

## A novel use of the endoscopic cyclophotocoagulative probe for the management of excisional goniotomy induced chronic recurrent hyphema

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### ABSTRACT

**Purpose:** To describe the management of a case of chronic, recurrent hyphema following excisional goniotomy with the Kahook Dual Blade.

**Observations:** One week following uncomplicated surgery, the patient presented with eye pain, elevated intraocular pressure, and layered hyphema. The hyphema resolved with conservative measures but recurred several times with similar symptoms over the next several months. An attempt to stenose the “oozing” collector channel using the argon laser was unsuccessful. Treatment of the angle with an endoscopic semi-conductor diode laser (endoscopic cyclophotocoagulative or ECP) probe successfully altered the angle preventing further episodes of recurrent hyphema. The primary glaucoma procedure failed necessitating a filtering procedure.

**Conclusions and importance:** Clinician should be aware of this potential complication, its treatment options, and outcomes.

### 1. Introduction

Intraoperative bleeding is common in glaucoma surgery involving incision or excision of the trabecular meshwork (TM), but persistent and/or recurrent hemorrhage is rare. This is a case of chronic, recurrent hyphema following excisional goniotomy performed with the Kahook Dual Blade (New World Medical, Ranch Cucamonga, CA).

### 2. Case report

A 59-year-old Hispanic female was referred to our practice for evaluation and management of uncontrolled primary open angle glaucoma (POAG) in both eyes (OU). She had a history of unmedicated intraocular pressures of 26 mmHg right eye (OD) and 24 mmHg left eye (OS) measured at the referring physicians office. Selective laser trabeculoplasty was performed OU one year prior to referral to our practice, which failed to yield a reduction in intraocular pressure (IOP). Upon presentation to our practice, the best-corrected visual acuity (BCVA) was 20/20 OU and intraocular pressure (IOP) was 21 mmHg right eye (OD) and 22 mmHg left eye (OS) using Goldmann tonometry. The patient reported compliance with her topical therapeutic regimen which included bimatoprost every night (qHS) and timolol/brimonidine twice daily (BID) OU. The patient was intolerant to topical carbonic anhydrase

inhibitors due to burning on instillation. Gonioscopy revealed angles open to the ciliary body 360° with 2+ homogenous pigmentation of the TM OU without goniosynechiae or bridging vessels. There was no blood in Schlemm’s canal. Moderate ocular surface disease was present with 2+ superficial punctate keratopathy. She was pseudophakic with well-centered in-the-bag posterior chamber intraocular lenses OU. Posterior segment evaluation revealed a cup-disc ratio of 0.55 OU with a normal macula, vessels, and periphery. Pachymetry readings were 521 μm OD and 519 μm OS. Automated visual fields showed an early superior arcuate defect OD with a mean deviation (MD) of -6.40 and correlated with the inferior thinning of the retinal nerve fiber layer (rNFL) on ocular coherence tomography (OCT). The visual field in the left eye fluctuated from visit to visit but was relatively intact with non-specific changes and a MD of ranging from -1.50 to -3.30 but did have a glaucoma hemifield test that was “borderline”. The rNFL exhibited thinning in the neural retinal rim OU with apparent progressive thinning OS (Fig. 1), suggesting the presence progressive glaucomatous optic neuropathy.

On the basis of elevated IOP, the clinical appearance of the optic nerve, and early progressive rNFL loss on OCT, it was determined that the patient would benefit from a lower target IOP.<sup>1,2</sup> Options included adding a fourth medication, repeating SLT, or performing an incisional micro-invasive glaucoma surgical (MIGS) procedure. Given the patient

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was suffering from moderate OSD and alternate topical hypotensive agents, including preservative-free medications were not covered by the patients insurance plan, a fourth-medication was excluded. Because of her previously poor response to SLT, the decision was made to perform excisional goniotomy in the left eye. The left eye was chosen for therapy first despite having the better visual field because of the progressive thinning of the rNFL but planned on potential surgical intervention for OU. The procedure has been described previously.<sup>3,4</sup> Upon excision of approximately 3 clock hours of the trabecular meshwork, regurgitation of blood into the anterior chamber through multiple collector channels was observed, as is common with most TM-based angle surgical procedures.<sup>4-9</sup> While evacuating the OVD from the anterior chamber using an irrigation/aspiration (I/A) handpiece, the episcleral vessels in the nasal portion of the globe were noted to blanch, denoting patency of the distal conventional outflow system. The wound was hydrated with balanced salt solution and the anterior chamber was pressurized to approximately 25 mmHg, as measured with a Barraquer tonometer.

