

# iStent Trabecular Micro-Bypass and Concurrent Cataract Surgery: 24 Month Results

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## INTRODUCTION

Medical therapies that treat glaucoma act either by reducing aqueous production or increasing the outflow of aqueous via the trabecular or uveoscleral pathways. Trabecular bypass has been found to enhance the facility of outflow and reduce IOP to physiological levels.<sup>1</sup> To that end, the iStent® (Glaukos Corp., Laguna Hills, CA) was developed to address some of the limitations of current medical and surgical therapies for treating glaucoma including ocular morbidity, extrusion, hemorrhage, infection, hyphema and corneal edema. The device aims to bypass the trabecular meshwork, which is considered to be responsible for the increased outflow resistance leading to glaucoma, connecting the anterior chamber with Schlemm's Canal. This procedure attempts to re-establish fully-developed physiological steady-state outflow, leaves the conjunctiva untouched, and negates the risk of complications associated with filtering blebs.

The purpose of this study was to evaluate the safety and efficacy of the iStent® Trabecular Micro-bypass Stent in patients undergoing concurrent cataract and glaucoma surgery.

## METHODS

- This was a prospective, non-randomized, open-label, multi-center, multi-country, 24-month clinical evaluation of the efficacy and safety of the Glaukos iStent® Trabecular Bypass Micro Stent for the treatment of open-angle and/or pseudoexfoliation glaucoma in patients (n=59) with IOP uncontrolled by their current ocular hypotensive medication(s).
- No washout of patients' current ocular hypotensive medications was required.
  - Patients discontinued use of all agents immediately postoperatively and were instructed to resume treatment only if the investigator determined additional IOP lowering was needed.

### Outcome measures

- The primary outcome measure was IOP as measured by Goldmann applanation tonometry.
- The secondary outcome measure was number and type of glaucoma medications pre- and post-operatively.

### Inclusion criteria

- Diagnosis of open-angle glaucoma, including pseudoexfoliation glaucoma or pigmentary glaucoma.
- Current use of at least one glaucoma medication.
- IOP  $\geq$  18 mmHg (as measured at last two consecutive office visits).
- Concurrent diagnosis of cataract requiring cataract surgery and intraocular lens implantation.
- Scleral spur clearly visible with gonioscopy.
- Available and willing to attend follow-up visits for 2 year study duration.
- Signed informed consent.

### Exclusion criteria

- Any type of glaucoma other than open-angle glaucoma, pseudoexfoliation, or pigmentary glaucoma.
- Presence of cloudy corneas with opacity determined likely to inhibit gonioscopic view of the nasal angle.
- History of any incisional or cyclodestructive glaucoma surgery in the study eye.
- History of any cataract surgery in the study eye.
- Elevated episcleral venous pressure.
- History of trauma to the eye or ocular surface disorder.
- Existing peripheral anterior synechia (PAS).
- Prior history of refractive procedures that may prevent accurate IOP measurements (e.g., RK, PRK, LASIK).

### Surgical procedure

- Patients underwent implantation of the Glaukos iStent® Trabecular Bypass Micro Stent at the conclusion of standard clear cornea cataract surgery with a 2.5 to 3.5 mm incision.
- The iStent® was guided into Schlemm's canal using ab-interno gonioscopy (using a Swan-Jacobs gonioscope).

### Follow-up evaluations

- Post-operative study visits were at days 1-2 days and 7-14 days and months 1, 2, 3, 6, 12, 18, and 24.
- Study visits included IOP measurement, slit lamp examination, evaluation of number of glaucoma medications, and adverse event assessment.
- Stent location and condition were evaluated gonioscopically.

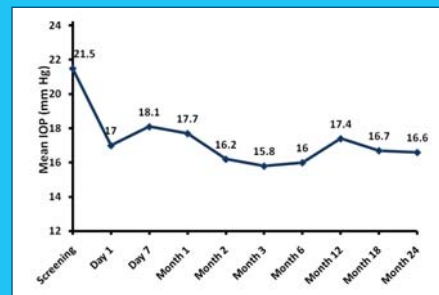
### Patient demographics

- Most patients were:
  - Female (66.1%)
  - Caucasian (98.3%)
- Mean age was 75 years (range: 28-87).
- Ophthalmic history:
  - PXE: 16.9%
  - PDS: 8.5%
  - Macular degeneration: 15.2%
  - Prior ALT: 6.8%
- Baseline mean IOP was  $21.5 \pm 4.07$  mmHg (all treated eyes).
- Baseline mean number of medications was 1.7 (all treated eyes).

### Safety

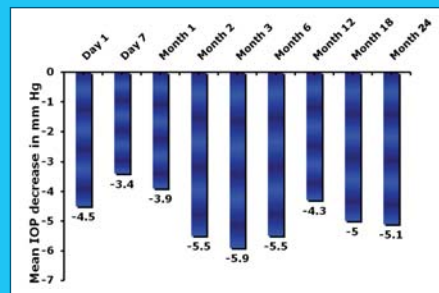
- The most commonly reported procedure/stent adverse events were:
  - Stent lumen obstruction (n=7)
  - Iris touched by device (n=6)
  - Malpositioned stent (N=9)
    - In six subjects no secondary surgical intervention was performed, as it seemed that the stent was actually functioning, (most patients experienced a reduction in IOP and number of medications from baseline).
  - Two subjects underwent stent replacement and one subject underwent stent repositioning.
- There was no touching of the endothelium, no excessive bleeding, no iris damage, or hyphema observed.
- There was no reported incidence of hypotony, post-surgical flat chambers and/or choroidal effusion.
- Five patients underwent surgical intervention for IOP failure (defined as IOP > 18 mm Hg on two consecutive study visits at the 3 month follow-up or later).
- One patient had a BCVA loss of > 1 line at or after three months postoperative.

