Refractory Primary Open-Angle Glaucoma Treated with Ab Interno Canaloplasty (ABiC)

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INITIAL PRESENTATION

Chief Complaint

Elevated intraocular pressure (IOP) left eye

History of Present Illness (HPI)

A 59-year-old male presented with a history of Granulomatosis with Polyangiitis (GPA) - formerly known as Wegener's Granulomatosis, medically-uncontrolled primary open angle glaucoma (POAG), and pathologic myopia. He had previously undergone retinal detachment repair with a scleral buckle and subsequent glaucoma drainage device (GDD) implantation for refractory glaucoma. Over time, both of these developed recurrent erosion with exposure, requiring multiple revisions. At this time, he was referred by an outside provider with an IOP of 31 mm Hg in his contralateral (better seeing) eye on maximum tolerated medical therapy (MTMT).

Past Ocular History

- Pathologic Myopia – both eyes (OU)
- Retinal Detachment 1984 s/p (status post) Scleral Buckle and Cryotherapy right eye (OD) – complicated by subsequent exposure of encircling band
- status post (s/p) Laser-Assisted In-Situ Keratomileusis (LASIK) OU 1990

- Phacoemulsification with intraocular lens implant & Baerveldt Tube 2001 OD – complicated by recurrent erosion
- Cataract left eye (OS)

Past Medical History

- GPA
- Asthma
- Type 2 Diabetes Mellitus
- Hypertension
- History of Tobacco use
- History of bowel perforation

Past Surgical History

- Colostomy

Medications

- Brimonidine three times a day (TID) OS
- Latanoprost every night at bed time (QHS) OS
- Brinzolamide TID OS
- Pilocarpine four times a day (QID) OS
- Vigamox twice a day (BID) OD
- Acetazolamide 250mg by mouth TID
- Erythromycin ointment BID OU
- Prednisone 10mg
- Budesonide
- Metoprolol
- Spironolactone
- Tizanidine
- Acetaminophen-Hydrocodone
- Docusate
- Milk of Magnesium
- Potassium

Allergies

- None

Family History

- Grandmother (Paternal) with Glaucoma

Social History

- Former smoker

Review of Systems

- Negative except as listed in HPI

OCULAR EXAMINATION

Visual Acuity

- Right eye (OD): 20/125, pinhole to 20/70
- Left eye (OS): 20/50, pinhole to 20/25

Ocular Motility

Full both eyes (OU)

Intraocular Pressure

- OD: 8 mm Hg
- OS: 24 mm Hg

Central Corneal Thickness

- OD: 410 microns
- OS: 462 microns

Pupils

- OD: 5 mm in dark, 3 mm in light, no relative afferent pupillary defect (RAPD)
- OS: 4 mm in dark, 3 mm in light, + posterior synechiae (PS), no RAPD

Slit lamp exam

OD

- External/Eyelids: Permanent temporal tarsorrhaphy
- Conjunctiva: tube superotemporally with thin conjunctival coverage. Inferonasal scleral buckle exposed.
- Cornea: Epithelium intact, 3.5 mm (vertical) x 4 mm (horizontal) stromal thinning (80% thickness) inferiorly, inferior stromal neovascularization
- Anterior chamber: deep, no cell or flare, tube superotemporally, embedded in iris but patent
- Iris: Normal architecture
- Lens: Posterior chamber intraocular lens
- Anterior Vitreous: Hazy

OS

- External/Eyelids: Normal
- Conjunctiva: Clear and quiet
- Cornea: Clear, no endothelial pigment or keratic precipitates
- Anterior chamber: slightly shallow
- Iris: inferotemporal peripheral iridectomy patent, trans-illumination defects temporally, poor dilation
- Lens: 2+ Nuclear Sclerosis, broad posterior synechiae temporally
- Anterior Vitreous: clear