The patient was started on a standard post-op regimen of bromfenac 0.07% daily (Prolensa, Bausch and Lomb, Bridgewater, NJ) and moxifloxacin 0.5% four times daily. A microhyphema was present at one day,

which initially cleared, but the patient subsequently experienced intermittent episodes of recurrent micro-hyphema associated elevated intraocular pressures as high as 40 mmHg with concomitant pain and reduction of vision. These episodes were treated with a combination of topical and systemic aqueous suppressants, as well as topical steroids. These episodes occurred following Valsalva activity or when her head was positioned below her heart. On one such occasion, gonioscopy revealed the angle was open to the ciliary body but active emission of blood was observed through a single collector channel (Fig. 2) in the area previously treated with goniotomy. An unsuccessful attempt was made to photocoagulate or induce stenosis of this collector channel with the argon laser using spot sizes of 100–300 μm, power of 200–400 mW, and duration of 0.5 seconds.

Three months following surgery, ongoing hemorrhage with decreased vision, elevated IOP and pain prompted a return to the operating room to attempt to close the collector channel associated with blood regurgitation using the endoscopic cyclophotocoagulation (ECP) probe (Iridex, Mountain View, CA). Intraoperative gonioscopy with pressure applied to the nasal aspect of the globe revealed blood emerging from multiple collector channels (Fig. 3). The blood was