### Mean IOP at each study visit (all treated eyes)



- Implantation of the iStent® provided a significantly reduced mean IOP throughout the follow-up period (P<.0001).

### Mean Reduction in IOP at each study visit (all treated eyes)

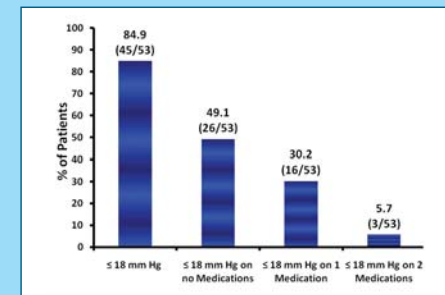


- Placement of the iStent provided statistically significant reductions in IOP from the medicated baseline.
  - Mean reductions ranged from 3.4 mm Hg (14.2%) to 5.9 mm Hg (25.4%) (P<.001).
  - At 24 months, the mean IOP reduction from the medicated baseline was  $5.1 \pm 4.2$  mm Hg.

### Figure 1. iStent® pictured on U.S. Penny

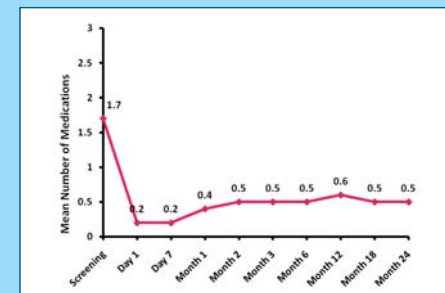


### Percentage of patients reaching an IOP $\leq$ 18 mm Hg at Month 24 (all treated eyes)



- At 24 months, 45 patients (84.9%; n=53) had an IOP of  $\leq$  18 mm Hg, with a mean IOP of  $15.8 \pm 2.08$  mm Hg.

### Mean number of ocular hypotensive agents used at each study visit (all treated eyes)



- Implantation of the iStent provided a statistically significant reduction in the mean number of medications required to control IOP at each follow-up visit (P<.0001).
  - At baseline, the mean number of medications was  $1.7 + 0.93$
  - Postoperatively, the mean number of medications decreased to between 0.2 and 0.6, without substantial diminution of effect.
  - The mean decrease from the number of medications at screening throughout 24 months of postoperative evaluation ranged from 1.1 to 1.5, with a mean decrease of  $1.1 + 0.8$  at month 24 (P < 0.0001).

## DISCUSSION

- In the present study, the implantation of the stent in combination with the extraction of cataract and implantation of an IOL resulted in a statistically significant mean IOP reduction of  $5.1 \pm 4.2$  mmHg (P<0.001).
- This reduction in IOP is greater than IOP reductions previously reported for cataract surgery alone.
  - Numerous studies have shown a reduction in IOP after uncomplicated clear corneal phacoemulsification surgery primarily ranging from 2-3 mmHg in eyes that also had glaucoma.<sup>2-4</sup>
- The stent significantly reduced the mean number of medications needed to control IOP at 24 months (1.1 fewer medications, P<0.001) and allowed most patients to completely discontinue all glaucoma medications.
- Implanting the stent via the same small temporal clear corneal incision used to perform phacoemulsification and place the IOL resulted in no additional ocular trauma.
  - In addition, the ab-interno gonioscopic and conjunctival-sparing procedure was less invasive than traditional ab-externo procedures.
- Since this study was conducted, the stent tip design has been modified for ease of entry through trabecular meshwork and ease of insertion through Schlemm's canal, resulting in less trauma to surrounding tissue.
  - The inserter design was also modified to optimize stent release characteristics.
  - Recent studies with the newer design have shown easier insertion and lower rate of stent obstruction and malposition.
- The IOP-lowering efficacy of the stent observed in the present study support earlier theoretical and in vitro work in which Zhou introduced a hypothesis that evaluated the effect of a theoretical channel created through the trabecular meshwork (a trabecular bypass) on the facility of outflow and IOP.
  - Bahler and associates confirmed Zhou's finding in the laboratory when they conducted an in vitro study.
    - The results from placing a single stent was that IOP was lowered from 21.4 mm Hg +/- 3.8 mm Hg to  $12.4 \pm 4.2$  (P<.001). This corresponds to an 84% increase in facility of outflow.<sup>5</sup>

## CONCLUSION

- The stent provided significant reductions in IOP and reduced patient reliance on topical ocular hypotensive medications throughout the follow-up period.
- The amount of IOP lowering exceeded the IOP levels that have been reported by cataract surgery alone.<sup>2-4</sup>
- The stent was well tolerated and biocompatible in patients and most adverse events were related to the surgical procedure.
- iStent® implantation in open-angle glaucoma patients undergoing cataract surgery should be considered as an alternative surgical approach to provide clinically significant reductions in IOP and drug burden.
- While these results are promising, longer-term follow-up and additional clinical studies are warranted and ongoing.

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