AGS 2020 Poster Schedule

Poster abstracts are available online at www.americanglaucomasociety.net.

THURSDAY, FEBRUARY 27
7:00 AM – 8:00 AM  Poster Presentation Session (1-46)
7:00 AM – 5:00 PM  Poster viewing (1-46)

FRIDAY, FEBRUARY 28
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7:00 AM – 5:00 PM  Poster viewing (47-104)

SATURDAY, FEBRUARY 29
7:00 AM – 8:00 AM  Poster Presentation Session (105-151)
7:00 AM – 4:05 PM  Poster viewing (105-151)

THURSDAY, FEBRUARY 27
Minimally Invasive Glaucoma Surgery (MIGS)

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FRIDAY, FEBRUARY 28

Traditional Surgery, Sustained Delivery, New Drugs, IOP Evaluation

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**SATURDAY, FEBRUARY 29**

**VF, Imaging, Diagnostics, Social/Financial/Personal Determinants of Health**

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Minimally Invasive Glaucoma Surgery (MIGS)

Outcomes of Iridex MicroPulse P3 (MP3) with Higher-Than-Usual Settings for the Management of Elevated Eye Pressure

NANDITA ANAND1, Abraham Nirappel1, Emma Klug, Marika Chachanidze, David Sola-Del Valle
1 Massachusetts Eye & Ear

Purpose/Relevance
To highlight outcomes of MP3 laser with higher-than-usual settings (at least 180 seconds per hemisphere using 2000-2400 mW in power) as well as a mix of sweeping and stop-and-continue techniques by reporting early and late postoperative intraocular pressure (IOP), visual acuity, number of IOP-lowering medications, and complications rates.

Methods
A retrospective chart review of patients who underwent MP3 at Massachusetts Eye and Ear (MEE) under one provider from January 2017 to August 2019 was conducted. Preoperative baseline characteristics including visual acuity and baseline IOP were recorded. Patients were followed postoperatively to assess long-term IOP reduction, visual acuity, glaucoma medication burden, and complication rates. Paired t-tests were used to check if there were significant changes in visual acuity from the pre-op visit at any of the follow-up visits. Paired t-tests were also used to assess the changes in glaucoma medication burden over time.

Results
A total of 57 patients were included in the study. At the 6-week follow-up visit, 48% of patients achieved at least a 50% reduction in preop IOP and 66% of patients achieved at least a 20% reduction. At the 6-month follow-up visit, 43% of patients maintained at least a 50% IOP reduction while 66% of patients maintained at least a 20% IOP reduction. At 1 year, 24% of patients maintained at least a 50% reduction while 58% percent of patients maintained at least a 20% reduction in IOP. Of the 57 patients, 2 (3.5%) had cystoid macular edema following the procedure and 2 (3.5%) of the patients had fibrin formation. Both these complications resolved by the 3-month follow-up visit with no long-term sequelae. There were no significant changes in the visual acuity following the procedure at any of the follow-up visits. There were significant decreases in the glaucoma medication burden postoperatively at both the 6-week and 1-year follow-up visits (P < .001).

Discussion
Using higher-than-usual settings with the Iridex MP3 laser along with a mix of sweeping and stop-and-continue techniques may be of value for the management of increased eye pressure. The long-term IOP reduction and complication rates observed seem to compare favorably to studies examining MP3 done under more traditional settings.1,2 This IOP reduction persists in the majority of patients up to 1 year and may help decrease medication burden.

Conclusion
Higher-than-usual Iridex MP3 settings as well as a mix of sweeping and stop-and-continue techniques may achieve improved IOP reduction and decrease medication burden in patients with a favorable safety profile.

References
2 Sustained Five-Year Safety and IOP Outcomes in Open-Angle Glaucoma Subjects Treated with Trabecular Micro-Bypass Stents (iStent Inject)

JASON BACHARACH
North Bay Eye Associates, Inc.

Purpose/Relevance
To prospectively evaluate long-term performance of second-generation trabecular micro-bypass stents (iStent inject®) implanted as a standalone procedure in eyes with open-angle glaucoma (OAG) not controlled on 1 ocular hypotensive medication.

Methods
This 5-year controlled, prospective, single-arm study enrolled subjects with OAG and preoperative intraocular pressure (IOP) of 18-30 mmHg on 1 medication and 22-28 mmHg after washout. All subjects underwent implantation of 2 iStent inject stents as a standalone procedure. Assessments through Month 60 (M60) included IOP, medication burden, adverse events, visual acuity, visual field, and findings from slit-lamp, gonioscopy, and fundus/optic nerve examinations.

Results
All subjects (n = 57) underwent successful iStent inject implantation as a standalone procedure and completed 60M follow-up. Preoperatively, mean IOP on a single medication was 19.5 ± 1.5 mmHg and unmedicated (post-washout) IOP was 24.4 ± 1.3 mmHg. At all visits through M60, mean IOP was ≤14.6 mmHg. At M60, mean IOP was 12.9 mmHg (34% and 47% reduced vs. preoperative medicated and unmedicated IOPs, respectively; P < 0.0001 for both). At M60, of med-free eyes, 91% of eyes achieved IOP ≤18 mmHg and 91% had IOP reduction ≥20% vs. preoperative washout IOP. All but 4 eyes were not on medications at M60. Favorable safety included no intraoperative or device-related AEs, visual acuity of 20/40 or better in 93% of eyes, and stable cup-to-disc ratio and visual fields.

Discussion
In this prospective study of OAG eyes with IOP not controlled on 1 medication, standalone iStent inject implantation resulted in significant, sustained, and safe IOP reductions through 5 years postoperative, with the majority of eyes medication-free.

Conclusion
The study demonstrated an appealing benefit-to-risk profile for iStent inject implantation as a sole procedure, consistent with existing evidence of the safety and effectiveness of this device.

References
**3 Outcomes of Combined Cyclophotocoagulation with Trabecular Meshwork Bypass Minimally Invasive Glaucoma Surgeries in the Treatment of Advanced Open-Angle Glaucoma**

JONATHAN BUTTRAM¹, Morohunranti Oguntoye-Ouma, Kevin Chen, Won Kim

¹ Walter Reed National Military Medical Center

**Purpose/Relevance**

To report on the outcomes of combining cyclophotocoagulation (CPC) with trabecular meshwork bypass minimally invasive glaucoma surgery (TMB-MIGS) in the treatment of advanced open-angle glaucoma.

**Methods**

A retrospective, non-comparative study of a single surgeon’s practice. The CPC techniques used were micropulse transcleral CPC and/or endoscopic CPC (ECP). The TMB-MIGS techniques used were: trabecular bypass stents (iStent, iStent Inject, Hydrus), ab interno trabeculectomy (Kahook Dual Blade, Trabectome), ab interno trabeculotomy (lighted microcatheter, Trab 360, Omni System), and ab interno canaloplasty.

**Results**

In this mixed race group of 41 patients (56% African American, 37% Caucasian, 5% Asian, 2.4% Latino), the average HVF MD was -16.1 dB. 18 (44%) had failed prior glaucoma procedures, including trabeculectomy and/or glaucoma drainage implants. The mean preoperative intraocular pressure (IOP) was 21.6 +/- 6.8 mmHg on 3.4 +/- 1.3 medications. 39 patients had ≥ 1 month follow up with postoperative (postop) IOP of 12.0 +/- 3.7 mmHg (p < 0.01) on 2.0 +/- 1.4 medications. 32 patients had ≥ 6 months follow up with postop IOP of 13.3 +/- 2.2 mmHg (p < 0.01) on 2.3 +/- 1.3 medications. 21 patients had ≥ 12 months follow up with postop IOP of 12.8 +/- 2.4 mmHg (p < 0.01) on 1.9 +/- 1.3 medications (p = 0.10). 20 patients had ≥ 24 months follow up with postop IOP of 12.2 +/- 1.6 mmHg (p < 0.01) on 2.4 +/- 1.2 medications (p = 0.47). 13 patients had ≥ 36 months follow up with postop IOP of 12.1 +/- 2.4 mmHg (p < 0.01) on 2.4 +/- 1.0 medications (p = 1.00). 8 patients had ≥ 48 months follow up with postop IOP of 11.3 +/- 2.0 mmHg (p < 0.01) on 2.7 +/- 1.1 medications (p = 0.52). 11 eyes (26.2%) had complications: rebound iritis (5), fibrinous anterior chamber reaction (2), IOP > 40 mmHg (1), retinal detachment (1), CME (1), hypotony > 1 month (1), peripheral anterior synechiae occlusion (1). 6 failures (15%) required additional surgical intervention managed with glaucoma drainage implants (4), Cypass (1), and phacoemulsification with synechialysis and ECP (1).

**Discussion**

In patients with advanced glaucoma, particularly in those who have already failed GDI or trabeculectomy, few options exist for additional IOP lowering. Using the combination of ECP and TMP-MIGS resulted in statistically significant lowering of IOPs for up to 48 months while maintaining a reasonable safety profile.

**Conclusion**

This study suggests that combining TMB-MIGS and CPC can lead to sustained IOP reduction with a favorable safety profile in patients with advanced open-angle glaucoma including those who have failed traditional glaucoma filtration surgeries.

**References**

4 Long-term Efficacy of Minimally Invasive Glaucoma Surgery in Uveitic and Steroid-Responsive Glaucoma

REBECCA CHEN¹, Jonathan Eisengart
¹ Cole Eye Institute, Cleveland Clinic Foundation

Purpose/Relevance
Minimally invasive glaucoma surgery (MIGS) devices are effective in primary open angle glaucoma, but their role is unclear in uveitic and steroid-induced glaucoma. We investigated the efficacy of gonioscopy-assisted transluminal trabeculotomy (GATT) and Kahook dual blade (KDB).

Methods
This was a retrospective chart review of patients undergoing GATT or KDB surgery by a single surgeon since 2015. Inclusion criteria were age ≥18 years, diagnosis of uveitic and/or steroid-induced glaucoma, and ≥12 months of postoperative follow-up. Comparisons were made using paired or unpaired t-test or chi-square test.

Results
24 eyes of 21 consecutive patients were enrolled, including 66% female with age of 50 ± 17 years (range 18 to 74). Glaucoma subtypes included 4 (17%) eyes steroid-induced, 2 (8%) eyes uveitic, and 18 (75%) eyes with a combined mechanism. 13 eyes underwent GATT and 11 underwent KDB. Preoperative IOP was 27.8 ± 10.2 mmHg on 3.4 ± 1.2 medications. GATT eyes had higher preoperative IOP than KDB eyes (32.3 ± 9.3 vs. 22.5 ± 8.8 mmHg, P = 0.008). There was no difference in preoperative medications or glaucoma distribution between surgery groups.

At 12 months, GATT eyes experienced IOP reduction of -19.8 ± 10.1 mmHg (n = 13; P < 0.001; IOP 12.5 ± 2.6), with reduction of -2.8 ± 1.6 medications (P < 0.001). At 18 months, IOP reduction was -13.5 ± 11.6 mmHg (n = 6; P = 0.02; IOP 14.0 ± 4.0), with reduction of -2.0 ± 1.7 medications (P = 0.02). At 24 months, IOP reduction was -18.3 ± 7.7 mmHg (n = 7, P = 0.007; IOP 11.3 ± 0.60), with reduction of -2.3 ± 1.7 medications (P = 0.006). The most common complication of GATT was hyphema; 1 of 13 patients required surgical washout for hyphema.

At 12 months, KDB eyes experienced IOP reduction of -6.2 ± 7.6 mmHg (n = 11; P = 0.01, IOP 16.4 ± 4.7), with reduction of -1.3 ± 2.0 medications (P = 0.03) at 12 months. At 18 months, IOP reduction was -10.7 ± 10.4 mmHg (n = 7; P = 0.02; IOP 14.0 ± 3.4), with reduction of -1.7 ± 1.7 medications (P = 0.02). At 24 months IOP reduction was -18.3 ± 7.6 mmHg (n = 3; P = 0.03; IOP 11.3 ± 6.0), with reduction of -2.3 ± 2.9 medications (P > 0.05). There were no significant complications associated with KDB.

Compared to KDB eyes, GATT eyes had greater IOP reduction (-19.8 ± 10.1 vs. -6.2 ± 7.6 mmHg, n = 24, P = 0.001), lower postoperative IOP (12.5 ± 2.6 vs. 16.4 ± 4.7 mmHg, P = 0.02), greater reduction in medications (-2.8 ± 1.6 vs. -1.3 ± 2.0, P = 0.02), and fewer medications (0.7 ± 1.1 vs. 1.9 ± 1.4, P = 0.02) at 12 months postoperatively. There was no difference in IOP or medication reduction between GATT and KDB at 18 and 24 months (n = 13 and 10, respectively, P > 0.05).

Discussion
On average, patients experienced 18 mmHg IOP reduction and reduction of 2 medications at 2 years postoperatively with either device. GATT reduced IOP and medications faster than KDB.

Conclusion
Both GATT and KDB are effective surgical treatments for uveitic, steroid-induced, or combined mechanism glaucoma.

Reference
Clinical Outcomes Following a Novel Technique of Sub-Tenon XEN Gel Stent Implantation with Conjunctival Peritomy

ANNA DO1, Joseph Panarelli, Hardik Parikh
1 New York University

Purpose/Relevance
To describe the safety and efficacy of a novel sub-Tenon implantation technique of the XEN 45 Gel Stent (Allergan, Inc., Dublin, Ireland) using an open conjunctival peritomy and ab-externo approach.

Methods
This retrospective study included 30 eyes with glaucoma refractory to maximal medical therapy. All surgeries were performed by one surgeon (JP) at an academic institute.

The study follows the surgical outcomes of a novel surgical technique for XEN 45 Gel Stent implantation: open conjunctival ab externo. The main outcome measures defined complete surgical success as achieving ≥20% IOP reduction from baseline without medications, while qualified success was defined as the same endpoint on medications. Failure was defined as requiring needling or subsequent incisional glaucoma procedure. Intraoperative and postoperative complications were studied.

Results
30 eyes of 27 patients were included in the study. Mean age was 72 ± 8.0 years. Mean preoperative IOP was 27.08 ± 6.9 mm Hg on 3.36 ± 0.81 glaucoma medications. Mean IOP at postoperative month 6 (n = 24 eyes) was 13.3 ± 5.5 mm Hg (P < 0.01) on an average of 0.4 ± 0.8 (P < 0.01) medications. At 12 months (n = 14 eyes) the average IOP was 13.4 ± 2.4 mm Hg (P < 0.01) on an average of 0.2 ± 0.4 (P < 0.01) glaucoma medications. Complete surgical success was achieved in 80% of eyes at the last follow-up visit. One eye required postoperative needling (6.7%), and no eyes required further glaucoma surgery. The common postoperative complications included hypotony, defined as IOP < 5 mm Hg (27%), and transient hyphema (23%) on postoperative day 1.

Discussion
An open conjunctival approach allows for implantation of the Xen Gel Stent beneath the Tenon’s layer, allowing for direct visualization and micro-manipulations as needed to ensure that the distal tip is not entangled in the Tenon’s layer, allowing for higher complete surgical success and lower needling rates. Prospective evaluation to compare this method with conventional implantation will allow for further comparison between the two surgical techniques.

Conclusion
Implantation of the Xen Gel Stent with opening of the conjunctiva is a safe and efficacious procedure to lower IOP with lower needling rates.

References
6 12-Month Outcomes of Stand-Alone Excisional Goniotomy in Mild to Severe Open-Angle Glaucoma

MOHAMMED ELMALLAH
Ocala Eye

Purpose/Relevance
To describe 12-month intraocular pressure (IOP) and medication outcomes following excisional goniotomy as a stand-alone procedure in eyes with mild to severe glaucoma.

Methods
This was a retrospective analysis of data from surgeons at 8 centers (6 US, 2 Mexico). Eyes with mild to severe glaucoma undergoing standalone excisional goniotomy with the KDB Dual Blade (KDB; New World Medical, Rancho Cucamonga, CA) were followed for 12 months postoperatively. Data were collected preoperatively, intraoperatively, and at day 1, week 1, and 1, 3, 6, and 12 months postoperatively. Primary outcomes included reduction in IOP and the number of IOP-lowering medications from baseline through 12 months.

