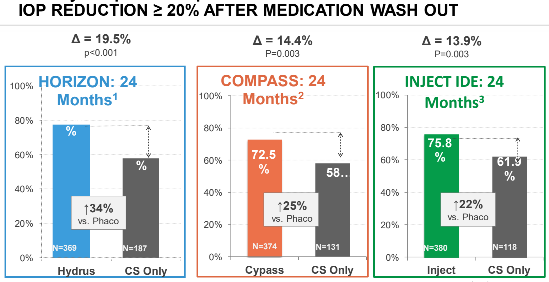
	HORIZON[1]		COMPASS[2]		iSTENT INJECT[3]	
	HYDRUS	CS Only	CYPASS	CS Only	INJECT	CS Only
N	369	187	374	131	387	118
Age	71 ± 8	71 ± 8	70 ± 8	70 ± 8	69 ± 8	70 ± 8
Female - %	56%	56%	53%	55%	58%	54%
Caucasian - %	79%	82%	84%	82%	73%	73%
Visual Field - MD	-3.6 ± 2.5	-3.6 ± 2.6	-3.4 ± 2.9	-3.7 ± 3.0	-3.4 ± 3.3	-3.4 ± 3.1
Mean IOP - mm Hg (screening)	17.9 ± 3.1	18.1 ± 3.1	17.4 ± 2.9	17.6 ± 3.0	17.5 ± 3.0	17.5 ± 2.8
Mean Medications	1.7	1.7	1.7*	2.2*	1.6†	1.5†
Washed out DIOP§ - mm Hg	25.5 ± 3.0	25.4 ± 2.9	24.4 ± 2.8	24.5 ± 3.0	24.8 ± 3.3	24.5 ± 3.1

* COMPASS allowed 0 medications at baseline (n=87). Average IOP and meds for medicated patients shown (Ref #2). † Mean medication count derived from data in inject SSED (Ref #3).
§ Included DIOP range was slightly different: 22-34 (HORIZON), 21-33 (COMPASS), 21-36 (INJECT).

1. Samuelson TW, Chang DF, Marquis R, et al. A Schlemm canal microstent for intraocular pressure reduction in primary open-angle glaucoma and cataract: The HORIZON Study. *Ophthalmology* 2019;126:29-37.
2. US Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED): CyPass® System (Model 241-S) . US Food and Drug Administration website https://www.accessdata.fda.gov/cdrh_docs/pdf15/P150037B.pdf. Published July 29, 2016..
3. US Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED): iStent inject Trabecular Micro-Bypass System. US Food and Drug Administration website. https://www.accessdata.fda.gov/cdrh_docs/pdf17/P170043b.pdf. Published June 21, 2018.

46

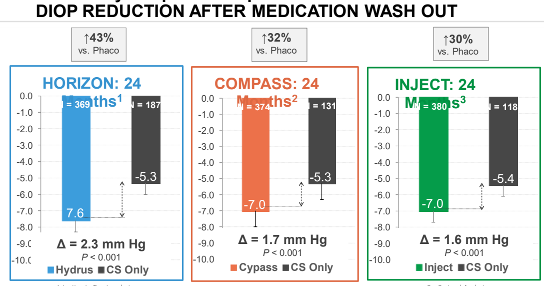
Primary Endpoint Comparison
IOP REDUCTION ≥ 20% AFTER MEDICATION WASH OUT



1. Samuelson TW, Chang DF, Marquis R, et al. A Schlemm canal microstent for intraocular pressure reduction in primary open-angle glaucoma and cataract: The HORIZON Study. *Ophthalmology* 2019;126:29-37.
2. US Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED): CyPass® System (Model 241-S) . US Food and Drug Administration website https://www.accessdata.fda.gov/cdrh_docs/pdf15/P150037B.pdf. Published July 29, 2016..
3. US Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED): iStent inject Trabecular Micro-Bypass System. US Food and Drug Administration website. https://www.accessdata.fda.gov/cdrh_docs/pdf17/P170043b.pdf. Published June 21, 2018

47

Secondary Endpoint Comparison
DIOP REDUCTION AFTER MEDICATION WASH OUT



1. Samuelson TW, Chang DF, Marquis R, et al. A Schlemm canal microstent for intraocular pressure reduction in primary open-angle glaucoma and cataract: The HORIZON Study. *Ophthalmology* 2019;126:29-37.
2. US Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED): CyPass® System (Model 241-S) . US Food and Drug Administration website https://www.accessdata.fda.gov/cdrh_docs/pdf15/P150037B.pdf. Published July 29, 2016..
3. US Food and Drug Administration. Summary of Safety and Effectiveness Data (SSED): iStent inject Trabecular Micro-Bypass System. US Food and Drug Administration website. https://www.accessdata.fda.gov/cdrh_docs/pdf17/P170043b.pdf. Published June 21, 2018

48

OMNI™ SURGICAL SYSTEM

INDICATION

The OMNI™ Surgical System is a manually operated device for delivery of small amounts of viscoelastic fluid, for example Healon® or HealonGV® from Abbott Medical Optics (AMO), Amvisc® from Bausch & Lomb, or PROVISC® from Alcon, during ophthalmic surgery. It is also indicated to cut trabecular meshwork tissue during trabeculotomy procedures.

49

OMNI™ SURGICAL SYSTEM

Combines two distinct implant-free procedures in one device

Transluminal viscoelastic delivery + Titratable trabeculotomy

Targets three points of resistance in the conventional outflow pathway:

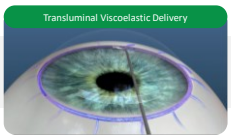
1. Trabecular Meshwork
2. Schlemm's Canal
3. Distal Collector Channels

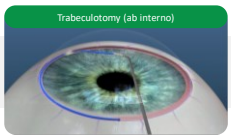
Each of these procedures is sufficiently established to have its own Category 1 CPT code

Standalone procedure or in conjunction with cataract surgery

50

ANTERIOR SEGMENT PROCEDURES WITH THE OMNI™ SYSTEM





51