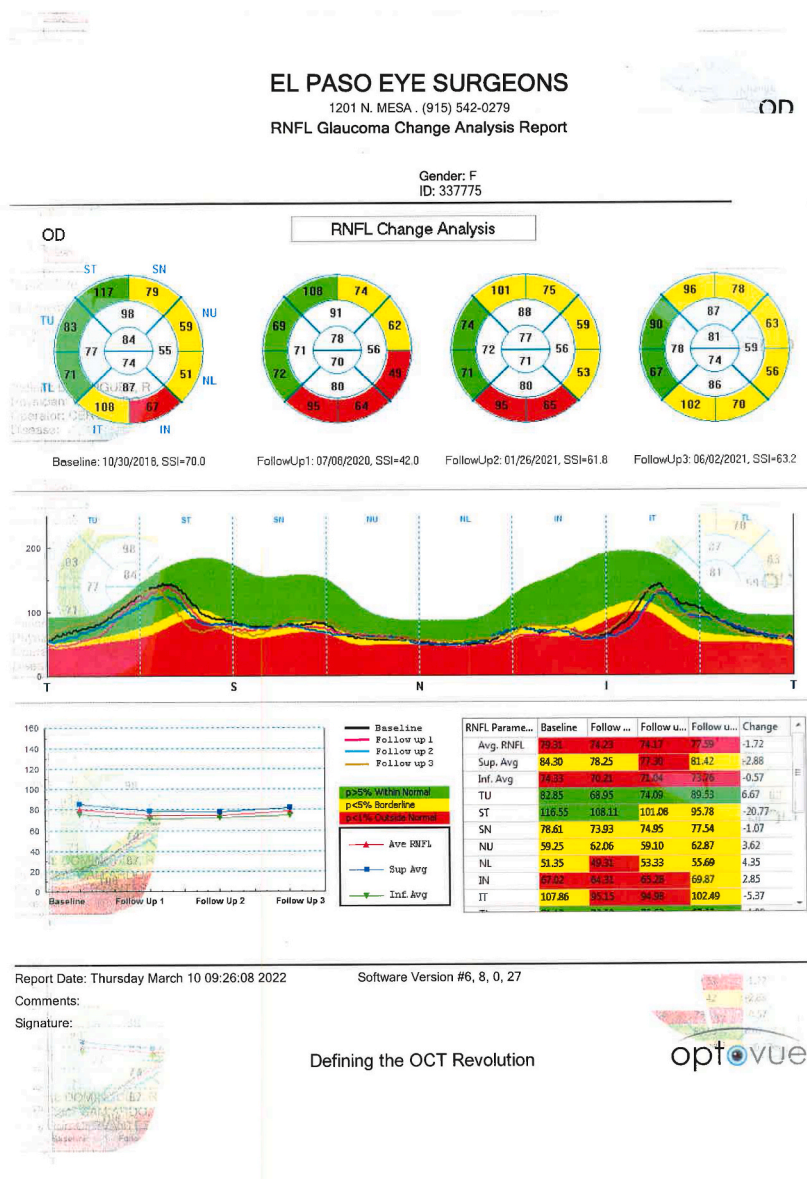
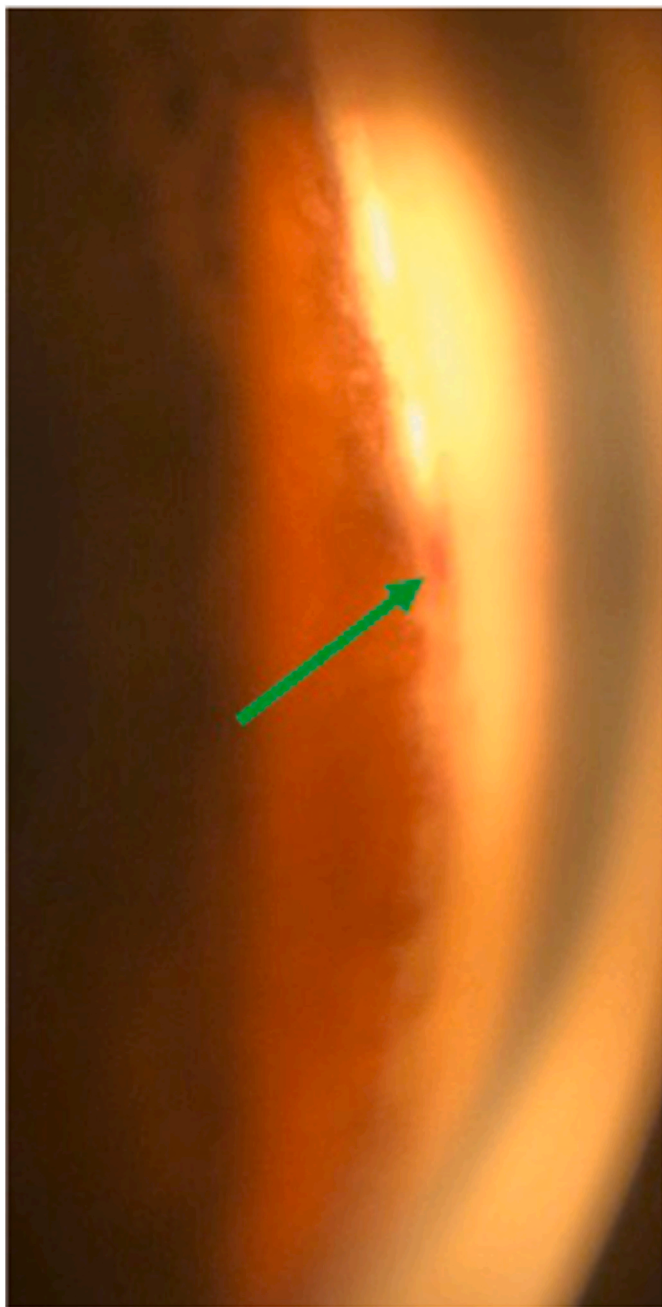
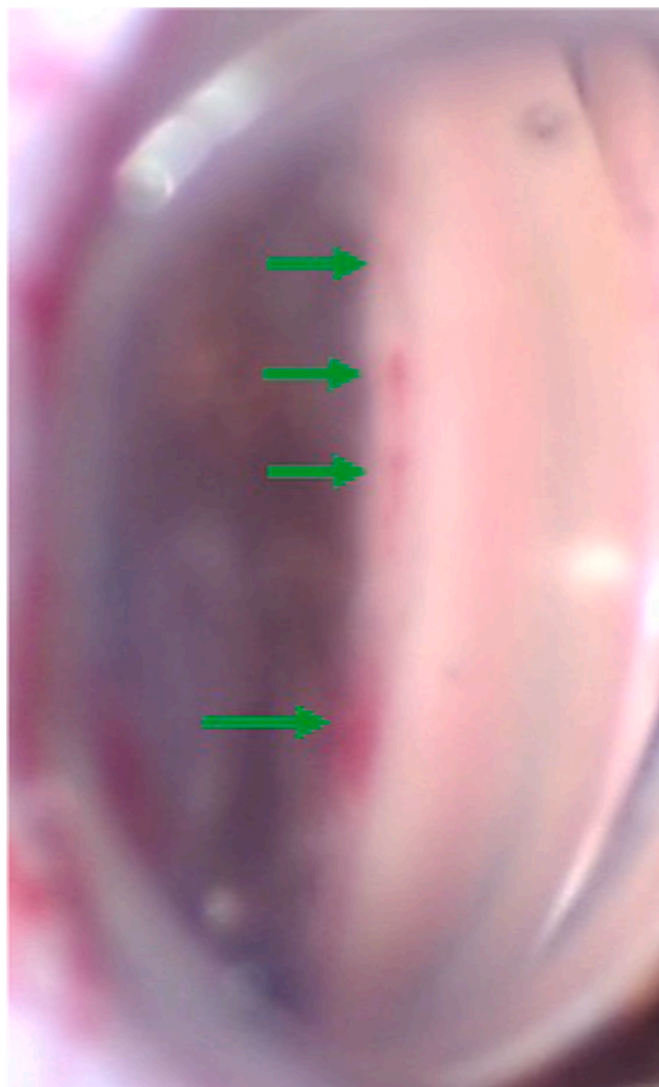