Gonioscopy

- OD: no view

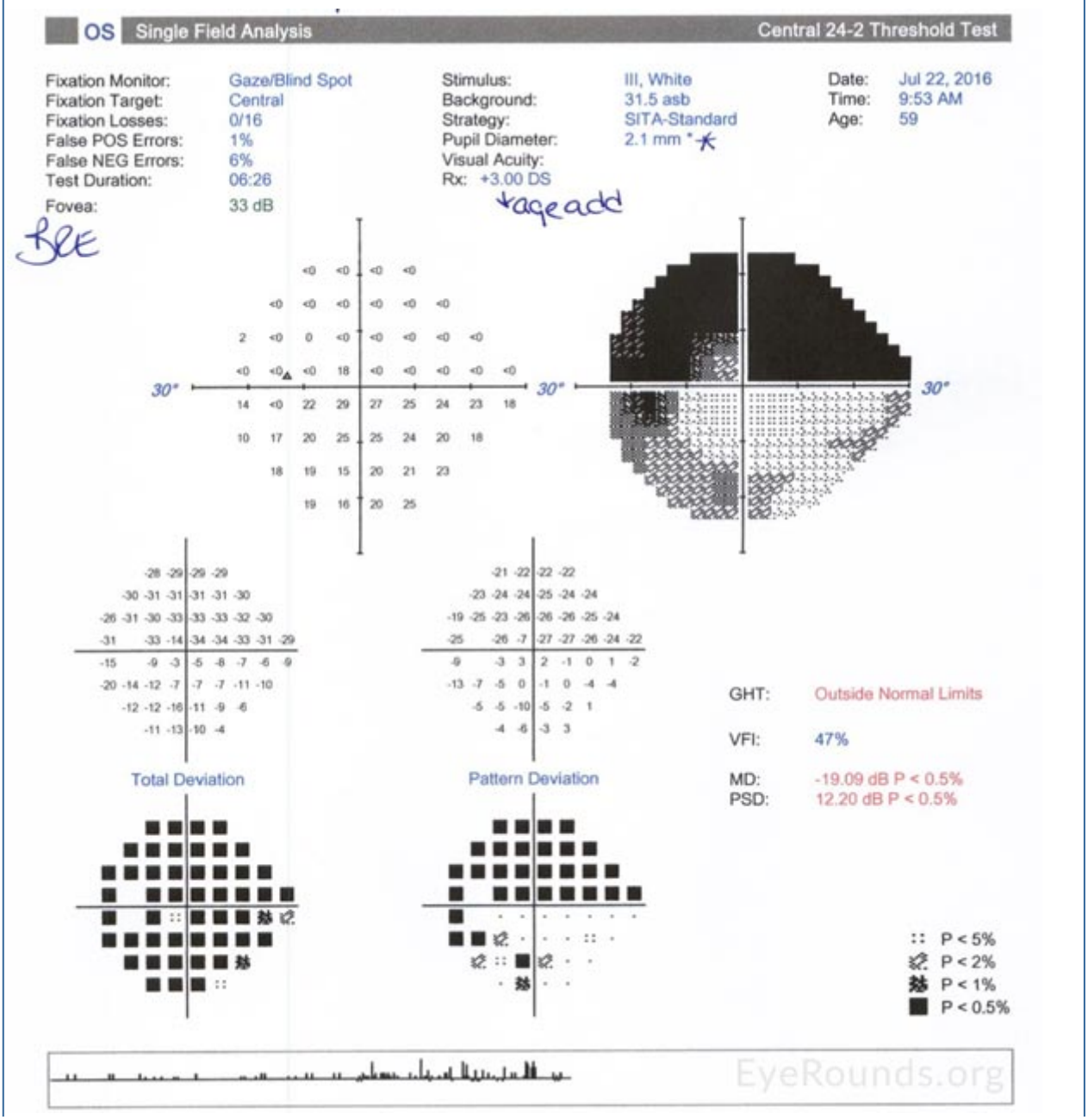
- OS: C(B)30b (Spaeth)* with 1-2+ pigmentation of the trabecular meshwork (*see Spaeth gonioscopic grading system (http://gonioscopy.org/index.php?option=com_k2&view=item&layout=item&id=305&Itemid=884))

Dilated fundus examination (DFE)

- OD: Peripapillary atrophy (PPA), pale, cupped nerve with 0.9 cup to disc ratio
  - Macula: flat
  - Peripheral laser/cryo scars, peripheral cobblestone with scleral buckle.
- OS: PPA, optic nerve with inferotemporal thinning and 0.7 cup to disc ratio
  - Macula: flat
  - Normal macula/vessels/periphery

Additional testing

***Figure 1**. Humphrey visual field 24-2 OS only: Good reliability. Dense superior hemifield loss. Inferior arcuate defect.*