Results
42 eyes were analyzed, of which the majority (86%) had primary open-angle glaucoma; the remainder had pigmentary or exfoliative (12%), or angle closure (2%) glaucoma. The majority of eyes (81%) were classified as having moderate to severe disease and were failing maximal tolerated medical therapy. At baseline, mean IOP was 21.6 (SE 0.8) mmHg and mean number of medications was 2.5 (0.2). Through 12 months postoperatively, mean IOP reductions from baseline to each visit ranged from 4.2 (16.4%) to 6.2 (25.5%) mmHg (p<0.0001 at all time points). Likewise, mean medication reductions at each visit ranged from 0.4 (16.9%) to 0.9 (32.0%) and were significantly lower than baseline at all time points (p value range 0.0003 to 0.028) except at month 12 (p=0.113). Adverse events included 4 IOP spikes (one at day 1, two at week 1 attributed to steroid use, and one at month 3). Six eyes (14%) underwent secondary glaucoma surgeries (two at month 1, two at month 3, one at month 6, and one at month 10) during the 12-month follow up period.

Discussion
86% of eyes, the majority of which had moderate to severe glaucoma, avoided the need for invasive bleb-based glaucoma surgery for one year after undergoing standalone excisional goniotomy with KDB. Statistically significant and clinically relevant reductions in IOP were seen at every time point. Additionally, reduction in mean medication use was significant for the majority of follow-up visits.

Conclusion
Standalone excisional goniotomy with KDB can significantly lower IOP and help avoid or delay the need for more invasive glaucoma surgery among patients with more advanced glaucoma, over the course of a 12-month treatment period.

Reference
Comparison of Clinical Outcomes After Micropulse and Continuous Wave Transscleral Cyclophotocoagulation

MONICA ERTEL1, Cara Capitena Young, Jeffrey Soohoo, Rebecca Epstein, Mina Pantcheva, Jennifer Patnaik, Malik Kahook, Leonard Seibold

1 University of Colorado

Purpose/Relevance
To compare clinical outcomes between micropulse (mpCPC) and continuous wave cyclophotocoagulation (CPC).

Methods
Retrospective chart review was performed on cyclophotocoagulation patients at University of Colorado between 2013 and 2019. All glaucoma subtypes and severities were included. Pediatric patients (age <18 years) and eyes with no light perception vision at baseline were excluded. Outcome measures were intraocular pressure (IOP), number of glaucoma medications, visual acuity (VA), and retreatment. Follow-up information was recorded at day 1, week 1, and months 1, 3, 6, and 12.

Results
54 eyes were included: 30 CPC and 24 mpCPC. A majority of eyes had severe glaucoma in both CPC (79.2%) and mpCPC (83.3%) groups. Mean pre-op IOP was significantly higher in the CPC compared to the mpCPC group (30.1 vs. 22.2 mmHg, respectively, P = 0.002). There was a statistically significant decrease in IOP at all post-operative time points with both CPC and mpCPC. At 12 months, mean IOP was reduced to 15.2 mmHg in the CPC and 13.3 mmHg in the mpCPC group. Mean percent reduction in IOP from baseline was significantly greater in the CPC group at 6 months (42% vs. 11%, P = 0.046) but became similar at 12 months (44% in CPC vs. 34% in mpCPC, P = 0.11). With CPC, there was a significant medication reduction up to 6 months; however, this became nonsignificant at 1 year (P = 0.09). With mpCPC, a significant medication reduction occurred at all time points except 3 and 6 months. Retreatment was required in 7/24 (29%) mpCPC and 5/30 (17%) CPC eyes. In the CPC group, VA was worse at baseline but remained unchanged at each post-op time point. In the mpCPC group, there was an initial decline in VA at post-op day 1, but VA returned to baseline at all other time points.

Discussion
There is limited literature comparing mpCPC and CPC outcomes.1 In this study, mpCPC and CPC resulted in a significant reduction in IOP while offering a reduction in glaucoma drop burden. Neither treatment modality resulted in a reduction of visual acuity. Both mpCPC and CPC required a significant rate of retreatment.

Conclusion
Both mpCPC and CPC are effective options for IOP reduction without vision compromise in patients with severe glaucoma.

Reference
8 Ab Interno Canaloplasty Combined with Phacoemulsification and Ab Interno Canaloplasty Stand-Alone Procedure in Medically Controlled Glaucoma

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1 Oftalmosalud

Purpose/Relevance
To evaluate the efficacy and safety of ab interno canaloplasty combined with phacoemulsification and the ab interno canaloplasty as a stand-alone procedure in patients with medically controlled open angle glaucoma.

Methods
This comparative non-randomized retrospective study evaluated the 12-month outcomes of patients with medically controlled open angle glaucoma who underwent combined phacoemulsification with ab interno canaloplasty and ab interno canaloplasty as a stand-alone procedure. The primary outcome was mean preoperative and postoperative intraocular pressure; the secondary outcomes included the reduction in number of glaucoma medications, visual acuity, and complications.

Results
107 eyes of sixty-three patients were included; intraocular pressure was 16.19 ± 7.92 mmHg and 17.10 ± 6.68 mmHg for the Phaco and ABiC group and the stand-alone ABiC group, respectively at baseline, and 10.84 ± 1.57 mmHg (P < 0.001) and 11.41 ± 1.65 mmHg (P = 0.003), respectively at the 12-month follow-up. Medications decreased from 2.2 ± 1.7 to 0.2 ± 0.6 (P < 0.001) in the Phaco and ABiC group; 82% of eyes were medication free. In the stand-alone ABiC group, medications decreased from 2.7 ± 1.3 to 0.7 ± 1.2 (P < 0.001); 63% of eyes were medication free at 12 months. The difference in IOP and medication reduction in both groups was statistically significant at the 12-month follow-up, without significant differences between the groups. Visual acuity outcomes and complication rates were similar between the 2 groups.

Discussion
Both procedures achieved efficient and safe reduction in intraocular pressure as observed in patients with medically controlled open angle glaucoma at the 12-month follow up. When ab interno canaloplasty is added to phacoemulsification, the mean intraocular pressure is more greatly reduced, but this difference between the interventions is not statistically or clinically significant.

Conclusion
Both groups achieved efficient and safe reduction in intraocular pressure as observed in patients with medically controlled open angle glaucoma at the 12-month follow up. The canaloplasty ab interno was effective at reducing the mean intraocular pressure and glaucoma medications with or without cataract surgery.

Reference
9 Survey of Microinvasive Glaucoma Surgery (MIGS) and Other Glaucoma Surgical Experience Among United States Ophthalmology Residents

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Purpose/Relevance
To assess the glaucoma surgical experience of United States ophthalmology residents during training, including exposure to microinvasive glaucoma surgery (MIGS) and other novel glaucoma surgical techniques.

Methods
A 10-item anonymous web-based questionnaire (Qualtrics) surveying current US ophthalmology residents regarding their experience with glaucoma procedures and practice intentions was emailed to all 120 Accreditation Council for Graduate Medical Education (ACGME)-accredited ophthalmology residency programs for distribution. Responses were collected between January 21 and March 4, 2019. Chi-squared analysis was performed on survey responses.

Results
161 of 1479 US ophthalmology residents responded (11%). 19% of respondents reported intention to subspecialize in glaucoma. Regarding intended management of glaucoma in practice post-training, 16% responded no intended management, 14% medical management only, 47% medical and minimal surgical interventions, and 23% medical and advanced surgical interventions. 118 (73%) reported MIGS experience as primary surgeon during training. The iStent was the most common MIGS technique with which residents reported primary surgical experience during training (58%). 22% of residents intending to surgically manage glaucoma in their practice do not receive any MIGS experience during residency training. Although the likelihood of any primary MIGS experience during residency was not significantly different by region (p = 0.16), anticipated primary MIGS procedure volume varied significantly by geographic region (p = 0.037).

Discussion
Despite the increasing utilization of novel MIGS procedures, there is currently no ACGME standard for minimum required experience with these techniques during ophthalmology residency1. It is unknown to what degree US ophthalmology residents are exposed to these techniques during training or how experience varies nationwide, as these procedures are not currently tracked in trainee case logs. This study demonstrates that the degree of experience with MIGS techniques during residency training varies significantly.

Conclusion
Despite a majority intending to surgically manage glaucoma in their practice post-residency, a significant number of US ophthalmology residents receive minimal or no MIGS experience during training. Glaucoma surgical training varies by geographic region.
References

10 The Effect of Iris Color on Outcomes of Micropulse Cyclophotocoagulation in Adult Glaucoma Patients at One Year

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Purpose/Relevance
Micropulse transscleral cyclophotocoagulation (mTSCPC), unlike traditional cyclophotocoagulation, causes minimal inflammation and ischemic insult to the ciliary body, thereby posing significantly lower risks of hypotony or inflammation-related complications. However, its long-term safety and efficacy, and possible variables on its outcome such as iris pigmentation, is lacking in current literature. Evaluating the relationship between iris pigmentation and long-term outcomes will help optimize and individualize treatments to lower IOP.

Methods
Retrospective review of 95 eyes of 81 adult glaucoma patients who received mTSCPC at University of Missouri, Columbia, Missouri, were included. Patient’s IOP, medications, visual acuity, complications, adverse events, and additional IOP-lowering procedures were collected preoperatively and postoperatively on day 1, week 1, and months 1, 3, 6 and 12. Patient’s iris color was collected via over-the phone subjective questions. The primary outcome was procedural success defined by ≥20% IOP or ≥1 medication reduction without additional IOP-lowering procedures at 1 year. Secondary outcomes were percentage of patients who achieved IOP ≤18 mmHg, mean IOP and medication reduction, time to additional glaucoma procedure, any complications, and relationship between iris color and successful outcome at 1 year.

Results
At 1 year, 72.3% (47/81) of eyes had achieved success criteria. 57.6% (38/66) of all eyes achieved an IOP ≤18 mmHg. Mean IOP was significantly (P < 0.002) reduced from 23.8 ± 7.8 mmHg preoperatively to 18.3 ± 6.5 mmHg at 1 year. Mean ± SD medication number did not significantly decrease (P < 0.136) from 2.9 ± 1.2 at baseline to 2.7 ± 1.3 at 1 year. 56.8% (54/95) of eyes required either a repeat mpCPC treatment or additional glaucoma intervention. There was an estimated mean time to additional procedure of 366.4 ± 32.3 days (SEM). Iris color was not significantly associated with success at 1 year (P = .308). There was no procedure-related complication in this study cohort.

Discussion
Patients with a variety of glaucoma types and severity achieved significant IOP reduction 1 year after receiving mTSCPC. Over half of the patients were able to achieve 1-year IOP of ≤18 mmHg following mTSCPC. Success rates increased in the follow-up period after the procedure. 53.8% and 72.3% of patients achieving success at 6 months and 1 year, respectively.

Conclusion
mTSCPC appears to be a safe and effective non-invasive means to lower IOP for refractory glaucoma patients. Our study demonstrates that although need for repeat procedure is high within 1 year, complication is extremely rare. Iris colors do not seem to affect outcomes of the procedure, and no special adjustment in energy settings may be necessary to achieve successful outcomes.

References
II Initial Outcomes of Combined Phacoemulsification with Endocyclophotocoagulation with and Without Ab Interno Trabeculotomy in Open-Angle Glaucoma

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Purpose/Relevance
To evaluate and compare the efficacy and safety of combined phacoemulsification and endocyclophotocoagulation with and without ab interno trabeculotomy in patients with uncontrolled open angle glaucoma.

Methods
This comparative non-randomized retrospective study evaluated the 12-month outcomes of patients with uncontrolled open angle glaucoma who underwent combined phacoemulsification with endocyclophotocoagulation and ab interno trabeculotomy (group I) vs. phacoemulsification with endocyclophotocoagulation (group II). The primary outcome was mean preoperative and postoperative intraocular pressure; the secondary outcomes included the reduction in number of glaucoma medications, visual acuity, reported complete, qualified success or failure, and complications.

Results
Forty-six eyes of 36 patients were included; intraocular pressure was $16.96 \pm 3.66$ mmHg and $15.64 \pm 4.88$ mmHg for group I and group II ($P = 0.122$) respectively at baseline, and $11.44 \pm 2.15$ mmHg and $12.45 \pm 1.90$ mmHg, respectively ($P = 0.031$) at the 12-month follow-up. The complete success rate was 56% in group I and 55% in group II; the qualified success was 93% ($P = 0.011$) and 91% ($P = 0.011$), respectively. Medications decreased from $2.0 \pm 1.4$ to $0.8 \pm 1.0$ ($P < 0.001$) in group I and $1.5 \pm 1.3$ to $1.0 \pm 1.5$ in group II ($P = 0.032$). There was similar improvement in visual acuity in both groups. Complications were mild and resolved without intervention.

Discussion
ECP and ab interno trabeculotomy are complementary treatments in patients with chronic open angle glaucoma used to reduce aqueous humor production in order to control IOP; both procedures are easily performed when combined treatment with cataract surgery is also needed through the same clear corneal incision. This study found a clinically significant difference in reduction of IOP at the 9- and 12-month follow-up in patients with moderate chronic open angle glaucoma when trabeculotomy was added to a combination of phacoemulsification and ECP, with a very safety profile.

Conclusion
Both procedures achieved efficient and safe reduction in intraocular pressure as observed in patients with uncontrolled open angle glaucoma at the 12-month follow-up. When ab interno trabeculotomy is added to phacoemulsification and endoscopic cyclophotocoagulation, the mean intraocular pressure is more greatly reduced, and this difference between the interventions is clinically significant.

References
Effect of Pre-randomization Glaucoma Medication Washout on Intraocular Pressure in the COMPASS and HORIZON Trials

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Purpose/Relevance
To assess the effectiveness of topical ocular hypotensive medications in a large group of patients with open-angle glaucoma, and to extend the results of a previously published study1 by incorporating an independent complementary dataset.

Methods
Included were cohorts from the pre-randomization phases of two prospective, multicenter, interventional, randomized clinical trials—the COMPASS study of the Cypass® micro-stent2 and the HORIZON study of the Hydrus® micro-stent.3 In total, 1400 subjects (1400 eyes, 781 from HORIZON and 619 from COMPASS) with primary open-angle glaucoma who were using from 0 to 4 classes of topical ocular hypotensive medication underwent Goldmann applanation tonometry before and after a protocol-defined washout period.

Results
The mean (SD) age of subjects was 70.7 (8.0) years, and 55.6% were female. Prostaglandin analogues were used by 74.8% of subjects, beta blockers by 38.0%, alpha adrenergic agonists by 22.6%, and carbonic anhydrase inhibitors by 18.6%. The mean treated IOP for patients using 0 (n = 102), 1 (n = 703), 2 (n = 354), 3 (n = 214), or 4 (n = 27) medications was 24.2 (3.2), 17.7 (3.3), 17.4 (3.2), 17.5 (3.4), and 16.8 (4.0) mmHg. The mean change in IOP after washout was 0.2 (2.8), 5.7 (3.3), 6.9 (3.7), 8.8 (5.0), and 9.4 (4.2) mmHg, representing an IOP rise of 0.0 (11.8), 34.5 (23.6), 42.5 (26.7), 53.3 (32.4), and 60.0 (33.8) percent (P < 0.001, one-way ANOVA). Changes in IOP with medication washout were similar between the HORIZON and COMPASS cohorts. No statistically significant difference in IOP rise following washout was detected among individual prostaglandin analogues in patients on monotherapy for whom specific prostaglandin analogues were known (n = 329).

Discussion
IOP change following medication washout approximates real-world effectiveness by minimizing Hawthorne effect adherence inflation. Two independent clinical trial cohorts show similar levels of dose-dependent IOP elevation upon medication washout.

Conclusion
Cessation of topical ocular hypertensive medications results in a dose-dependent increase in IOP in treated open-angle glaucoma patients.

References
13 Three-Year Follow-Up of Ab-Interno Canaloplasty with iTrack Catheter: A Large, Single-Center Retrospective Review

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Purpose/Relevance
Ab-interno canaloplasty (ABiC) has been shown to effectively increase aqueous outflow through Schlemm’s canal and distal collector channels via iTrack catheter-guided viscodilation. It offers a less invasive and more efficient surgical alternative to traditional canaloplasty. Our study aims to evaluate the sustained intraocular pressure (IOP) and medication reduction offered by ABiC over a 36-month period at a single institution.

Methods
Our study is a non-randomized, retrospective chart review of the long-term surgical outcomes of ABiC performed by attending physicians, fellows and residents at the Dean McGee Eye Institute in Oklahoma City, OK. Data ranges from January 2013 to September 2017. Baseline demographic information, preoperative diagnosis, lens status, and disease burden are reported, in addition to postoperative IOP and medication reduction at 6, 12, 24 and 36 months.