Fig. 1. OCT showing progressive thinning of the mean rNFL.



**Fig. 2.** Blood reflux through collector channel during recurrent hyphema episode.

cleared from the angle and the anterior chamber was pressurized using a dispersive ophthalmic viscosurgical device (Viscoat, Alcon Laboratories, Fort Worth, TX), to tamponade the regurgitating collector channels. The ECP probe was then used to apply thermal energy to the nasal angle in the area of the denuded canal. No overt shrinkage of the angle structures was observed though bubbles were seen in the angle following laser application. The laser was set to continuous wave with an energy setting of 250 mW. The probe placed approximately 0.5 mm away from the angle and the aiming beam was focused directly on the open collector channels emitting blood. The laser was applied for approximately 1.5 seconds. Care was taken to avoid direct laser exposure to corneal endothelial cells by ensuring the aiming beam was posterior to Schwalbe's line. Residual viscoelastic was removed using the I/A hand-piece with no visible ongoing blood regurgitation was seen. Upon wound hydration, the eye was pressurized to approximately 25 mmHg, which



**Fig. 3.** Blood reflux through collector channels into the anterior chamber upon intraoperative pressure gonioscopy prior to angle treatment with ECP probe.

was measured using a Barraquer tonometer. On the first postoperative day, 1+ circulating RBCs were noted; these resolved during the first postoperative week without further recurrence. However, the IOP remained above target, despite being restarted on all pre-operative topical medications and the patient required a filtration procedure (Xen45 gel stent implant, Allergan, Dublin, Ireland) to maintain IOP control. No episodes of recurrent hyphema have occurred since treatment with the ECP probe.

### 3. Discussion

Minimally invasive glaucoma surgeries (MIGS) have been developed over the past several years to fill the unmet need for a safe surgical procedure for patients with mild to moderate POAG who would benefit from modest reductions in IOP and/or the need for IOP-lowering medications without the risks associated with traditional filtering procedures such as trabeculectomy or tube-shunt implantation.<sup>10-14</sup> As many MIGS procedures are now coupled with cataract surgery, both safety and rapid visual recovery become important considerations.<sup>15</sup>

Transient blood reflux into the anterior chamber following goniotomy/trabeculotomy procedures has been well documented and, in fact, is so common as to be considered an "expected" occurrence in the early post-op period. Blood reflux has been reported in virtually all of the