Pre Operative	20/50 sc (without correction)	20/25	24	Brinzolamide Brimonidine Latanoprost Pilocarpine Oral acetazolamide	
Day 1	20/400 sc	20/300	40	Brinzolamide Brimonidine Pilocarpine	3+ RBC with small clot
Week 1	20/40 sc	20/40	08	Brimonidine Pilocarpine	2+ RBC, 1+ WBC, no clot/layering
Week 2	20/40 sc	20/40	10	Brimonidine Pilocarpine	Rare cell, no hyphema
Week 3	20/30 sc	20/25	09	Brimonidine Pilocarpine	Deep and quiet
Week 4	20/40 -2 sc	20/30	10	Brimonidine	Deep and quiet
Week 8	20/25 -2 cc (with correction)	NI	16	Brimonidine Brinzolamide	Deep and quiet

Discussion

Numerous clinical studies have suggested that traditional canaloplasty may be as effective as trabeculectomy at lowering IOP, with a favorable safety profile (1-5). Canaloplasty has several advantages, including its minimally-invasive nature, lack of permanent fistula or bleb, and effective IOP control in patients with mild to moderate open angle glaucoma. This surgery accesses, catheterizes and viscodilates all aspects of the outflow resistance including the trabecular meshwork (TM), Schlemm's canal, and collector channels (6).

ABiC combines the IOP lowering effect of traditional *ab externo* canaloplasty with a newer *ab interno* approach achieved under direct gonioscopic visualization. Similar to the traditional approach, the *ab interno* approach circumferentially catheterizes 360 degrees of Schlemm's canal with the Ellex iTrack illuminated microcatheter. Combined with viscodilation utilizing a viscoadaptive ophthalmic viscosurgical device, this procedure breaks adhesions within the canal, stretches the TM and possibly creates microperforations within the inner wall of the TM (7). This allows the eye's natural outflow system to be restored to the physiologic state instead of creating a bypass route. The initial entry into the eye and canal differ with the *ab interno* approach by creating a clear corneal incision and a small 1-2 clock hour goniotomy in the nasal angle under direct gonioscopic visualization. In contrast, traditional canaloplasty requires conjunctival dissection and formation of a partial thickness scleral flap to unroof Schlemm's canal. It then often utilizes a 9-0 or 10-0 Prolene tension suture to keep Schlemm's canal under tension and therefore patent. No sutures are required in the *ab interno* approach. Furthermore, ABiC allows the surgeon to avoid incising conjunctiva and dissecting a scleral flap, theoretically increasing the ease and success of potential future incisional glaucoma surgeries. So while it is true that *ab externo* canaloplasty is perhaps less invasive than trabeculectomy or tube shunt surgery, ABiC seems more fitting to be considered minimally-invasive glaucoma surgery.

As seen in our video (**Video 1** (http://eyeorunds.org/atlas-video/cataract-surgery-with-viscocanalostomy.htm)), the procedure is currently most easily performed using a flexible illuminated microcatheter through a clear corneal incision. One feature to look for during the operation is episcleral venous blanching during the viscodilation, which indicates an open collector channel system (8).

Safety Profile and Complications

Potential intra-operative complications reported with *ab externo* canaloplasty include inability to cannulate Schlemm's canal, Descemet membrane detachment, and improper microcatheter passage [1,2,9,10]. Post-operatively, this procedure can result in hyphema, cataract formation, IOP spikes and/or hypotony. No choroidal detachments, suprachoroidal hemorrhages, blebitis or bleb-associated endophthalmitis have been reported [11]. Contraindications to *ab interno* canaloplasty might be similar to those for GATT, proposed by Grover *et al.* [12]. These include an unstable intraocular lens, inability to identify angle structures, a closed angle, or severe corneal endothelial compromise. Relative contraindications are prior corneal transplantation or inability to elevate the head 30 degrees for the first 1-2 weeks after surgery. Unlike GATT, one might be able to consider this procedure in patients who are unable to stop anticoagulation or are prone to bleeding, since the meshwork is only dilated instead of torn circumferentially. As such, the primary risk for hyphema results from creation of the nasal goniotomy.