Results
A total of 1110 charts were gathered, and 1013 patients met our study’s inclusion criteria. Of these, 721 cases were performed by attending physicians, 210 by fellows, and 82 by residents. Caucasians represented the most common ethnicity (n = 720, 64.9%), followed by African Americans (n = 171, 15.4%). At 12 months, IOP was reduced from baseline by 15.5% and medication use was reduced from baseline by 60.2%. At 36 months, the effect was sustained (from baseline, 15.3% IOP reduction and 50.0% medication reduction). Furthermore, patients across the entire disease spectrum (as defined by perimetry testing) were able to achieve and maintain 20% IOP reduction off all medications.

Discussion
Our study on the efficacy of ABiC is unique in its number of patients and duration of follow-up. The IOP- and medication-lowering effect of ABiC appears to be sustained, even at 36 months postoperatively. Patients with mild to moderate glaucoma are more likely to achieve greater than 20% of IOP reduction off all medications than those with severe or refractory disease.

Conclusion
Ab-interno canaloplasty (ABiC) is an effective MIGS procedure that offers a sustained reduction in IOP and medication use in glaucoma patients, even at 36 months. The procedure’s safety profile and long-term efficacy makes it an excellent surgical option for every glaucoma specialist.

References
Five-Year Outcomes of 2 Second-Generation Trabecular Micro-Bypass Stents (iStent Inject) Combined with Travoprost in Open-Angle Glaucoma On 2 Preoperative Medications

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Purpose/Relevance
To assess long-term safety and performance following standalone implantation of second-generation trabecular micro-bypass stents (iStent inject®) combined with travoprost in subjects with open-angle glaucoma (OAG) not controlled on 2 preoperative medications. The combination of these 2 treatments target both the trabecular and uveoscleral aqueous outflow pathways.

Methods
This 5-year prospective single-arm study enrolled subjects with OAG on 2 ocular hypotensive medications and with preoperative intraocular pressure (IOP) of 18-30 mmHg (medicated) and 22-38 mmHg (post-washout). All subjects underwent standalone implantation of iStent inject and started once-daily topical travoprost on postoperative Day 1. Annual medication washouts were performed. Assessments included IOP, medications, adverse events, visual acuity, visual fields, and findings from slit-lamp, gonioscopic, optic nerve, and funduscopic examinations.

Results
All 53 enrolled subjects underwent uncomplicated iStent inject implantation and completed 5 years of follow-up. At M60 postoperative, mean IOP on travoprost reduced to 12.1 mmHg, a 39% reduction vs. preoperative IOP of 19.7 mmHg on 2 medications (P < 0.0001). At M61 (after washout), mean unmedicated IOP was 16.1 mmHg, a 35% reduction vs. preoperative washout IOP of 24.9 mmHg (P < 0.0001). Mean medicated IOP remained ≤13.1 mmHg at all postoperative visits through M60. 92.5% of eyes achieved M60 IOP ≤18 mmHg on travoprost, and 88.7% achieved IOP ≤15 mmHg on travoprost. All but 4 subjects were on travoprost alone throughout the course of the study; the 4 subjects required an additional medication. Visual acuity, cup-to-disc ratio, and visual fields remained stable through M60 versus preoperative.

Discussion
In glaucomatous eyes with IOP not controlled on 2 medications, standalone iStent inject implantation and postoperative topical travoprost resulted in sustained 5-year IOP and medication reductions, with favorable safety.

Conclusion
These prospective longitudinal outcomes show safe and sustained improvements in IOP and medications after iStent inject implantation in combination with topical prostaglandin, corroborating the growing evidence base supporting the use of this device to treat glaucoma.

Reference
15 The Efficacy of Two Trabecular Micro-Bypass Stents with Phacoemulsification Surgery Compared to Trabeculectomy with Phacoemulsification Surgery

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Purpose/Relevance
Evaluate the efficacy of intraocular pressure (IOP) lowering, decrease in medication burden, and safety profile in the implantation of 2 trabecular micro-bypass stents (iStent®) placed in conjunction with cataract surgery versus trabeculectomy performed with cataract surgery at two military hospitals between January 1, 2013, and August 14, 2018.

Methods
This is a retrospective comparative study. Primary outcome measures included IOP and glaucoma medication reduction. Secondary outcome measures included adverse events, follow-up visits required by 3 months postoperatively, and subsequent glaucoma surgeries. IOP analyzed using mixed-models approach; Wilcoxon signed-rank test to evaluate medication reduction; and Mantel-Haenszel test to assess medication differences between groups.

Results
Groups statistically equivalent by ethnicity, gender, age, diagnosis, and mean maximum pre-treatment IOP. The Trabeculectomy Group had more severe visual field loss (Humphrey Visual Field mean deviation -12.1 ± 7.2 dB vs. -6.5 ± 7.3 dB) and used more glaucoma medications. Mean preoperative IOP in the iStent® Group (n = 69) was 19.2 ± 2.4 mmHg and at 3 years was 13.9 ± 3.9 mmHg. Preoperative IOP in the Trabeculectomy Group (n = 44) was 18.3 ± 3.0 mmHg and at 3 years was 12.3 ± 3.8 mmHg. Medications in the iStent® Group were 2.3 ± 1.3 preoperatively and 1.6 ± 1.5 at 3 years. Medications in the Trabeculectomy Group were 3.4 ± 1.0 preoperatively and 1.4 ± 1.1 at 3 years. Follow-up visits at 3 months were 4.8 ± 2.1 in the iStent® Group vs. 10.9 ± 2.9 in the Trabeculectomy Group. In the iStent® Group, 11.6% of eyes had adverse events vs. 68.2% of eyes in the Trabeculectomy Group. Additional incisional surgery was required in 2.9% of eyes in the iStent® Group compared to 18.2% of eyes in the Trabeculectomy Group.

Discussion
IOP and medication burdens were significantly lower in both groups at 3 years postoperatively, with no significant difference between groups. In the iStent® group, the mean required follow-up visits at 3 months, adverse events, and required additional surgeries were all significantly lower than the trabeculectomy group.

Conclusion
Two trabecular micro-bypass stents with cataract surgery provides statistically comparable decreases in IOP and medication burden, with a more favorable safety profile and fewer postoperative visits compared to trabeculectomy with cataract surgery.

References
Long-term Outcomes of iStent Trabecular Micro-Bypass Stenting with Cataract Surgery Including VF, OCT, and Disease Progression: Real-World Case Series

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Purpose/Relevance
To assess trabecular bypass stent (iStent™, Glaukos Corporation; San Clemente, USA) with phaco over 5 years of follow-up. Outcomes analyzed include IOP and medication usage as well as structure and function as assessed with VF and OCT. Determination of progression was judged by the surgeon.

Methods
This retrospective case series includes 220 OAG eyes implanted with iStent combined with cataract surgery. Although all eyes have been followed to at least 1 year, a subset have follow-up data out to 5 years. Key data analyzed included IOP, medications, VF, and/or OCT. Progression of disease was assessed by the surgeon using VF and/or OCT outputs.

Results
Mean preop IOP was 16.8 ± 3.8 mmHg on 1.3 ± 0.9 meds (n = 220). Mean postop IOP at 5 years was 14.7 ± 2.8 on 0.6 ± 0.7 meds (n = 35) (P < 0.001, both IOP and meds). As the majority of eyes have reached 3-year postop, the 3-year consistent cohort of 132 eyes was also analyzed (P < 0.001, both IOP and meds). Outcomes from the 3-year consistent cohort revealed similar outcomes. Progression of disease was subjectively determined by the surgeon pre- and post-op VF and OCT outputs. Progression assessed with VF was done in 147 eyes (mean 38 months postop); OCT in 204 eyes (mean 36 months postop), and the combination of both VF and OCT in 117 eyes where data was available. Using VF alone, 90% of eyes were non-progressors. Using OCT alone, 93% were non-progressors. Using both VF and OCT, 98% were non-progressors. Favorable safety was observed, with no significant complications.

Discussion
This study represents a large cohort of eyes treated with iStent with phaco over a significant follow-up period and is the first study to evaluate progression of glaucoma. The study demonstrates the safe and durable IOP and medication reduction of iStent trabecular bypass stenting with cataract surgery over 5 years, consistent with existing clinical evidence. Importantly, both structure and function evaluated using VF and OCT were stable over time, with the majority of eyes deemed to be non-progressors by the surgeon.

Conclusion
Efficacy, safety, and VF and OCT outcomes of combined trabecular bypass stenting with cataract surgery were studied in a real-world practice. Reduction of IOP and medications was sustained out to 5 years. VF and OCT were stable, with a large majority of eyes deemed to have no progression based on surgeon evaluation.

References
17 XEN Gel Stent Insertion in Patients with Failed Trabeculectomy: A Novel Surgical Approach

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Purpose/Relevance
To review a novel surgical technique of ab externo XEN Gel Microstent placement through prior scarred trabeculectomy flap.

Methods
Retrospective case series of 13 patients with trab failure and elevated intraocular pressure (IOP) undergoing ab externo XEN implantation through the trab flap. One surgeon (MRM) performed all procedures in selected patients with scarred trab flaps and overlying mobile conjunctiva (Figure 1). Demographic data, pre-operative drops, prior surgeries, visual acuity, IOP, and qualified success (defined as IOP reduction ≥ 20% with/without topical hypotensive agent) were measured. All patients received a single aqueous suppressant for IOP greater than 8 mmHg akin to protocol for larger glaucoma drainage devices.

Results
13 patients were included, ranging in age from 58 to 92 years (6 Caucasian and 7 African-American). Pre-operative diagnoses included primary open angle (8), chronic angle closure (2), uveitic (1), pigmentary (1), and pseudoxfoliation (1) glaucoma. All patients had prior fornix-based trabeculectomy with MMC in the operative eye. 8 right eyes and 5 left eyes were included. Mean pre-operative logMAR visual acuity measured 0.42 ± 0.36; mean pre-operative drops averaged 2.6 ± 1.12. Mean pre-operative IOP: 26 ± 9 mmHg. Mean post-operative IOPs: day one, 8 ± 6 mmHg (P = 0.002); week one, 10 ± 4 mmHg (P = 0.005); month one, 12 ± 3 mmHg (P = 0.01). At 1 month, blebs were characterized as: elevated (3), moderately elevated (5), low-lying (3), and diffuse (2). At 1 month, mean post-operative logMAR visual acuity was 0.42 ± 0.27 (P = 0.07) and post-operative drops: 0.92 ± 0.64 (P = 0.001).

Discussion
A statistically significant decrease in IOP from baseline was noted at day 1, week 1, month 1, with fewer medications needed at 1 month than baseline (P = 0.0002). There were 3 treatment failures and overall 77% qualified success rate, higher than the 48% qualified success rate of bleb needling with MMC alone. Vision recovered to baseline by 1 week in 46% of patients, 1 month in 77% of patients and with continued improvement in 3 patients at last follow-up.

Conclusion
Placement of XEN via an ab externo approach through a failed trab flap provides significant IOP-lowering effect with minimal conjunctival manipulation and rapid return of vision. Further analysis of longevity of pressure lowering will provide additional insight into this innovative procedure.

Reference
Goniotomy Using the Kahook Dual Blade in Severe and Refractory Glaucoma: One-Year Outcomes

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Purpose/Relevance
To describe efficacy and safety of goniotomy with trabecular meshwork excision using the Kahook Dual Blade (KDB, New World Medical Inc., Rancho Cucamonga, CA) in patients with severe or refractory glaucoma.

Methods
Retrospective multicentric case series of 40 eyes with severe or refractory glaucoma as defined by ICD-10 conducted in the United States, Mexico and Switzerland. Primary efficacy outcome was a 20% or more decrease in intraocular pressure (IOP) from baseline at 12 months. Secondary efficacy outcome measures were probability of achieving an IOP ≤16 or 18 mmHg at 12 months and the mean IOP change from baseline at 12 months. Medication use required to obtain target IOP at last follow-up and adverse events were analyzed.

Results
The proportion of eyes achieving an IOP reduction of more than 20% from preoperative baseline at 12 months was 37.5% (n = 15). The mean IOP decreased from 18.1 ± 5.0 mmHg at baseline to 14.8 ± 3.7 mmHg at 12 months (18.2% reduction, P < 0.001). At 12 months, 67.5% and 82.5% achieved an IOP ≤16 and ≤18 mmHg, respectively, with or without medications. The mean number of glaucoma medications decreased from 2.5 ± 1.4 to 1.7 ± 1.2 (32% reduction, P = 0.002). Intraoperative blood reflux was observed in 32.5% of cases (n = 13), with spontaneous resolution in all cases. No severe complications were reported. One case presented uncontrolled IOP and required glaucoma filtering surgery at 9 months.

Discussion
In this cohort of patients with severe and refractory glaucoma, goniotomy with the KDB significantly reduced IOP and medication use at 12 months, with a low rate of complications.

Conclusion
Goniotomy with trabecular meshwork excision using the KDB could be an alternative surgery for severe or refractory glaucoma before considering more invasive surgery.

References
19 Efficacy and Safety of Micropulse Transscleral Cyclophotocoagulation in Uncontrolled Mild to Severe Glaucoma: A Single-Center Canadian Study

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Purpose/Relevance
Micropulse transscleral cyclophotocoagulation (M-TSCPC) has been shown efficacious in reducing intraocular pressure (IOP).¹ We aimed to evaluate the outcomes related to M-TSCPC in a heterogenous glaucoma population, including eyes refractory to prior glaucoma surgeries.

Methods
In this retrospective case series, eyes with mild to severe glaucoma that underwent M-TSCPC using Iridex Cyclo G6 laser for IOP reduction were included. Success was defined as IOP ≤ 21 mmHg and absence of further glaucoma surgeries. Changes in IOP and medication burden were assessed using general linear models with significance at P < 0.05. Transient adverse events and complications were also noted.

Results
A total of 95 eyes with a mean age of 65.39 ± 15.25 years were included, of which 34 had no prior glaucoma interventions, 41 had prior incisional glaucoma surgery, 8 had minimally invasive glaucoma surgery (MIGS), and 12 had undergone both incisional and MIGS surgeries. The mean pre-laser number of medications was 3.32 ± 1.20, and the average visual field mean deviation was -14.16 ± 8.45 dB. No differences were observed in baseline characteristics across the groups (P > 0.05). The cumulative one-year survival for the whole cohort was 37%. With no intergroup differences (log rank P-value = 0.904), the subgroup analysis revealed survival rates of 58% for those with no prior glaucoma surgery, 29% for those with prior incisional glaucoma surgery, 27% for those with MIGS, and 46% for those with both incisional and MIGS surgery. At one year, IOP decreased by 23%, from 25.26 ± 7.71 to 19.56 ± 7.94 (P < 0.001) while medication use remained stable (P = 0.341). Post-operatively, 17 and four eyes underwent incisional and MIGS surgeries, respectively. Transient adverse events included steroid response in 21, cystic macular edema in four, uveitis in three, and hypotony in two eyes.

Discussion
Safety and efficacy of M-TSCPC has been previously established; however, a paucity of evidence exists regarding the outcomes of this novel glaucoma procedure in eyes refractory to prior glaucoma surgeries. Our results highlight that M-TSCPC is a safe treatment option with good one-year outcomes in eyes with uncontrolled glaucoma, a significant proportion of which constituted refractory eyes.

Conclusion
Our data support the one-year safety and efficacy of M-TSCPC to further reduce the IOP in a heterogenous glaucoma population, including eyes refractory to prior glaucoma surgeries.
Reference

20 Retrospective Study: Outcomes of Ab Interno Hydrus Microstent with Concomitant Cataract Surgery

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Purpose/Relevance
To evaluate the outcomes of an ab interno implanted stent (Hydrus microstent) with concomitant cataract surgery in subjects with glaucoma over 3 years post-operatively.

Methods
This study was conducted on 151 glaucoma eyes who had undergone Hydrus microstent combined with cataract surgery (retrospective study). Primary outcome was success defined as < medication than baseline with IOP ± 1 mmHg from baseline or ≤ medication than baseline with 2 mmHg IOP reduction from baseline. Secondary outcomes were complications, interventions, reoperations, number of classes of medications.