MIGS devices in this category, including excisional goniotomy with the KDB,<sup>3,4</sup> trabecular ablation (Trabectome, Microsurgical Technology, Redmond, WA),<sup>5</sup> gonioscopy-assisted transluminal trabeculotomy,<sup>9</sup> and combined viscodilation/trabeculotomy using the OMNI surgical system (Sight Sciences, Menlo Park, CA).<sup>9</sup> In some cases, the occurrence of intraoperative blood is ubiquitous, as evidenced by a 100% incidence in a series of 115 eyes undergoing Trabectome surgery; all cases cleared within 7 days.<sup>16</sup> Prospective randomized controlled trials have not been reported for OMNI or KDB. In a non-randomized case series of an OMNI predicate device (Trab360), the incidence rate for hyphema was 50.6%, with an average time to resolution of 36 days.<sup>17</sup> In one non-randomized case series of KDB, the incidence rate of blood reflux was 30.8% and described by the authors as “expected with unroofing of several collector channels”.<sup>18</sup> In another case series comparing KDB to iStent, blood reflux was described as “an expected component of angle surgery”, although the rate was substantially higher following KDB (19.8%) than iStent (4%).<sup>19</sup> Persistence of blood beyond the first postoperative week, frank layered hyphema, and/or recurrent active bleeding are uncommon following these MIGS procedures. In a series of 262 eyes undergoing Trabectome surgery, 12 cases of delayed-onset hyphema (4.8%) were reported, occurring an average of 8.6 months (range 2–31 months) postoperatively; all but one resolved spontaneously, with the exception being one case that required trabeculectomy for IOP elevation recalcitrant to medical therapy (and which notably recurred 6 months post-trabeculectomy).<sup>20</sup>

Postoperative hyphema is less common following implantation of trabecular bypass stents. In the pivotal HORIZON clinical trial for Hydrus (Ivantis, Irvine, CA) the incidence of significant postoperative hyphema was only 0.5% in both the Hydrus + Phaco cohort and the Phaco Only cohort.<sup>8</sup> Post-operative hyphema was not listed among the adverse events in the publications for the pivotal trials for iStent and iStent inject, so the rates were not reported. In terms of delayed onset or recurrent hyphemas, only two cases have been reported following trabecular microbypass (iStent, Glaukos, San Clemente, CA) implantation. The first had onset 6 months postoperatively, was associated with device malposition and medically-uncontrolled IOP elevation, and required explantation.<sup>21</sup> The second occurred 13 months postoperatively with a recurrence at 19 months and was managed conservatively.<sup>20,22</sup> Delayed hyphema following trabeculectomy has also been reported.<sup>20,23</sup>

#### 4. Conclusions

As this case and those reviewed above demonstrate, procedures that incise or excise the TM substantially as a means of increasing aqueous outflow pose the risk of persistent, delayed, and/or recurrent hyphema, while in procedures in which a device is implanted through a microgoniotomy such events are exceedingly rare or unreported. Some cases of recurrent hyphema are associated with reductions in visual acuity, increases in IOP, or both. Treatment for these cases may be conservative—topical and/or oral IOP-lowering medications—but some eyes will require surgical intervention. In this reported case, the novel application of ECP successfully “cauterized” the collector channels that were emitting blood from the downstream episcleral system after argon laser therapy failed. Clinicians should be aware of this uncommon complication and the options available for—and outcomes associated with—its management.

#### Patient consent

Consent to publish the case report was not obtained. This report does not contain any personal information that could lead to the identification of the patient.

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#### Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

#### Declaration of competing interest

Glaukos, Ivantis, Sight Sciences, Nova Eye, Allergan: Consultant, speaker and clinical investigator. New World Medical Clinical: Investigator.