Published Results

Table 2. *Mark J. Gallardo, MD (El Paso Eye Surgeons, PA) and Mahmoud A. Khaimi (Dean McGee Eye Institute, OK) ab-interno canaloplasty all eyes [13]*

Examination	***N***	***Median IOP (mm Hg) ± SD***	***Median Medication (n) ±-SD***
Maximum recorded IOP	*106*	*21.0 ± 5.4*	*2.0 ± 1.0*
Baseline IOP	*106*	*18.0 ± 6.6*	*2.0 ± 1.0*
1 month	*100*	*16.0 ± 5.2*	*0 ± 0.6*
3 months	*48*	*15.0 ±4.5*	*0 ± 1.0*
6 months	*20*	*14.5 ± 2.7*	*0.00 ±1.0*

Table 3. *Mark J. Gallardo, MD (El Paso Eye Surgeons, PA) and Mahmoud A. Khaimi (Dean McGee Eye Institute, OK) Ab-interno canaloplasty with cataract surgery [13]*

Examination	***N***	***Median IOP (mm Hg) ± SD***	***Median Medication (n) ± SD***
Maximum recorded IOP	*68*	*21.0 ± 5.6*	*2.0 ± 1.0*
Baseline IOP	*68*	*17.5 ± 5.1*	*2.0 ± 1.0*
1 month	*63*	*14.0 ± 4.1*	*0.00 ± 0.3*
3 months	*30*	*14.0 ± 3.7*	*0.00 ± 1.0*
6 months	*13*	*12.0 ± 2.6*	*0.00 ± 0.0*

Published case series for ABiC are sparse in the literature as of 2016, the largest having been published by Gallardo and Khaimi. Of 106 patients treated, there was an average IOP decrease of 35% and a 100% drop in glaucoma medications. With combination of cataract surgery, the drop in IOP was 38.4% at 6 months.

Early clinical evidence indicates that ABiC is safe and effective in mild to-moderate POAG with similar IOP-lowering effects compared to traditional canaloplasty. Unlike other MIGS procedures, the viscodilation that accompanies ABiC ensures that all known potential "blockages" in the ocular outflow pathway are addressed, including the ostia of the collector channels.

Summary

This case represents the use of an angle-based glaucoma surgery for the treatment of a 59-year-old patient with open-angle glaucoma and granulomatosis with polyangiitis. His results support the effectiveness and relative safety of this therapy. *Ab-interno* canaloplasty provides the advantage of sparing the conjunctiva for potential future interventions while opening access to Schlemm's canal for 360 degrees, especially in patients who will have high visual demands soon after surgery (and are thus unlikely to tolerate moderate to severe post-operative hyphema with GATT), who are unable to safely stop anticoagulants, or who have known bleeding diatheses.

DIAGNOSIS

Refractory primary open-angle glaucoma treated with *Ab interno* Canaloplasty (ABiC)

Indications	Contraindications
• Medically-uncontrolled primary or secondary open-angle glaucoma • Can be performed with or without concurrent cataract surgery	• Unstable intraocular lens • Inability to identify angle structures • Chronically closed iridocorneal angle/Angle closure glaucoma • Severe corneal endothelial compromise
Complications	**Efficacy [13]**
• Transient hyphema (mild) • Early IOP spike secondary to retained viscoelastic in Schlemm's Canal • Subsequent steroid-Induced elevation of IOP • Cataract formation	• Mean IOP decrease of 7.5 mmHg (35%) with 2 (100%) fewer glaucoma medications used at 6 months in patients undergoing ABiC alone • Mean IOP decrease of 9 mmHg (38.4%) with 2 (100%) fewer glaucoma medications used at 6 months in patients undergoing ABiC with phacoemulsification

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(../cases-i/case247/1-fig-abic-LRG.jpg)

CLINICAL COURSE

There was little doubt that the IOP was too high in his better-seeing eye on maximum tolerated medical therapy, including oral acetazolamide. Given his history of pathologic myopia and recurrent erosions of both his scleral buckle and tube, he was felt to be at high risk for complication with traditional incisional glaucoma surgery. As such, we recommended minimally-invasive glaucoma surgery (MIGS) to spare the conjunctiva, along with phacoemulsification improve vision and maximize his IOP reduction. While many MIGS modalities could be successful in his case, we recommend *ab Interno* canaloplasty (ABiC), primarily to avoid the impact a potentially protracted hyphema from GATT could have on his activities of daily living given his monocular status. After extensive discussion, the patient agreed to proceed, understanding that further incisional surgery could prove necessary if ABiC were not able to be completed safely or failed to adequately lower his pressure. The narrated recording of this surgery can be seen in Video 1 (http://webeye.ophth.uiowa.edu/eyeforum/atlas-video/cataract-surgery-with-viscocanalostomy.htm). (http://webeye.ophth.uiowa.edu/eyeforum/video/Glaucoma/GATT.htm)