Results
Post-operative year 1 and 3 success were 76.2% and 56.8%, respectively. The mean age of participants was 72 years, with a mean baseline IOP of 18 mmHg with a median number of medication classes of 3. Rate of complications after the first postoperative month was 9.3%, with the top 2 being blurry vision (6%) and persistent uveitis (1.3%). Median classes of medication at 3 years was 1.4 ± 1.4.

Discussion
Hydrus implantation with concomitant cataract surgery provides excellent outcomes in glaucoma patients. Our results were similar to those in the Horizon study that presented data at 2 years follow-up. Number of classes of glaucoma medication at last follow-up greatly decreased compared to baseline.

Conclusion
Hydrus implantation with cataract surgery has good outcomes at 3-year follow-up.

Reference
21 Mapping the Aqueous Veins Outflow System and Its Relation to Canaloplasty Surgery Outcomes

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Purpose/Relevance
Predicting the efficacy of intraocular pressure (IOP) reduction from micro-invasive glaucoma surgeries (MIGS) remains a major challenge. For the Schlemm canal-based MIGS, it is assumed that IOP reduction is mediated by modulation of aqueous humor flow into the aqueous veins distal to Schlemm canal. At present, there is no pre-operative test to determine the density and integrity of the distal aqueous veins comprising the major aqueous veins and the intrascleral venous plexus (ISVP). Our hypothesis is that higher density of aqueous veins is associated with lower IOP after canaloplasty.

Methods
Using Fiji (ImageJ) and fluorescein as a tracer, we developed a method to quantify fluorescein-filled major aqueous veins and the ISVP in patients with glaucoma who have undergone canaloplasty.¹

Results
We used our image analysis protocol to quantitate veins from multiple images per patient that included major aqueous vein counts and ISVP cumulative cross-sectional area.² Among 77 canaloplasty videos from a single surgeon, 16 videos from 15 patients (59 ± 20.4 years; 5 female, 10 male; 1 African American, 12 Caucasian, 2 other) met criteria for high-quality images.

Discussion
The preliminary results show an unexpected trend of a weak, positive correlation between the average post-operative 1-year IOP and major aqueous vein counts. However, the ISVP cross-sectional area showed a weak trend toward lower IOP with larger ISVP cross-sectional area, which supports the hypothesis that the ISVP system is a regulatory component of the aqueous outflow pathway.³

Conclusion
A larger dataset will expand on these preliminary observations of fluorescein as a tracer for major aqueous veins, the ISVP, and role of the aqueous veins as potential biomarkers for glaucoma surgery. These preliminary observations will also help guide our development of a pre-operative assessment of the density of aqueous veins and how they relate to IOP outcomes of Schlemm canal-based surgeries.

References
Demographic Differences in the Effectiveness of Minimally Invasive Glaucoma Surgery (MIGS) Devices/Procedures

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Purpose/Relevance
MIGS is increasingly being performed in the US to treat glaucoma. The IRIS registry was used to examine the effectiveness of MIGS devices/procedures. The prevalence and severity of glaucoma, the utilization of various glaucoma procedures, and associated outcomes are concomitant with demographic characteristics of eyes undergoing MIGS. The goal of this study was to evaluate the demographic differences and the effectiveness of MIGS devices/procedures.

Methods
Patients aged ≥40 years with a diagnosis of open angle glaucoma, surgically naive, and undergoing cataract surgery between 1/1/2013 and 12/31/17 were included in this retrospective cohort study (N = 28,086 eyes). Variables included types and severity of glaucoma, number of medications, decrease in IOP and stratification among different ethnic groups. Descriptive statistics and odds ratios (OR) estimated with multivariable logistic regression were used to describe the association of these variables with having a MIGS procedure.

Results
Primary open angle glaucoma was the most common diagnosis (N = 21,017). Mean intraocular pressure prior to MIGS was 17.45 mmHg, with 85.6% on topical therapy. Seventy-two percent of eyes underwent iStent, with the remainder using other devices. A successful outcome, defined as a decrease in the number of medications or greater than 20% reduction of IOP from baseline, was achieved in 69.5% of eyes undergoing MIGS and cataract surgery. Sixty percent of eyes with mild to moderate glaucoma were on 1-2 medications after one year. Super-success as defined by a decrease in the number of medications and greater than 20% reduction in IOP from baseline. Among the racial/ethnic groups, only the black patients were more likely to achieve super-success (OR = 1.13, 95% CI: 1.03, 1.24) compared to white patients. No statistically significant differences were observed by gender, race and other ethnic or racial groups.

Discussion
Eyes of black patients were more likely to achieve super-success compared to white patients.

Conclusion
Decreasing the number of medications while maintaining an acceptable IOP can lessen the economic burden in glaucoma patients. As new surgical devices enter the market we will need to educate the ophthalmic community about how their effects may differ clinically among our glaucoma patients.

Reference
Purpose/Relevance
To compare the success rate and outcomes of targeted supra-tenon’s placement of ab interno gelatin microstent versus non-targeted. Despite theoretical merits of targeting the subconjunctival space to avoid intra-tenon’s placement of microstent, there is currently no published long-term data.1,2

Methods
Primary outcome was time to failure (IOP outside of 6-17 on no medications) on two consecutive visits despite in-clinic maneuvers (including needling). Secondary outcomes included IOP cutoffs of 14 and 21, interventions, complications, and reoperations.

Results
45 eyes in 42 patients received non-targeted microstent placement, and 25 eyes in 24 patients received targeted supra-tenon’s microstent placement. HR for non-targeted relative to targeted placement was 0.96 (95% CI, 0.50 – 1.87); proportional success at 1 year were 0.49 (0.08) for non-targeted and 0.52 (0.10) for targeted microstent placement. There were 29 and 18 interventions (38% and 40% had needling with MMC), respectively, with 16% reoperation rate in both groups. Non-targeted group had a higher number of general complications (e.g., hyphema, choroidal effusion, hypotony maculopathy)—28 (62%) vs. 9 (36%) (P = 0.04)—than non-targeted group but similar microstent-specific complications (e.g., blocked Xen, Iris Xen touch) (4 vs. 3).

Discussion
Targeted supra-tenon ab interno gelatin microstent placement resulted in less general complications, such as hyphema and choroidals, while having similar success rate as non-targeted placement at post-operative year 1. Targeted supra-tenon placement also had similar intervention and reoperation rates as non-targeted placement of ab interno gelatin microstent.

Conclusion
Targeted ab interno gelatin microstent had less general complications with similar success, intervention, and reoperation rate as non-targeted supra-tenon’s placement at 1 year post-operation follow-up.

References

Figure 1
24 Short-term Outcomes of a Trans-scleral Gelatin Stent: Ab Interno vs. Ab Externo Stent Placement

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Purpose/Relevance
To investigate surgical success rate, IOP reduction, medication reduction and bleb needle revision rate of a single surgeon’s initial Xen gel stent (Allergan: Dublin, Ireland) placement performed through either an ab interno or an ab externo open conjunctiva technique.

Methods
This is a retrospective comparative case series in a refractory glaucoma patient population in New York City. A single surgeon performed a trans-scleral gel stent technique using an ab interno technique for over one year before changing the technique to an ab externo approach. After IRB approval, patient medical records were reviewed for baseline demographics, surgical technique, IOP, medication use, needle revision rate, and need for subsequent surgical intervention. Patients were included if the trans-scleral stent was performed as a standalone procedure or with cataract surgery and if at least 3 months of follow-up information was available.

Results
Patient records meeting inclusion criteria were identified for ab interno (n = 57) and ab externo (n = 25) patients. Baseline IOP was 23.86 ± 8.7 mm Hg on 2.58 ± 1.6 medications for the ab interno group compared to an IOP of 26.0 ± 10.1 mm Hg on 3.1 ± 1.3 medications for the ab externo group (P ≥ 0.2). At month 3, mean IOP was 17.7 ± 8.1 mm Hg on 1.5 ± 1.3 medications for the ab interno group compared to 18.2 ± 6.1 mm Hg on 1.2 ± 1.5 medications for the ab externo group (P > 0.4). At month 3, there was a 25.8% reduction of IOP in the ab interno group and 30% IOP reduction in the ab externo group. Sixty-one percent of patients in the ab interno group achieved a 20% IOP reduction from baseline at 3 months compared to 76% of ab externo patients. Revision of the bleb was performed in 22/57 (39%) ab interno patients compared to 7/25 (28%) ab externo patients. Secondary glaucoma surgery other than bleb needle revision (e.g., tube shunt) was performed in 8/57 ab interno patients (14.0%) compared to 1/25 (4%) ab externo patients. There was a single extruded stent noted in an ab interno patient at month 2, which was removed in the office setting. Otherwise, there were no reoperations for surgical complications or other serious complications in either group.

Discussion
The trans-scleral gel stent, performed ab interno or ab externo, reliably reduced IOP in a refractory glaucoma patient population. While differences between techniques were modest, all variables examined, including IOP reduction, proportion of patients achieving 20% IOP reduction, medication reduction, bleb needle revision and surgical reoperation rates, favored the ab externo group, although not always statistically so. Both techniques exhibited excellent safety results.

Conclusion
The trans-scleral gel stent can reduce IOP and medication use when implanted using an ab interno or ab externo open conjunctiva approach. The ab externo approach may be associated with fewer bleb revisions or reoperations and a slightly higher rate of success.

Reference
25 Outcomes of Ab Interno Versus Ab Externo XEN Gel Stent Implantation

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Purpose/Relevance
The XEN gel stent is a minimally invasive glaucoma surgery device traditionally implanted via an ab interno approach.¹ Ab externo implantation has been described² and has potential for less Tenon’s entanglement. We compared outcomes of ab interno and ab externo XEN implantation; few, if any, direct comparisons of this type have been reported.

Methods
Medical records of adults who underwent XEN gel stent implantation by a single surgeon (JSM) at Wills Eye Hospital since March 2017 were retrospectively reviewed. The t-test and chi-square test were used to compare continuous and categorical data, respectively.

Results
55 eyes from 45 consecutive patients with at least 6 months of follow-up data were included. 19 eyes and 36 eyes, respectively, underwent ab externo and ab interno XEN implantation. Demographic features were not significantly different between ab externo and ab interno groups, including age (72 ± 10 vs. 73 ± 8 years), male gender (41.2% vs. 34.4%), and Caucasian race (70.6% vs. 62.5%). Preoperatively, eyes with ab externo XEN implantation had IOP 18.3 ± 5.4 mmHg and 2.9 ± 1.6 medications. At 6 months, there was IOP reduction of 5.5 ± 6.4 mmHg (P = 0.001) and reduction of 1.5 ± 2.2 medications (P = 0.01). Preoperatively, eyes with ab interno XEN implantation had IOP 22.7 ± 7.6 mmHg and 2.9 ± 1.2 medications. At 6 months, there was IOP reduction of 6.9 ± 8.7 mmHg (P = 0.0001) and reduction of 2.2 ± 1.5 medications (P < 0.0001). There was no difference in IOP or medication reduction between groups at 6 months. The proportion of patients requiring bleb needling through 6 months was less for ab externo than ab interno implantation (10.5% vs. 52.8%, P = 0.002).

Discussion
Both ab externo and ab interno approaches to XEN gel stent implantation are effective for glaucoma management. Both achieved similar IOP and medication reduction at 6 months. The ab externo approach demonstrated the additional benefit of reduced early post-operative bleb needling.

Conclusion
Ab externo XEN implantation is an effective technique that may reduce the rate of early bleb needling.

References
26  Current State of Micro-Invasive Glaucoma Surgeries in Ophthalmology Residency Education

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Purpose/Relevance
The Accreditation Council for Graduate Medical Education (ACGME) Ophthalmology Residency Review Committee expects graduating residents to perform at least five “glaucoma filtering/shunting procedures” as primary surgeon. Recently, micro-invasive glaucoma surgeries (MIGS) have become common and are often performed by comprehensive ophthalmologists, so all residents should have some exposure to these procedures. The purpose of this study is to describe the current state of glaucoma education in United States residencies, with attention to MIGS.

Methods
De-identified case logs from residents graduating in 2018 were requested from program directors of all United States ophthalmology residency programs. The number and type of cases performed as primary surgeon were tabulated. Data from residents in the same program were averaged, and the number of cases per resident was calculated for each procedure and program. For sub-analysis, trabeculectomy and tube shunt were pooled together as “traditional glaucoma surgery,” and iStent, Cypass, XEN, goniotomy, and trabeculotomy were pooled together as “micro-invasive glaucoma surgery.”

Results
Data from 152/476 (32%) residents from 36/111 (32%) programs were received. The median and range cases per resident were: cataract (220, 81-315), trabeculectomy (3, 0-12), tube shunt (5, 1-15), iStent (2, 0-25), Cypass (0, 0-4), XEN (0, 0-4), goniotomy (0, 0-20), trabeculotomy (0, 0-1), trans-scleral cryopexy (2, 0-17), endocyclophotocoagulation (0, 0-4), laser peripheral iridotomy (10, 5-22), laser trabeculoplasty (9, 5-111). For traditional glaucoma surgery, the median cases per resident was 8, the range was 2-23, and 3/36 (8%) programs had an average of <5 cases/resident. For MIGS, the median cases per resident was 3, the range was 0-47, and 7/36 (19%) programs had an average of <1.

Discussion
The depth and breadth of glaucoma procedures performed by graduating ophthalmology residents as primary surgeon varies widely. Despite the ACGME requirement that residents must perform at least 5 glaucoma filtering/shunting procedures as primary surgeon, an estimated 8% of residency programs graduate residents with an average of <5 traditional glaucoma surgeries. There are currently no ACGME requirements for MIGS, and an estimated 19% of residency programs graduate residents with an average of <1 MIGS procedure. iStent was the most common MIGS procedure performed by residents graduating in 2018.

Conclusion
Some residency programs are not meeting the minimum requirements for traditional glaucoma surgery, possibly in part due to the increasing popularity of MIGS. Inclusion of MIGS as a distinct category in the ACGME case log system would reflect the growing role of MIGS in clinical practice as well as help ophthalmic educators track resident MIGS training.

References
27 Reduction in Incisional Glaucoma Surgery After 4 Years with a Schlemm’s Canal Microstent Combined with Cataract Surgery for Treatment of Primary Open Angle Glaucoma

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Purpose/Relevance
Several microinvasive glaucoma surgery (MIGS) techniques combined with cataract surgery have been shown to reduce IOP and medication use postoperatively from 6 months to 2 years in randomized clinical trials. The purpose of this study was to assess 4-year outcomes in patients who underwent cataract surgery alone compared to those who underwent cataract surgery combined with implantation of a Hydrus® Microstent.

Methods
Subjects with primary open angle glaucoma (POAG) and visually significant cataract with washed-out diurnal IOP 22 - 34 mmHg were randomized 2:1 to undergo cataract surgery with or without a Hydrus Microstent in the HORIZON study.1 Scheduled study visits were conducted through 48 months postoperative.

Results
556 eyes were randomized after cataract surgery to Hydrus (HS, n = 369) or no further treatment (CS, n = 187). The HS and CS groups did not differ with respect to baseline characteristics. At screening, IOP and glaucoma status were comparable in both groups for the following: mean number of IOP-lowering medications in HS vs. CS groups (1.7 ± 0.9 for both, P = 0.9), pre-washout IOP (17.9 ± 3.1 mmHg vs. 18.1 ± 3.1 mmHg, P = 0.6), pre-surgery washout diurnal IOP (25.5 ± 3.0 vs. 25.4 ± 2.9 mmHg, P = 0.9), and visual field mean deviation (-3.61 ± 2.49 dB vs. -3.61 ± 2.60 dB, P = 1.0). At 4 years, the proportion of eyes requiring no medications was significantly higher in the HS group (65% vs. 41%, P < 0.001), and the mean unmedicated IOP was lower in the HS group (16.7 vs. 17.3). There was a significant reduction in the cumulative risk of incisional glaucoma surgery at 4 years (1.9% vs. 6.9%, hazard ratio = 0.25, P = 0.013, logrank P = 0.007). From 2 to 4 years, mean central endothelial cell count fell by 3% in the HS group (2060 ± 480 HS vs. 2014 ± 502, P = 0.9) and 2% in the CS group (2183 ± 425 vs. 2144 ± 420, P = 0.9). There were no significant differences in other adverse events at 4 years compared to 2 years.