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#### References

1. Abu SL, Marín-Franch I, Racette L. Detecting progression in patients with different clinical presentations of primary open-angle glaucoma. *J Glaucoma*. 2021;30:769–775.
2. The Advanced Glaucoma Intervention Study (AGIS): 7. The relationship between control of intraocular pressure and visual field deterioration. The AGIS Investigators. *Am J Ophthalmol*. 2000 Oct;130(4):429–440.
3. Berdahl JP, Gallardo MJ, ElMallah MK, et al. Six-month outcomes of goniotomy performed with the Kahook dual blade as a stand-alone glaucoma procedure. *Adv Ther*. 2018;35(11):2093–2102.
4. Greenwood MD, Seibold LK, Radcliffe NM, et al. Goniotomy with a single-use dual blade: short-term results. *J Cataract Refract Surg*. 2017;43(9):1197–1201.
5. Minckler D, Mosaed S, Dustin L, Ms BF. Trabectome (trabeculectomy-internal approach): additional experience and extended follow-up. *Trans Am Ophthalmol Soc*. 2008;106:149–159. discussion 159–160.
6. Samuelson TW, Sarkisian Jr 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: two-year results. *Ophthalmology*. 2019;126(6):811–821.
7. 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(1):29–37.
8. Grover DS, Godfrey DG, Smith O, Feuer WJ, Montes de Oca I, Fellman RL. Gonioscopy-assisted transluminal trabeculotomy, ab interno trabeculotomy: technique report and preliminary results. *Ophthalmology*. 2014;121(4):855–861.
9. Brown RH, Tsegaw S, Dhamdhare K, Lynch MG. Viscodilation of Schlemm canal and trabeculotomy combined with cataract surgery for reducing intraocular pressure in open-angle glaucoma. *J Cataract Refract Surg*. 2020;46(4):644–645.
10. Richter GM, Coleman AL. Minimally invasive glaucoma surgery: current status and future prospects. *Clin Ophthalmol*. 2016;10:189–206.
11. Lavia C, Dallorto L, Maule M, Ceccarelli M, Fea AM. Minimally-invasive glaucoma surgeries (MIGS) for open angle glaucoma: a systematic review and meta-analysis. *PLoS One*. 2017;12(8), e0183142.
12. Pillunat LE, Erb C, Junemann AG, Kimmich F. Micro-invasive glaucoma surgery (MIGS): a review of surgical procedures using stents. *Clin Ophthalmol*. 2017;11:1583–1600.
13. Chen DZ, Sng CCA. Safety and efficacy of microinvasive glaucoma surgery. *J Ophthalmol*. 2017;2017, 3182935.
14. Gedde SJ, Herndon LW, Brandt JD, Budenz DL, Feuer WJ, Schiffman JC. Postoperative complications in the Tube versus Trabeculectomy (TVT) study during five years of follow-up. *Am J Ophthalmol*. 2012;153(5):804–814.
15. Saheb H, Ahmed II. Micro-invasive glaucoma surgery: current perspectives and future directions. *Curr Opin Ophthalmol*. 2012;23(2):96–104.
16. Jea SY, Francis BA, Vakili G, Filippopoulos T, Rhee DJ. Ab interno trabeculectomy versus trabeculectomy for open-angle glaucoma. *Ophthalmology*. 2012;119(1):36–42.
17. Sarkisian SR, Mathews B, Ding K, Patel A, Nicek Z. 360° trabeculectomy in refractory primary open-angle glaucoma. *Clin Ophthalmol*. 2019;13:161–168.
18. Dorairaj SK, Seibold LK, Radcliffe NM, et al. *Adv Ther*. 2018;35:1460–1469.
19. ElMallah MK, Seibold LK, Kahook MY, Williamson BK, Singh IP, Dorairaj SK. 12-Month retrospective comparison of Kahook dual blade excisional goniotomy with iStent trabecular bypass device implantation in glaucomatous eyes at a time of cataract surgery. *Adv Ther*. 2019;36:2515–2527.
20. Ahuja Y, Malihi M, Sit AJ. Delayed-onset symptomatic hyphema after ab interno trabeculectomy surgery. *Am J Ophthalmol*. 2012;154(3):476–480. e472.

21. Khouri AS, Megalla MM. Recurrent hyphema following iStent surgery managed by surgical removal. *Can J Ophthalmol*. 2016;51(6):e163–e165.
22. Sandhu S, Arora S, Edwards MC. A case of delayed-onset recurrent hyphema after iStent surgery. *Can J Ophthalmol*. 2016;51(6):e165–e167.
23. Olayanju JA, Hassan MB, Hodge DO, Khanna CL. Trabeculectomy-related complications in Olmsted County, Minnesota, 1985 through 2010. *JAMA Ophthalmol*. 2015;133(5):574–580.