Video 1: *Ab Interno Canaloplasty. Daniel I Bettis, Jason Kam*

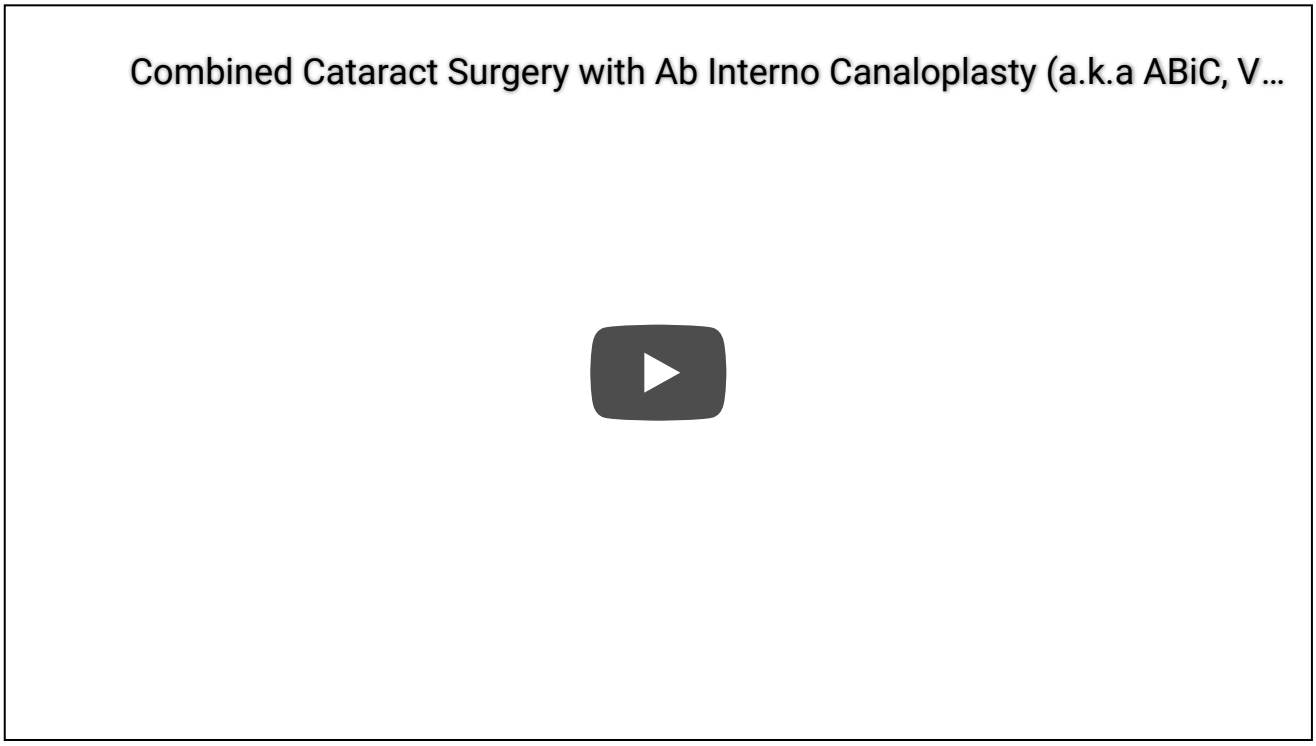

Table 1. *This table outlines the visual acuity and IOP of the post-operative visits for the left eye. On post-operative day 1, there were 3+ RBCs (red blood cells) and a small (<1mm clot inferiorly) with an IOP spike (likely from retained viscoelastic). IOP goal was low teens.*

	Visual Acuity	Visual Acuity Pin hole	IOP	Anti-Glaucoma Medications	Notes

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Suggested citation format

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