Discussion
Hydrus microstent when combined with phacoemulsification results in sustained IOP and medication reduction for up to 4 years postoperative with no significant diminution of effect between postoperative years 2 and 4. The treatment arm showed a significant reduction in secondary incisional glaucoma surgery (trabeculectomy or tube shunt) despite similar IOP values. The limitations of medical therapy (non-compliance, circadian IOP fluctuation) are well documented2 and could be a contributing factor to the difference in secondary surgery. There were no significant changes in safety findings from the 2-year findings.

Conclusion
The addition of a Hydrus Microstent at the time of cataract surgery can significantly lower the risk of postoperative incisional glaucoma surgery.
References


A Single-Surgeon Interventional Case Series of 80 Ab Interno XEN Gel Stent Implantations

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Purpose/Relevance
To evaluate the outcomes of 80 consecutive XEN Gel Stent (Allergan Plc., Dublin, Ireland) implantations performed by a single surgeon.

Methods
A retrospective chart review was conducted of all XEN implant surgeries performed by a single surgeon (IPC) between February 3, 2017, and September 24, 2018. Implantations were performed with an ab-interno approach and utilized mitomycin C. Preoperative and postoperative intraocular pressure (IOP), preoperative and postoperative number of glaucoma medications, previous tube shunt/valve implantation, and postoperative needling rate were analyzed. Subgroup analyses included whether surgery was performed with or without concurrent cataract surgery and patient ethnicity (Caucasian, African American, Asian, Other).

Results
Eighty XEN implantations were performed in 71 patients with glaucoma. At a mean follow-up of 18.0 months (S.D. ± 8.6), the percentage IOP decrease was 58.0%. The average number of glaucoma medications decreased from a mean of 2.76 to 1.12. The overall postoperative needling rate was 28.8% (23/80), with a median time to needling of 1.7 months. The needling rate in standalone XEN was 24.6% (17/69), compared to cataract+XEN needling rate of 54.5% (6/11), but this difference did not achieve statistical significance with Fischer exact test (P = 0.069). Similarly, the needling rates of Caucasian (28.8%, 19/66) and African American (27.3%, 3/11) subgroups were not statistically different (P = 1.0). Needling rates of eyes with previous tube shunt or valve implantation (44.4%, 4/9) was not significantly different than that of eyes without history of tube implantation (26.8%, 19/71) (P = 0.27).

Discussion
Ab interno XEN Gel Stent implantation with mitomycin C was associated with lower IOP and fewer medications at mean 18 months’ follow-up. Concurrent cataract surgery, previous tube shunt/valve implantation, and patient ethnicity were not associated with greater needling rates.

Conclusion
XEN Gel Stent may provide significant reduction in IOP with acceptable needling rates at 18 months, regardless of patient ethnicity, history of previous tube shunt/valve surgery, or whether implantation is performed with or without cataract surgery.

Reference
29 Surgical Outcomes of Gonioscopy-Assisted Transluminal Trabeculotomy with and Without Concomitant Cataract Surgery in Young and Middle-Aged Adults

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Purpose/Relevance
Gonioscopy-assisted transluminal trabeculotomy (GATT) has been shown to reduce the intraocular pressure (IOP) and medication burden in eyes with open angle glaucoma (OAG)¹⁻³ and congenital glaucoma;⁴ however, evidence in young and middle-aged adults remains limited. Here we report the surgical outcomes related to GATT with and without concomitant cataract surgery in young and middle-aged patients.

Methods
In this retrospective case series, eyes of patients between 18 and 65 years of age that underwent GATT were included. Success was defined as IOP \(< 21\) mmHg, a reduction \(\geq 20\%\) compared to baseline, and absence of additional glaucoma surgery or loss of light perception.⁵ Changes in IOP, medication burden, and best-corrected visual acuity (BCVA) were assessed using generalized linear models. Safety measures included adverse events and complications.

Results
21 eyes of 18 patients with a mean age of 45.34 ± 13.94 years and a minimum of 6 months of follow-up (16 with one year follow-up) were included. Glaucoma diagnoses included 8 primary OAG, 6 juvenile OAG, 4 uveitic glaucoma, 2 angle recession glaucoma, and 1 pigment dispersion glaucoma. 15 eyes underwent GATT, and 6 received GATT combined with cataract surgery (CE-GATT). The 12-month cumulative survival was 81%. Intraocular pressure decreased significantly, from 28.57 ± 10.54 mmHg to 13.11 ± 3.70 (54% reduction, \(P < 0.001\)) and 15.29 ± 3.69 (47% reduction, \(P = 0.004\)) at 6 and 12 months postoperatively, respectively. Medication use decreased from 3.62 ± 1.07 to 1.26 ± 1.19 (65% decrease, \(P < 0.001\)) and 0.79 ± 1.12 (78% reduction, \(P < 0.001\)) at 6 and 12 months postoperatively, respectively. The most common adverse events included transient postoperative hyphema in 13 eyes, IOP spike in 11 eyes (10 of which underwent anterior chamber tap), and corneal edema in 4 eyes. Postoperative BCVA remained stable.

Discussion
There is a paucity of evidence regarding the efficacy of GATT in young and middle-aged adults. Our results highlight that this surgical procedure has good one-year outcomes with an acceptable safety profile, supported by the significant IOP and medication reduction observed postoperatively. It is possible that the pathophysiology of OAG in younger patients is more localized to the trabecular meshwork, therefore making GATT a particularly suitable procedure for these patients.

Conclusion
Our data support the one-year safety and efficacy of GATT with and without concomitant cataract surgery in young and middle-aged adults with open angle glaucoma.
References


30 Outcomes of the iStent Trabecular Micro-Bypass Implant: Three-Year Follow-up

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Purpose/Relevance
The first-generation iStent micro-bypass is the smallest implantable medical device approved for use in humans. The microinvasive glaucoma device is designed to connect the anterior chamber to Schlemm's canal by bypassing the trabecular meshwork, increasing outflow facility, and reducing IOP. This retrospective longitudinal case series analyzes (1) the long-term reduction in IOP and medication use in patients with glaucoma that have undergone iStent implantation with 36 months of follow-up, (2) the demographic and ocular factors associated with successful IOP and/or medication reduction, and (3) the postoperative complication and reoperation rates.

Methods
170 eyes of 132 patients with a diagnosis of glaucoma underwent iStent implantation at a single institution. Baseline and postoperative IOP and medication use were compared using paired-samples t-test and Wilcoxon signed-rank test, respectively. Survival analysis was performed with success defined as (1) same IOP ± 1 mmHg with medication reduction, (2) 20% IOP reduction with same or less medication use, (3) criteria 1 or 2. Hazard ratios of failure were calculated using Cox proportional hazards model accounting for age, gender, ethnicity, glaucoma type, number of iStents and phacoemulsification.

Results
Mean follow-up time was 57.2 ± 21.7 months. 87.6% of cases were performed in conjunction with phacoemulsification. Median pre-operative IOP was 18 mmHg (IQR 6), and median number of medication classes was 3 (IQR 2). Median IOP and number of medications decreased to 15 mmHg (IQR 3) and 1 (IQR 3), respectively, at 3 years (n = 153, both P < 0.001). 6.5% of patients were on no medications, and 56.5% on ≥3 medications preoperatively, with 34.6% on no medications and 31.4% on ≥3 medication classes postoperatively. 44.1% met success criteria 1, 22.4% met criteria 2, and 50.0% met criteria 3 at 3 years. Combined mechanism versus primary open angle glaucoma diagnosis had a decreased likelihood of success for both success criteria 1 and 3 (HR 3.93, 95% CI, 1.43 – 10.79; and HR 4.04, 95% CI, 1.46 – 11.17, respectively). 1 patient had intraoperative iridodialysis and 7.1% experienced postoperative hyphema. 5.8% had stent obstruction with 3.5% requiring laser. Reoperation rate was 11.2%, consisting of 2 cases of trabeculectomy and remaining cases having Xen, InnFocus microshunt, or tube shunt implantation.

Discussion
The first-generation iStent provides modest IOP lowering and medication reduction by postoperative month 3 through to 3 years of follow-up. There was a mean reduction of 3.15 mmHg in IOP and 1 hypotensive medication class. Most complications were transient and reoperations were minimal.

Conclusion
The iStent demonstrates long-term IOP and medication burden reduction, with minimal complications. Further long-term monitoring will allow for better characterization of the micro-bypass along the spectrum of glaucoma management.
References


Real-World Experience with Second-Generation Trabecular Micro-Bypass Stents (iStent inject®) Implanted in Conjunction with Phacoemulsification

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Purpose/Relevance
This study aims to evaluate the safety and performance of the second-generation trabecular micro-bypass stent system (iStent inject®) implanted in combination with cataract surgery.

Methods
This is a retrospective, consecutive case series from a single glaucoma surgeon. This cohort includes 31 eyes implanted with iStent inject with cataract surgery. Assessments include IOP, medication use, and standard safety evaluations. Last follow-up takes into consideration all available data at different follow-up timepoints, including a subset reaching post-op 12 months. Continued patient monitoring and data collection of iStent inject cases is planned with the intent of reporting a larger sample size with longer-term outcomes by the time of the presentation.

Results
In the current cohort, 31 patients averaging 67.9 years of age with mild-moderate open-angle glaucoma and comorbid cataract were successfully implanted with the iStent inject stents in conjunction with cataract surgery. Mean preoperative IOP is $17.3 \pm 5.1$ mmHg on $1.2 \pm 1.2$ medications. Mean IOP at the last follow-up visit is $14.2 \pm 3.7$ mmHg on $0.4 \pm 0.9$ medications (average follow-up time is ~5 months). This represents a 18% IOP reduction (3.1 mmHg reduction) and a 67% reduction in the number of medications ($P < 0.05$ for both IOP and medications). 74% of eyes are med-free at the last follow-up compared to 42% prior to surgery. Favorable safety was observed, with no significant intraoperative or postoperative complications.

Discussion
The iStent inject adds to the existing treatment options for glaucoma. Early outcomes from this study show promising IOP and medication reduction in mild-moderate OAG; longer-term data will be useful.

Conclusion
As US surgeons are introduced to the recently available iStent inject, sharing of clinical evidence from real-world usage is useful. Early clinical experience with the iStent inject trabecular stents demonstrated clinically meaningful and statistically significant IOP and medication reduction. A high safety profile has been observed, consistent with the published literature.

Reference
32 Outcomes of Primary Cyclophotocoagulation Using the Slow Coagulation Continuous Wave Settings: One-Year Results

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Purpose/Relevance
To report treatment outcomes of primary cyclophotocoagulation (CPC).

Methods
A retrospective study, including a total of 53 eyes of 52 patients with medically uncontrolled glaucoma and no previous incisional ocular surgery undergoing transscleral CPC. The primary outcome measure was surgical success (intraocular pressure [IOP] ≤ 21 mmHg and reduced ≥ 20% from baseline, IOP > 5 mmHg, no reoperation for glaucoma, no loss of light-perception vision). Secondary outcome measures included visual acuity, IOP, and complications.

Results
Mean age of the patients at time of surgery was 58 years ± 15, and mean follow-up was 9.8 months ± 7.0. Mean IOP was 23.1 ± 9.2 mmHg at baseline and 16.9 ± 1.3 mmHg at last follow-up (P < 0.001). The number of glaucoma medications was 3.8 ± 1.0 at baseline and 2.6 ± 1.3 at last follow-up (P < 0.001). Patients were divided into two groups based on their baseline IOP, ≥ 21 mmHg (high group; n = 24) or < 21 mmHg (low group; n = 29). The cumulative probability of failure during the first year of follow-up was 38.3% in the high IOP group and 69.0% in the low IOP group (P = 0.039). The mean logMAR visual acuity worsened from 1.0 ± 1.1 at baseline to 1.2 ± 1.0 at last follow-up (P = 0.001). LogMAR decreased by 2 or more lines from baseline in 22 eyes (42%) at last follow-up. 31 eyes (59%) had a baseline best corrected visual acuity (BCVA) of 20/100 or better (baseline logMAR < 0.7). Nine eyes out of 16 (56%) had worsening of cataract, 4 (44%) of which underwent cataract surgery during the study period. Inflammation persisting more than 1 month occurred in 13 eyes (25%) and macular edema in 3 eyes (6%).

Discussion
CPC has been emerging as an alternative to incisional surgery in the treatment of glaucoma, especially with emergence of treatment parameter modulations that render the procedure safer and better tolerated.1 Our results demonstrate greater efficacy in patients with baseline IOP of > 21 mmHg. Patients also had reduction in the number of glaucoma medications, an important quality-of-life measure. Mild loss of BCVA occurred in a significant number of patients, largely due to progression of cataract—we anticipate much better outcomes in pseudophakic patients. Study limitations include the retrospective nature of the study, small number of enrolled eyes, short duration of follow-up, and different treatment parameters and perioperative medication protocols, where the intraoperative steroid and NSAID regimen had not been standardized in these early CPC cases.

Conclusion
Higher baseline IOP was associated with a higher success rate in patients undergoing slow coagulation primary CPC. Our early experience with CPC is evolving with different anti-inflammatory protocols, and our utilization of primary CPC is increasing, especially in the pseudophakic population.

Reference
33 Outcomes of Phacoemulsification Combined with Endocyclophotocoagulation and Kahook Dual Blade Goniotomy

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Purpose/Relevance
To evaluate the additional effect of endocyclophotocoagulation (ECP) at the time of phacoemulsification and Kahook Dual Blade (KDB) goniotomy in glaucoma patients.

Methods
We conducted a retrospective chart review of patients seen at the University of Colorado Eye Center who received either KDB goniotomy with phacoemulsification (phaco-KDB, n = 326) or KDB goniotomy + ECP with phacoemulsification (phaco-KDB/ECP, n = 146). Patients of all glaucoma types and severities were included.

Results
Mean IOP in the phaco-KDB group was significantly reduced from 16.4 mm{H}{H}hg to 13.7 mmHg at 6 months ($P < 0.0001$) and 13.7 mmHg at 12 months ($P < 0.0001$). Mean IOP was also reduced in the phaco-KDB/ECP group, from 16.6 mmHg to 13.5 mmHg at 6 months ($P < 0.0001$) and 13.9 mmHg at 12 months ($P < 0.0001$). The mean percent reduction in IOP was similar between study groups ($P = 0.70$). Glaucoma medication use was significantly reduced in both groups at one year, with no significant difference in number of medications between the phaco-KDB and phaco-KDB/ECP groups. Eyes in the phaco-KDB/ECP group demonstrated worse glaucoma severity compared to phaco-KDB eyes ($P = 0.0013$).

Discussion
Recently, less invasive glaucoma procedures have been combined at the time of cataract surgery to provide additional IOP reduction compared to a single glaucoma procedure. However, little evidence has been shown supporting the additional efficacy of these approaches. In this study, both phaco-KDB and phaco-KDB/ECP groups demonstrated significant reduction in mean IOP and glaucoma medication use at 6 and 12 months compared to baseline. However, mean IOP reduction was not statistically different between groups after 12 months, suggesting no additional effect of ECP in this population. Further study is required to determine if ECP truly offers little additional IOP-lowering effect to KDB goniotomy in more similar study groups at baseline.

Conclusion
At the time of cataract surgery, combined KDB/ECP does not seem to further reduce IOP or medication use compared to KDB goniotomy alone. These results may be confounded by differences in glaucoma severity between groups with/without ECP.

References
34 Comparison of Clinical Outcomes after XEN Gel Stent and Ex-Press Glaucoma Drainage Device

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Purpose/Relevance
This study aims to compare the clinical efficacy and safety outcomes of the XEN stent and Ex-Press device in glaucomatous eyes.

Methods
Records of consecutive eyes undergoing either surgery from February 2017 to June 2019 for uncontrolled glaucoma at the Sue Anschutz-Rodgers Eye Center were evaluated. The primary outcome was the incidence of surgical failure defined as an intraocular pressure (IOP) <6 mmHg, >18 mmHg or <20% reduction in IOP or no reduction in glaucoma medications for two consecutive visits after one month, reoperation for uncontrolled glaucoma, or loss of light perception vision. Secondary outcomes were mean IOP, IOP reduction, medication use, complications, and number of clinic visits in the first three months post-op.

Results
100 eyes (52 XEN and 48 Ex-Press) from 86 patients were evaluated. Baseline characteristics including glaucoma type and severity were similar between groups, with the exception of Xen patients having a lower percentage male (17% vs. 46%), older patients (median age 78 vs. 68 years), and a higher percentage Caucasian (88% vs. 69%). Baseline IOP and number of medications were similar between groups (21.4 vs. 18.8 mmHg, P = 0.10 and 2.8 vs. 3.1, P = 0.33). Using a Log-rank test of the Kaplan-Meier curves, the XEN group had a significantly higher failure rate at 1 year (30.8% vs. 12.5%, OR = 3.1 [CI: 1.1-9.2]; P = 0.04). The number of clinic visits post-op was significantly higher in the Ex-Press group (9.1 vs. 5.8 visits, P < 0.001). Mean IOP at 1 year was similar between groups (12.6 vs. 11.4 mmHg, P = 0.39); however, the number of medications was significantly higher in the XEN group (1.7 vs. 0.5, P = 0.001). The incidence of choroidals and hypotony were significantly higher after Ex-Press compared to XEN (9 vs. 1, P = 0.022 and 18 vs. 3, P = 0.001, respectively).

Discussion
To date, limited studies of XEN clinical outcomes have been published, with only one comparing XEN outcomes with trabeculectomy. Furthermore, this is the first study to have compared XEN to the Ex-Press glaucoma drainage device, which is implanted under a partial-thickness scleral flap similar to traditional trabeculectomy.

Conclusion
In this population, while the XEN stent offers a lower risk of adverse events and fewer clinic visits post-op, its surgical success rate was inferior to that of the Ex-Press shunt. Surgeons should consider patient’s risk for adverse events as well as surgical goals when deciding between these two procedures.

Reference
35 Circumferential Viscodilation Ab Interno Combined with Phacoemulsification for Treatment of Open-Angle Glaucoma: 12-Month Outcomes

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Purpose/Relevance
The objective of this study was to evaluate the reduction in intraocular pressure (IOP) and medication use for open-angle glaucoma patients 12 months post-surgery following ab interno circumferential viscodilation (VISCO360, Sight Sciences, Menlo Park, CA) in conjunction with phacoemulsification cataract surgery.

Methods
This was a retrospective chart review of all open-angle glaucoma patients treated with 360 degree ab interno viscodilation along with phacoemulsification cataract surgery by a single surgeon (NR) having 12 months of follow-up. Patients were stratified by baseline IOP. Group 1: pre-operative IOP of <18 mmHg (n = 69). Group 2: pre-operative IOP greater than or equal to 18 mmHg (n = 111). IOP was measured using Goldmann applanation tonometry. Medication use, the number of medication-free patients in each group at 12 months, and intra- and post-operative adverse events (AE) are reported. Analysis includes descriptive statistics and t-tests evaluating change from baseline.

Results
Groups 1 and 2 had mean baseline IOP of 14.3 and 22 mmHg. Medication use was 1.1 for Group 1 and 0.9 for Group 2. At 12 months IOP for Group 1 was similar to baseline (15.4 mmHg) but with a reduction in medications to 0.7 (P < 0.05). IOP for group 2 was reduced 21.4% to 17.3 mmHg (P < 0.001) on 0.9 medications (P = 0.7). The proportion of patients medication free at 12 months was 44.4% for Group 1 and 32.1% for Group 2. IOP spike in the first 30 days post-operative occurred in 7% in Group 2 but was not observed in Group 1.

Discussion
Treatment goals for the two groups differed: medication reduction for Group 1 and pressure reduction for Group 2. Viscodilation achieved significant medication reduction in Group 1 and IOP reduction in Group 2, with many patients (both groups) medication free at 12 months. AE were infrequent and transient.

Conclusion
Circumferential ab interno viscodilation is a safe, minimally invasive procedure that can be combined with cataract surgery and provide an IOP-lowering and medication reduction benefit sustained for at least 12 months for many patients with open-angle glaucoma.

Reference
**36 PreserFlo MicroShunt in the Surgical Management of Glaucoma Secondary to Uveitis**

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¹ Laval University

**Purpose/Relevance**

The management of uveitic glaucoma is challenging, often requiring surgery. We previously reported the utility of the XEN gel implant in selected patients.¹ The PreserFlo Microshunt (PMS) (formerly InnFocus) also provides a less invasive alternative to trabeculectomy and aqueous shunt.² We report the safety and efficacy of PMS implantation in a series of patients with uveitic glaucoma.

**Methods**

Retrospective, noncomparative, interventional case series of consecutive patients undergoing PMS implantation with mitomycin C (MMC) in uveitic glaucoma in a subspecialist uveitic glaucoma clinic during a 24-month period. Best-corrected visual acuity (BCVA), intraocular pressure (IOP), number of glaucoma medications, adverse events, and further medical or surgical treatment were recorded at baseline, day 1, week 1, and month 1, 3, 6, and 12 post-operatively.

**Results**

24 eyes of 24 patients underwent PMS implantation with MMC and completed a minimum of 12 months follow-up. The baseline IOP (mean ± SD) of 27.0 ± 9.6 mmHg was reduced to 8.1 ± 3.7, 9.7 ± 4.9, 15.7 ± 9.8, 16.7 ± 9.9, 16.0 ± 6.1, and 15.6 ± 5.8 at post-operative day 1, week 1, month 1, 3, 6, and 12, respectively (P < 0.001). The baseline number of IOP-lowering medications was 4.0 ± 0.9, reducing to 0.2 ± 0.5, 0.6 ± 1.1, 0.8 ± 1.2, and 0.9 ± 1.1 at post-operative months 1, 3, 6, and 12, respectively (P < 0.001). Complications included self-resolving hyphema, 1 eye, and recurrence of anterior uveitis, 4 eyes, 2 of which were associated with cystoid macular edema. There were no episodes of hypotony requiring intervention, bleb-related infection, nor PMS exposure during the 12-months of follow-up. BCVA and visual field mean deviation did not change significantly from baseline to month 12. Seven eyes (29%) required revision with further application of MMC for elevated IOP during the follow-up period, of which 4 later required a Baerveldt Glaucoma Implant.

**Discussion**

Good efficacy was observed after PMS insertion with MMC, with a favorable safety profile, no significant early hypotony, and less intense follow-up than after a trabeculectomy, in patients with uveitis. The PMS is more difficult to needle than a XEN, and hence the authors opted for revision in cases of unsatisfactory IOP control.

**Conclusion**

In selected cases of uveitic glaucoma, PMS implantation resulted in good IOP control after 12 months with minimal postoperative intervention. A significant proportion (29%) required further surgical intervention. Analysis of risk factors for failure will likely lead to improved surgical success.

**References**

37 Early Results of Second-Generation Trabecular Micro-Bypass Stents (iStent inject®) with Cataract Surgery in a Real-World Setting

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Purpose/Relevance
The iStent is a device used in microinvasive glaucoma surgery (MIGS) for lowering intraocular pressure (IOP) in patients with mild to moderate glaucoma during cataract surgery. It has been shown that those who get the iStent may be able to reduce their dependence on medications and have better IOP control many years down the line. The second-generation trabecular micro-bypass stent (iStent inject) was recently approved by the FDA. We would like to investigate the safety and initial outcomes of the iStent inject on IOP and number of post-op glaucoma medications in a real-world setting.

Methods
The study design is a retrospective chart review of eyes with mild-moderate open-angle glaucoma (OAG) implanted with iStent inject in combination with cataract surgery between August 2018 and February 2019. Pre-op and post-op IOP and medication data were gathered. Safety was assessed by intra- and post-op complications. Data will continue to be gathered to determine long term efficacy and safety measures.

Results
117 eyes were successfully implanted with iStent inject; 51 have reached 6-month follow-up. Mean preop IOP was 16.0 ± 4.1 mmHg on an average of 0.92 ± 0.93 meds (range: 0-4 meds). 30.8% of eyes had prior glaucoma surgery or laser procedures. At 6 months postoperatively, mean IOP reduced by 13.8% to 13.8 mmHg ($P = 0.00154$), and mean med burden decreased by 32% to 0.63 meds ($P = 0.0001$). The proportion of med-free eyes was 61% at 6 months. 77% of eyes had IOP ≤ 15 mmHg. Results were similarly favorable in the consistent cohort of eyes with 6-month follow-up (n = 51). No intraoperative complications, secondary glaucoma surgeries, or device-related adverse events occurred.

Discussion
Early outcomes with iStent inject implanted at the time of cataract surgery in our US patient population of mild to moderate OAG resulted in statistically and clinically significant reductions in IOP and medications through 6 months post-op with a favorable safety profile. Such reduction is likely due to the combined effect of cataract surgery and the efficacy of the device. We see a significant response even in eyes starting with lower IOPs and medications.

Conclusion
The study demonstrated a promising benefit-to-risk profile for iStent inject, corroborating existing literature showing the device’s efficacy and safety in the setting of cataract surgery.

References
To GATT or Half-GATT? Comparison of Ab Interno Circumferential 360 Degree Trabeculotomy vs. 180 Degree Trabeculotomy in the Treatment of Glaucoma

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Purpose/Relevance
To compare the safety and efficacy of gonio-assisted transluminal trabeculotomy (GATT) with a more limited “half-GATT” in treating patients with open-angle glaucoma. In the half-GATT procedure, an ab interno 180 degree trabeculotomy of the inferior trabecular meshwork is performed in combination with 180 degree viscodilation of the superior portion of Schlemm’s canal.

Methods
Retrospective chart review of 33 patients with open-angle glaucoma who underwent a GATT procedure and 22 patients who underwent a half-GATT. Outcome measures included change in intraocular pressure (IOP) and number of glaucoma medications at 3 months after surgery. Rate of hyphema at one week post-operatively was also evaluated.

Results
33 patients (average age 60 years) were included in the GATT analysis, and 22 patients (average age 68 years) were included in the half-GATT analysis. Preoperative mean IOP was 24.5 ± 3.2 mmHg with use of 2.7 ± 0.3 medications for GATT patients and 25.6 ± 3.7 mmHg with use of 3.1 ± 0.5 medications for half-GATT patients. For GATT patients, mean decrease in IOP at 3 months was 8.27 ± 3.3 mmHg and mean decrease in number of medications was 1.03 ± 0.4. For half-GATT patients, mean decrease in IOP at 3 months was 11 ± 3.9 mmHg and mean decrease in number of medications was 2.45 ± 0.6. There was no significant difference in IOP reduction between GATT and half-GATT groups (P = 0.28), although mean decrease in number of medications was higher for the half-GATT group (P < 0.001). The incidence of hyphema at the one-week post-operative visit was 42% for the GATT patients and 9% for the half-GATT patients.

Discussion
A limited 180 degree trabeculotomy in combination with 180 degree viscodilation of Schlemm’s canal, or half-GATT, shows similar efficacy to circumferential 360 degree trabeculotomy as performed in the GATT procedure. Hyphema, the most common complication of these procedures, was lower in the group undergoing a limited trabeculotomy.

Conclusion
Further research including larger patient groups and longer follow-up is needed to confirm these findings. Additionally, further study may identify demographic and clinical factors that may predispose towards success with either procedure.

Reference
Pre-operative Predictors of Gonioscopy-Assisted Transluminal Trabeculotomy (GATT) Outcomes

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Purpose/Relevance
The purpose of this study was to assess the correlation between select preoperative characteristics and IOP-lowering efficacy after GATT.

Methods
A retrospective chart review of all patients who underwent GATT by 3 glaucoma specialists (MRM, MJP) at Wills Eye Hospital from 2014 to 2018 was performed. Patients with preoperative documentation of pre- and post-dilation intraocular pressure (IOP) and/or selective laser trabeculoplasty (SLT), and follow-up of at least 3 months after GATT.

Results
A total of 58 eyes of 51 patients were included in the study. The mean age was 60 ± 17 and 26 (45%) were female. There were 48 eyes (83%) with primary open-angle glaucoma, 3 eyes (5%) with pseudoexfoliation glaucoma, 3 eyes (5%) with pigmentary glaucoma, 2 eyes with uveitic glaucoma (3%), and 2 eyes with juvenile open-angle glaucoma (3%). The mean baseline intraocular pressure (IOP) was 25.6 ± 9.5 mmHg on 2.9 ± 1.1 glaucoma medications. The mean follow-up time was 13.6 ± 15 months. At final follow-up, the mean IOP was 20.6 ± 12.8 mmHg (P = 0.006) on 2.1 ± 0.7 glaucoma medications (P = 0.005). The mean increase in pre- and post-dilation IOP was 1.5 ± 2.9 mmHg. There was a moderate degree of positive correlation between baseline IOP (r = 0.39) and absolute decrease in IOP after SLT (r = 0.48) with absolute decrease in IOP at final follow-up after GATT. No correlation was observed between post-dilation IOP change (r = 0.04) and baseline number of drops (r = -0.12) with absolute IOP reduction after GATT. There was no significant correlation between use of blood thinners and GATT success (r = 0.23).

Discussion
Prior studies have identified preoperative visual field mean deviation and intraoperative fluid wave as predictors of a successful surgical outcome following GATT. Our study suggests prior response to SLT may predict short-term GATT outcomes.

Conclusion
Prospective studies evaluating the role of SLT and other treatments targeting the trabecular meshwork are needed.

References
40 Surgical Outcomes of XEN45 Gel Stent Placement with MMC for Treatment of Glaucoma at a Single Tertiary Medical Center

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Purpose/Relevance
To evaluate the clinical outcomes of XEN45 gel stent surgery on IOP, glaucoma medication use, and surgical complications for poorly controlled glaucoma.

Methods
A prospective, non-comparative trial of XEN45 implant surgery with MMC in 75 patients. Pre-operative IOP was compared to IOP at post-op month 3, 6, and 12. The number of glaucoma medications and visual acuity were also compared at those time points. Surgical success is defined as an IOP < 18mmHg and >20% reduction in IOP on the same or few number of glaucoma medications. The need for additional glaucoma surgery, loss of >2 lines of vision was considered a failure.

Results
Prior to XEN implant surgery, the study population had an average baseline IOP of 23.0 (±7.0). At post-op month 3 (55 patients were analyzed), the IOP decreased to an average of 15.9mmHg (±4.6), which is a decrease of 61% (P<0.001). At month 6 (45 patients were analyzed), the average IOP was 15.4mmHg (±4.5). At the end of the 12 month follow-up, data from 36 patients were available for analysis. There was a statistic significant decrease of 38.4% in IOP, to 14.1mmHg (±4.6) (P<0.001). The number of IOP-lower eye drops also decreased significantly by 12 months, from average of 3.2 (±1.2) to 1.5 (±1.4). The average number of glaucoma drops decreased from 3.2 to 1.5 (P=0.018). Post-op complications include exposed XEN/conjunctival defect (2 patients), choroidal detachment (1 patient) and blebitis (1 patient). Bleb needling rate is 22.7%. Notably, 27% of patients had prior failed glaucoma surgery (excluding laser trabecuoplasty) prior to XEN placement. Surgical success as defined in the study is 61%. There was no change in average visual acuity at 12 months.

Discussion
XEN gel implantation with MMC at a tertiary medical center resulted in significant decrease in IOP and number of glaucoma medication at 12 months, and no significant change in visual acuity. About one-third of patients had prior failure glaucoma surgery. The needling rate was similar to prior published studies.

Conclusion
Our study contributes to growing clinical outcomes data being collected on XEN implantation for glaucoma treatment. Larger volume of data will allow for more accurate assessment of long-term surgical outcomes, help recognize surgical complications and optimize surgical implantation technique and post-op management.

References
Safety and Short-term Efficacy Outcomes of Using the OMNI® Device in Eyes with Primary Open Angle Glaucoma Undergoing Cataract Extraction

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Purpose/Relevance
To evaluate intra-operative safety and early post-operative outcomes of the OMNI device for treatment of primary open angle glaucoma (POAG) in eyes undergoing cataract extraction (CE).

Methods
Retrospective chart review was performed to identify patients with POAG who underwent CE in combination with ab-interno visco-canalostomy and ab-interno trabeculotomy using the OMNI device and who had completed six months of follow-up. Outcome variables included intraocular pressure (IOP), anti-glaucoma medication use, and any adverse events. T-test was used for statistical significance.

Results
A total of 44 eyes from 34 patients were reviewed. The stage of POAG was mild in 39%, moderate in 27%, and severe in 34% of eyes. Most common ethnicity was African American (84%). Average pre-operative IOP was 17.2 ± 4.7 mmHg on 1.8 ± 1.1 medicines. Mean post-operative IOP was 13.2 ± 3.8 mmHg on 1.2 ± 1.2 medicines (P < 0.01) at the six-month follow-up visit. Three eyes (7%) required additional glaucoma surgery. Two eyes (5%) had >1 mm of transient hyphema post-operatively. There were no intra-operative adverse events related to the use of the OMNI device.

Discussion
Ab-interno trabeculotomy and ab-interno visco-canalostomy have been independently shown to be effective surgical procedures to treat glaucoma.1,2 Trabeculotomy reduces resistance to outflow at the trabecular level, while visco-canalostomy may help reduce resistance to outflow at the level of the collector channels.3 The OMNI device is a new tool in the evolving field of minimally invasive glaucoma surgery that is capable of performing both procedures sequentially using one device. This retrospective study demonstrated that the OMNI device was able to accomplish both procedures without any significant intra-operative adverse events. Both IOP and medication use were significantly lowered at post-operative months one, three, and six. The rate of hyphema postoperatively was significantly lower in this study (5%) compared to other studies, likely due to concomitant use of visco-canalostomy with trabeculotomy.

Conclusion
In combination with CE, the OMNI device was able to safely and effectively carry out ab-interno visco-canalostomy and ab-interno trabeculotomy, resulting in a statistically significant reduction in IOP and medication burden in eyes with POAG.

References
42  Outcomes of Ab Interno Placement Versus Ab Externo Transconjunctival Placement of Xen 45 Gel Stents

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Purpose/Relevance
The Xen 45 gel stent is a minimally invasive glaucoma surgery, traditionally implanted in an ab interno approach.1,2 The purpose of this study was to compare the outcomes of ab interno placement versus ab externo transconjunctival placement of Xen 45 gel stents in patients with open-angle glaucoma.

Methods
This is a retrospective comparative case series of Xen 45 stent placement performed at Walter Reed NMMC. Group 1 had traditional ab interno placement. Group 2 had ab externo transconjunctival placement. Primary outcome measures were intraocular pressure (IOP) and medication use. Secondary measures were bleb needling rates, surgical times, and time to return to baseline visual acuity.

Results
29 patients were in Group 1, with an average age of 68.9, and 40 patients were in Group 2, with an average age of 71.3. African Americans made up 76% and 60% of Group 1 and 2, respectively. Average visual field loss by mean deviation was -13 dB in Group 1 and -15 dB in Group 2. Group 1 had preoperative IOP 22.8 ± 7.6 on 3.8 ± 0.9 medications and at postoperative months 5-8 had IOP 12 ± 3.3 on 1.5 ± 1.2 medications. Group 2 had preoperative IOP 26.1 ± 10.7 on 3.8 ± 1 medications and at postoperative months 5-8 had IOP 12.3 ± 3.08 on 1.4 ± 1.2 medications. 41% of patients in Group 1 and 30% in Group 2 required bleb needling. The average surgical time was 37 minutes for Group 1 and 21 minutes for Group 2. Return to baseline visual acuity by postoperative day 1, week 1, week 2, and week 3 for Group 1 was: 26%, 63%, 70%, and 85%; for Group 2 it was: 49%, 86%, 91%, and 97%. 34.5% of patients in Group 1 and 35% in Group 2 had complications. Complications included: IOP elevation > 30 mmHg (7), hyphema (4), iris obstruction of stent (4), rebound iritis (3), wound leak (3), choroidal effusions (2), hypotony maculopathy (2), corneal decompensation (1), symptomatic bleb extension (1), cystoid macular edema (1), corneal abrasion (1).

Discussion
Ab externo transconjunctival approach has not previously been compared to the traditional ab interno approach for Xen 45 placement. This study demonstrates similar IOP lowering, medication use reduction, and complication rates between the 2 approaches. The ab externo group had lower bleb needling rates and faster surgical times and postoperative visual recovery.

Conclusion
Ab externo placement of Xen 45 stents is a non-inferior approach to the ab interno approach, with improved surgical times and faster postoperative recovery.

References
43 A Retrospective Outcome Analysis of XEN Gel Stent

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Purpose/Relevance

The utilization of XEN Gel Stents in the management of refractory open angle glaucoma has been shown to be effective in both IOP lowering and medication lowering1. However, there is not yet robust data on the outcomes of patients receiving this therapy with regard to their IOP, medication requirements, bleb needling and further incisional surgery requirements. While adding to this understanding, we sought to demonstrate the progression of the IOP and medication class requirements throughout the early post-operative period to improve understanding of how these metrics of surgical success respond throughout the first 6 months.

Methods

A retrospective review was conducted to identify adult patients with advanced and refractory open angle glaucoma who received a XEN Gel Stent in ab-interno approach with or without phacoemulsification. Patients were included if they had completed 6 months follow up with applanation tonometry measured at each visit (0-1 day, 1 week, 2-4 week, 2-4 month, 6 month). Patients were excluded if they had any other surgery at the time of the XEN Gel Stent placement other than with phacoemulsification. The primary outcome was mean IOP and medication reduction at 6 months, any complications, and need for additional procedure or surgery within the 6 month postoperative period. Surgical success was determined to be a 30% reduction in IOP without any additional IOP lowering procedure or medication, and no vision-threatening complication. Secondary outcome included the percentage of patients who achieved IOP of 15 mmHg or less, percentage of patients requiring minor IOP lowering procedures (any laser or minor bleb needling) or more invasive incisional surgery, including repeat XEN gel stent.

Results

A total of 22 patients met inclusion criteria. The mean baseline IOP was 27.1±6.6, on 3.3±1.4 number of medications. The mean preoperative mean deviation on Humphrey Visual Field was -10.8±7.9. Six cases were combined with cataract surgery. At 6 months postop, the mean IOP reduction was 40.2±22.1% (11.6±8.2 mm Hg, P<0.00001), and the mean reduction of glaucoma medication was 2.3±1.6 (P=0.0002). 54.5% (12/22 patients) achieved IOP of 15 or less, with 50.0% (11/22 patients) also on less medication, and 40.9% (9/22 patients) with complete medication elimination. Ten patients (45.5%) required bleb needling in the postoperative period, with five of these patients achieving target IOP off all medication. Three patients (13.6%) required Ahmed glaucoma valve at 6 months. None of the patients had complications.

Discussion

Patients with advanced open angle glaucoma who received a XEN Gel Stent obtained a significant reduction in IOP (mean 40.2±22.1%) and medication (mean 2.3±1.6 classes), with more than 54% patients achieving target IOP of 15 or less, and 41% of them getting off all medication. In-office needling procedure was frequently required (45.5%), but this was often successful (50%) and vision threatening complications or need for more invasive procedure was rare during the 6 months follow up period.

Conclusion

XEN Gel Stent is a safe and effective procedure in lowering IOP and need for medication in severe and refractory adult open angle glaucoma patients. Although needling rate was relatively high, most patients achieved target IOP off all medications, and need for more invasive glaucoma procedure or complications were rare within 6 months.

Reference

44 Observational Case Series Evaluating Outcomes of a Single Surgeon's First 100 Cases of the Xen45 Gel Stent Implanted via an Ab-Interno or Ab-Externo Approach for the Management of Open Angle Glaucoma

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Purpose/Relevance
This case series aims to evaluate the outcomes of a single surgeon’s experiences with the Xen45 gel stent (Allergan, Inc., Irvine, CA) with concomitant use of mitomycin C and evaluate outcomes when implanted via an ab-interno (Xen) or a transconjunctival ab-externo approach (Xen-Ex).

Methods
Retrospective analysis of a consecutive case series of eyes undergoing filtration surgery using the Xen45 gel implant as a stand-alone procedure for the management of uncontrolled open angle glaucoma. All patients received concomitant mitomycin C at the time of surgery. Post-operative management included use of adjunctive 5-fluorouracil injections with or without bleb needling revisions. Primary end-points of the study include mean reduction in intraocular pressure (IOP) from baseline as well as reduction in medication burden. Secondary end-points included those with IOP < 18 mmHg and > 20% reduction from baseline and IOP < 15 mmHg and > 20% reduction from baseline. Complete success was recorded when secondary end-points were met without the need for topical anti-glaucoma therapy, qualified success was recorded when the same or fewer medications from baseline were needed to meet IOP target, and failure was indicated if surgery did not achieve desired IOP range with the same number of IOP medications. Up to 12-month results were tabulated for the ab-interno approach and up to 6-month results for the newly adopted ab-externo approach.

Results
Demographically, a preponderance of patients were Hispanic. Mean pre-operative IOP for the Xen subgroup and Xen-Ex subgroup were 23.83 ± 7.9 and 24.54 ± 7.3, respectively. Mean pre-operative medications: 3.32 ± 0.79 and 3.4 ± 0.79, respectively. At 3 months, mean IOP reduced in each subgroup to 13.95 ± 4.66 (35% reduction) ($P = 0.001$) for the Xen group and to 13.1 ± 3.9 (31% reduction) ($P = 0.001$) for the Xen-Ex group. Medication burden also reduced to 0.95 ± 1.26 and 0.23 ± 0.8, respectively. At 6 months, mean IOPs were 14.46 ± 5.27 (Xen) and 12.0 ± 5.1 (Xen-Ex) with an average medication use of 1.0 ± 1.0 and 1.25 ± 1.0, respectively. Needling rates at 6 months were 52% for the Xen group and 30% for the Xen-Ex group.

Secondary end-points at 6 months were as follows for complete/qualified success and failure: For the Xen group, IOP < 18 and > 20% reduction from baseline: complete success = 43%, qualified success = 36%, failure = 21%. IOP < 15 and > 20% reduction from baseline: complete success = 42%, qualified success = 29%, failure = 29%. For the Xen-Ex group, IOP < 18 and > 20% reduction from baseline: complete success = 83%, qualified success = 9%, failure = 8%. IOP < 15 and > 20% reduction from baseline: complete success = 71%, qualified success = 9, failure = 20%.

Discussion
We have seen an evolution in how we have utilized the Xen45 gel stent over the last few years. Our understanding of how to most effectively implant the device and manage blebs post-operatively is continuously growing. This an early assessment of our newer technique of introducing the Xen45 gel stent (Xen-Ex) through a transconjunctival technique as opposed to transcending the injector through the anterior chamber and delivering the stent into the subconjunctival space via an “ab-interno” approach. Delivering the device via an ab-interno approach has some limitations in that it requires a clear cornea and suitable, healthy conjunctiva in the superior to superior nasal quadrant. With the ab-externo approach, delivery of the device can be performed in additional areas of the globe, including the superior and superior temporal regions. To our knowledge, this will be one of the first studies describing post-operative outcomes of the ab-externo delivery of the Xen, which are compared to the ab-interno approach.

Conclusion
In this case series comprised of primarily a Hispanic population with OAG, patients receiving the Xen45 gel stent achieved a clinically and statistically significant reduction in both mean IOP and medication burden. Success rates appear relatively equal in both groups, with a slightly higher needling rate for the ab-interno group. Of importance, the author has performed several hundred additional Xen cases in between the first 50 ab-interno Xen subjects and his first 50 ab-externo subjects, which has provided an opportunity to understand how to manage the blebs in a more proactive fashion, which may have led to a decreased need for needling in the ab-externo group.

Reference
45 Second-Generation Trabecular Micro-Bypass Stents (iStent Inject®) with Cataract Surgery in Open-Angle Glaucoma: Single-Surgeon Outcomes

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Purpose/Relevance
To evaluate second-generation trabecular micro-bypass stents (iStent Inject®) combined with cataract surgery in eyes with open-angle glaucoma (OAG) in a predominantly Hispanic patient population. Such data are especially valuable given iStent inject’s fairly recent introduction in the U.S. and the relative paucity of data in this demographic group.

Methods
Retrospective case series of iStent inject implantation with phacoemulsification cataract surgery at a private ophthalmology center in El Paso, Texas. Efficacy measures consisted of mean intraocular pressure (IOP), mean number of medications (meds), and proportional analyses of IOP and med burden. Safety outcomes included visual acuity, visual fields, retinal nerve fiber layer thickness, and adverse events and complications. A larger cohort with longer-term outcomes will be available by the time of the conference, as follow-up is ongoing.

Results
This series included 56 eyes with predominantly primary open-angle glaucoma (POAG, 98%) and Hispanic ethnicity (66%); 39 eyes had 3- and 6-month data. Preoperatively, mean IOP was 16.8 mmHg on 1.71 mean meds (range 0-4 meds). Postoperatively, mean IOP reduced to 13.3 mmHg at 3 months (20.8% reduction; P = 0.0004) and 12.7 mmHg at 6 months (24.4% reduction; P < 0.0001); mean med burden reduced to 0.26 meds at 3 months (84.8% reduction; P < 0.0001) and 0.18 meds at 6 months (89.5% reduction; P < 0.0001). At 6 months postoperatively, 89.7% of eyes were med-free (vs. 17.9% preoperatively), and 87.2% of eyes had IOP ≤ 15 mmHg (vs. 35.7% preoperatively). Safety was favorable throughout.

Discussion
This real-world iStent inject dataset showed substantial IOP and med reductions through 6 months postoperatively in a predominantly Hispanic patient population with POAG. This efficacy was accompanied by favorable safety.

Conclusion
The combination of meaningful IOP and med reductions and favorable safety corroborates the promising benefit-risk profile seen in the existing literature for iStent inject.

Reference
A Retrospective Study of Cataract Surgery Combined with Ab-Interno Canaloplasty Using the iTrack Catheter and a Hydrus Microstent in Patients with Primary Open Angle Glaucoma

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1 El Paso Eye Surgeons

Purpose/Relevance
To examine the efficacy of combining 360-degree viscodilation of Schlemm’s canal using the iTrackTM catheter (ABiCTM, Ellex) with a Hydrus microstent (Ivantis) at the time of cataract surgery (CE).

Methods
A retrospective, two-surgeon study of patients with a diagnosis of primary open angle glaucoma (POAG) with a preoperative intraocular pressure (IOP) of ≥16 mmHg on 0-4 IOP-lowering meds with at least 3 months follow-up. 22 patients underwent CE with concomitant ABiC and a Hydrus microstent (CE/ABiC/Hydrus). 10 patients underwent cataract surgery with a Hydrus microstent alone (CE/Hydrus). Preoperative and postoperative exam, IOP, visual fields, OCT, meds, complications, and interventions were evaluated and compared between the two groups.

Results
The CE/ABiC/Hydrus group had a mean preoperative IOP of 20.1 ± 3.7 on a mean of 2.0 ± 1.4 IOP meds with a 3-month postoperative decrease in IOP to 13.7 ± 3.3 (P < 0.001) with meds decreasing to 0.4 ± 0.8 (P = 0.001) . The CE/Hydrus group had a mean preoperative IOP of 18.3 ± 2.5 mmHg on a mean of 0.8 ± 1.0 medications with IOP decreasing to 15.1 ± 3.4 (P = 0.08) with meds decreasing to 0.2 ± 0.4 (P = 0.08). The CE/ABiC/Hydrus group had a greater percentage decrease in mean IOP than the CE/Hydrus group (31.8% vs. 15.1%, P = 0.05). A low complication rate was observed in both groups.

Discussion
Existing evidence suggests that either cataract surgery combined with ABiC or a Hydrus microstent alone is an effective procedure in leading to improved postoperative IOP,1,2 but no study has looked at concomitant use of both procedures at the time of CE. When comparing both groups, the CE/ABiC/Hydrus group had more advanced glaucoma (c/d = 0.7 vs. 0.5, P = 0.02) and a higher preoperative medication burden, yet achieved a greater IOP-lowering effect, with 81% of patients off medications.

Conclusion
In patients with controlled and uncontrolled POAG, concomitant ABiC and Hydrus with CE is safe and effective at reducing IOP and medication burden, with a larger decrease in IOP than CE and Hydrus alone.

References
Traditional Surgery, Sustained Delivery, New Drugs, IOP Evaluation

47 Uveitic Glaucoma: A 10-Year Retrospective and Risk Factors for Requiring Filtering Surgery

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Purpose/Relevance
To describe the demographic and clinical characteristics of uveitic glaucoma (UG) and to identify risk factors for requiring filtering surgery.

Methods
Retrospective cohort. The medical records of all patients with uveitis who developed secondary glaucoma over a 10-year period (July 2009 to July 2019) were reviewed. Demographic, clinical data, and outcomes, as well as detailed ophthalmological history, were collected. Regression analysis and chi-squared tests were performed to identify risk factors for requiring filtering surgery.

Results
A total of 324 patients (373 eyes) were included, 56.5% (n = 183) of patients were female. Patient age ranged from 3 to 95 years, mean patient age was 50 (±19.67). Eighty-five percent of patients presented unilateral UG (47.2% OD, 37.7% OS), 15% presented bilateral disease. Anterior uveitis was the most frequent form of anatomical presentation, with 70.8% (n = 264), followed by panuveitis (18.2%), intermediate uveitis (9.4%), and posterior uveitis (1.6%). Regarding angle status, 63.4% (n = 236) eyes presented with open angle. BCVA at UG diagnosis was 20/300 or worse in 163 eyes (43.58%), 20/50-20/250 in 148 (39.57%), better than 20/40 in 62 (16.58%). BCVA at final follow-up visit was 20/50-20/250 in 214 (57.22%), 20/40 or better in 116 (31.02%), and 40 (10.7%) with 20/300 or worse. In the final follow-up, 283 eyes (75.67%) had a BCVA improvement over time, 82 (21.93%) had a decrease in BCVA, and 8 (2.1%) remained unchanged. At presentation, 75% of eyes presented with an IOP of 21 mmHg or higher, with a mean of 29.61 mmHg (±10.98) and a highest IOP recorded of 65 mmHg. At final follow-up, 77.27% of eyes had an IOP of <21 mmHg with medications, and 17.38% had a final IOP of <21 mmHg without treatment; 3.74% of eyes had a final IOP of >21 mmHg. In the final recorded visit, 36.1% of eyes required 3 or more medications. 69.52% (n = 260) eyes required filtering surgery for IOP control, 60.43% (n = 226) had an implantation of a glaucoma drainage device (GDD), 9.09% (n = 34) underwent a trabeculectomy; 5.88% (n = 22) required a second surgery (revision, GDD, trabeculectomy, GDD exchange) for adequate control. Requiring filtering surgery was associated with eyes previous surgeries (odds ratio [OR] = 2.91; P < 0.0001), older than 19 years old (OR = 4.66; P < 0.002), and in eyes that developed moderate and severe visual field loss (OR = 4.41; P < 0.005).

Steroid response, number of hypotension agents used, lens status (phakic, pseudophakic, aphakic), gender, laterality of disease, and anatomic diagnosis of uveitis did not show a significant risk for requiring filtering surgery.

Discussion
UG presented with high IOPs, and the majority of eyes required filtering surgery for IOP control. Previous surgery, age older than 19, and moderate to severe stage glaucoma were factors significantly related to requiring surgery; all of these are non-modifiable factors. Only 5.88% of eyes required a second surgery for optimization of IOP control. Visual acuity loss was not related to the presence of glaucoma, and a high percentage of eyes with UG presented an improvement in vision over time, related to antiinflammatory treatment.

Conclusion
UG in a Hispanic population had not been previously studied (to our knowledge). Some epidemiological characteristics vary in what has been previously described regarding UG in other populations. The risk factors we found to be related to requiring filtering surgery are non-modifiable.

References
48 Incidence of Corneal Transplant Graft Failure with Glaucoma Drainage Device Placed in the Anterior Chamber compared to the Ciliary Sulcus

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Purpose/Relevance
To determine whether rates of corneal transplant graft failure differ between glaucoma drainage devices (GDD) placed in the anterior chamber (AC) versus ciliary sulcus (CS).

Methods
Retrospective chart review of 47 eyes of 46 patients with history of both corneal transplant, either penetrating keratoplasty (PKP) or Descemet-stripping automatic endothelial keratoplasty (DSAEK), and GDD implantation followed at the University of Colorado between January 1, 2014, and August 1, 2019. The main outcome was incidence of graft failure, defined as need for repeat grafting procedure or evidence of clinical graft failure determined by a corneal specialist. Exclusion criteria included less than 2 months documented follow-up from either GDD or corneal transplantation and pars plana placement of GDD. Fischer’s exact testing was used to compare incidence of graft failure between GDDs placed in the AC versus CS.

Results
39 eyes of 38 patients with history of either PKP or DSAEK who underwent placement of a GDD in the AC (n = 27) or CS (n = 12) were included. Demographic data were similar between groups, though there were more females in the CS group (67% vs. 44%) and wider age range in the AC group (2-87 years) vs. the CS group (12-82 years). Mean follow-up time from GDD was 34.3 months and 15.5 months in the AC and CS groups, respectively. The majority of GDDs placed in each group were Ahmed Glaucoma Valves (n = 22 AC, n = 10 CS). Incidence of graft failure was 37% in the AC group and 16.7% in the CS group (P = 0.28).

Discussion
Prior studies have demonstrated a higher rate of graft failure in eyes with GDDs.1-3 Incidence of PKP graft failure has been quoted between 30% and 70% failure at 18 months to 2 years.1,2 DSAEK grafts are also known to have a higher rate of graft dislocation and failure in eyes with previous glaucoma surgery, with 37% failure in one study at 3 years.1,3 Surgeons may naturally opt to place a GDD in the sulcus or pars plana to ensure the tube is further away from the corneal endothelium. However, studies have not analyzed whether there is a measurable difference in rates of graft failure between AC and CS tube placement, and conclusions have been limited by small sample sizes. This study found that CS GDDs had half the incidence of graft failure compared to AC GDDs, but this difference was not significant given the small population size in our study.

Conclusion
In patients with corneal transplants, GDDs placed in the CS are associated with less graft failure but this difference did not reach statistical significance.

References
**Purpose/Relevance**
To describe surgeons’ early experience implanting a new valveless glaucoma drainage device (Ahmed ClearPath; New World Medical, Rancho Cucamonga, CA). The device features a flexible, contoured plate and anteriorly placed suture fixation points to facilitate attachment to sclera.

**Methods**
Surgeons using the device completed a survey for each device implanted (mean 3 cases per surgeon). Data collected included prior surgical experience with valveless drainage implantation, device implanted (250 or 350 mm²), and assessment of various performance metrics relative to prior experience with other valveless devices using a 5-point Likert scale (poor-worse-equivalent-better-excellent).

**Results**
Data from 66 procedures by 22 surgeons with a mean of 15.5 years’ experience implanting Baerveldt devices were analyzed. Overall, 29 250 mm² devices were implanted by 17 surgeons and 37 350 mm² devices were implanted by 17 surgeons. Across all metrics for both devices, 92-100% of responses were equivalent, better, or excellent. Compared to prior valveless device implantation, ease of fixing the device to sclera using suture holes was better or excellent in 100% (250) and 94% (350) of cases; device conformation to curvature of the globe was better or excellent in 96% (250) and 64% (350) of cases; and overall ease of use was better or excellent in 96% (250) and 82% (350) of cases. Operative time was equivalent or better in 100% (250; mean 36 minutes) and 92% (350; mean 32 minutes) of cases, and the overall intraoperative experience was better or excellent in 97% (250) and 78% (350) of cases.

**Discussion**
The device incorporates design elements specifically intended to overcome issues with existing devices (resulting in more flexible plate, anterior suture fixation points, true single quadrant design for the 250). Surgeons consistently found the new device easier to use than Baerveldt implants, resulting in shorter operative times. Both device sizes scored better or excellent ratings in the majority of cases on every metric assessed.

**Conclusion**
Early experience with the new valveless drainage is very positive. The design of this device facilitates its implantation with greater convenience, improved surgeon experience, and shorter operative times than Baerveldt implantation.

**Reference**
50 Factors Associated with Trabeculectomy Failure Following Phacoemulsification

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**Purpose/Relevance**
To investigate the long-term effects of phacoemulsification surgery on intraocular pressure (IOP) and glaucoma medication use in eyes with a functioning trabeculectomy, and to identify factors associated with subsequent bleb failure.

**Methods**
34 eyes of patients who underwent phacoemulsification surgery after a successful trabeculectomy have been included in this retrospective study. IOP pre and post phaco, preoperative topical steroid supplementation, intraoperative CDE (cumulative dissipated energy), and number of supplemental glaucoma medicines needed pre and post phaco were analyzed using standard statistical comparison tests. Eyes with IOP > 21 mmHg after the first month, a rise in IOP of > 25% from preoperative levels, or an increase in medication requirement of 2 or more medications, or needing further surgery, were classified as having failed blebs. All others were considered as having surviving blebs.

**Results**
For the whole sample, mean IOP levels were 20.64 mmHg (±6.24) before initial trabeculectomy, 10.44 mmHg (±4.35) before phaco, 11.97 mmHg (±5.80) one day after phaco, 13.48 mmHg (±4.78) one month after phaco, 11.65 mmHg (±4.67) 3 months after phaco, 2.26 (±3.96) 6 months after phaco, 13.11 mmHg (±4.87) 12 months after phaco, and 12.50 mmHg (±4.46) 24 months after phaco. There was a significant difference in failure rates between eyes with an IOP less than 10 mmHg before phacoemulsification and eyes with an IOP level greater than 10 mmHg (P = 0.0032). Postop IOP on day one was significantly higher in the eyes that went on to bleb failure (16.27 vs. 9.82 mmHg, P < 0.02). 11 eyes were classified as having trabeculectomy failure post-phacoemulsification. There was no significant effect of the time between trabeculectomy and phacoemulsification and the amount of the preoperative steroid medication on bleb failure. For the 11 eyes with blebs classified as failures post-phacoemulsification, the IOP levels were 13.00 mmHg (±3.85) before phaco, 26.50 mmHg (±2.12) on postop day one, 22.33 mmHg (±5.51) at one month postop, and 18.6 mmHg (±3.54) at one year postop. These values are all significantly different (P-value < 0.05) compared to patients with surviving blebs. However, mean intraoperative CDE for patients with failed blebs was 19.81 (±6.61), and for those with surviving blebs CDE it was 13.90 (±8.19), P = 0.04 for the difference.

**Discussion**
Approximately one in three functioning filtering blebs failed following phacoemulsification surgery. An IOP spike on postop day one may predict bleb failure, as does a higher preoperative IOP. Preoperative use of topical steroids did not confer a benefit. A higher CDE value, indicating greater ultrasound use during surgery, was noted in the blebs that failed, suggesting that phacoemulsification itself could induce bleb scarring.

**Conclusion**
Surgeons performing cataract surgery on patients with filtering blebs should be aware of the significant risk of bleb failure associated with the procedure.

**Reference**
Long-term Outcomes of Primary Trabeculectomy Versus Combined Phacoemulsification-Trabeculectomy Using Automated Electronic Health Record Data Extraction

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Stanford University

Purpose/Relevance
Trabeculectomy remains a gold-standard surgery for intraocular pressure (IOP) control in medication-resistant glaucoma. Cataract progression is a well-known side-effect of trabeculectomy in phakic eyes. Combining trabeculectomy with cataract extraction is an option, but it is unclear if outcomes are comparable to trabeculectomy alone. We sought to compare the efficacy of long-term IOP lowering between trabeculectomy (TE) and combined phacoemulsification-trabeculectomy (PTE) and to investigate factors, including demographics and glaucoma type, that may impact long-term outcomes.

Methods
This was a retrospective observational study of primary trabeculectomy procedures performed at a tertiary care academic medical center between 2010 and 2017 using electronic health records. We used Kaplan-Meier analysis to investigate time to trabeculectomy failure (see figure) and Cox proportional hazards modeling to investigate predictors of trabeculectomy failure, defined as undergoing a second glaucoma surgery in the operative eye or using a greater number of IOP-lowering medications than at pre-operative baseline at 6 months postoperatively or beyond.

Results
324 surgeries (222 TE; 102 PTE) from 274 patients were included in the analysis. Median follow-up time was 753 (IQR 232-1654) days. Mean baseline IOP was 21.2 (SD 8.29) mmHg, and 228 (70.2%) eyes were on 3 or more IOP-lowering medications prior to surgery. There were no significant differences in IOP between TE vs. PTE groups beyond postoperative year 1, with 28.9%-46.5% of TE and 35.5%-44.4% of PTE groups achieving IOP ≤10. The final IOP was similar in both groups (P = 0.24): 12.02 (SD 6.70) mmHg in the TE group and 11.1 (SD 5.44) in the PTE group. A total of 84 (25.9%) surgeries met failure criteria over the follow-up period. After adjusting for surgery type, sex, age, race, and glaucoma diagnosis, there were no significant differences in trabeculectomy failure except for female sex, which was associated with a significantly lower risk of trabeculectomy failure (P = 0.042, HR 0.56, 95% CI, 0.33-0.98).

Discussion
We found no significant difference in the risk of trabeculectomy failure in patients receiving primary trabeculectomy versus those receiving phacoemulsification combined with primary trabeculectomy.

Conclusion
Outcomes of combined phacoemulsification and trabeculectomy are comparable to trabeculectomy for patients with medication-resistant glaucoma.
Figure 1: Kaplan-Meier for composite outcome of receiving greater number of glaucoma medications compared to pre-operative baseline or undergoing a second laser or surgical glaucoma procedure. Log-Rank test to compare eyes that underwent primary trabeculectomy (Trab) compared to those that underwent combined phacoemulsification and trabeculectomy (Phaco-Trab) did not show a significant difference in chance of survival ($p = 0.17$).

References


The Relationship of Patient Distance to Postoperative Care on Follow-up Attrition and Glaucoma Surgery Outcomes

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Purpose/Relevance
Surgical interventions for glaucoma such as trabeculectomy and tube shunts require frequent follow-up and monitoring to assess for function, treatment evolution, and complications. The American Academy of Ophthalmology1 recommends strict follow-up adherence to maximize outcomes but does not provide recommendations considering procedure type, follow-up requirements, patients' proximity, and associated risk for attrition.

Methods
Setting: Tertiary referral academic center. Study Population: Patients with glaucoma over age 18 with trabeculectomies or drainage device implantations between April 4, 2014, and December 31, 2018. Observation Procedure: ICD codes identified specific diagnoses of glaucoma. CPT codes identified patients who had initial and corrective procedures. Straight-line distances from patients' residences to the Kittner Eye Center created radii of incidence of postoperative outcomes defined by: corrective procedures, postoperative IOPs, visual fields, and acuity. Residence to interstate access distance evaluated rurality. Canceled/no-show appointments were noted and means compared by two-tailed Student's t-test.

Results
203 patients met inclusion criteria. 6 months postoperatively, patients residing ≥50.5 miles from Kittner Eye Center had significantly more cancellations (t(143) = 3.39, P < .001, MD = 1.050, P < .001, 95% confidence interval [CI] 0.44 to 1.66), loss to follow-up (t(143) = 2.78, P < .01, MD = 23%, P < .01, CI 0.071 to 0.389) and worsened visual field outcomes (t(143) = 2.14, P < .05, MD = 0.20, P < .05, CI 0.021 to 0.380) than patients ≤25 miles from clinic. Significantly more patients that were lost to follow-up lived >20 miles from interstate access (n = 44) compared to those ≤10 miles away (n = 110) (P < .000).

Discussion
The results suggest patients living ≥50.5 miles from clinic or >20 miles from interstate access have increased follow-up cancellation rates and worse postoperative visual field outcomes. We speculate that the association between successful follow-up and postoperative outcomes is greater in the setting of procedures that require close monitoring and frequent intervention such as trabeculectomy.

Conclusion
The results suggest glaucoma specialists should note patients' proximity to follow-up care when deciding a surgical treatment intervention. Further studies can explore specific factors contributing to follow-up attrition, scheduling, and telemedicine or educational strategies to improve retention.

Reference
Direct Cyclopexy for Post-traumatic Cyclodialysis: Clinical Characteristics and Outcomes

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Purpose/Relevance
To describe the demographic and clinical characteristics and clinical outcomes of patients with cyclodialysis-associated clinical hypotony, who were treated with direct cyclopexy (DC) at a third-level glaucoma clinic.

Methods
Retrospective cohort. We analyzed the clinical records of all patients with the diagnosis of cyclodialysis cleft over a 5-year period, who were treated with DC. We recorded the main demographic characteristics, clinical characteristics, medical treatment outcomes, and surgical outcome in those cases who required it. To compare presurgical and postsurgical results we used a t-paired test. Correlations were assessed with Spearman and Wilcoxon tests.

Results
A total of 23 patients (23 eyes) were included, 91.3% of which were men. The mean patient age at diagnosis was 43.88 (±15.29) years. All patients included were treated with DC. The mean cyclodialysis cleft extent was 4.54 ± 3.68 meridians measured clinically and 5.37 ± 3.36 meridians measured by UBM. The mean number of direct surgical cyclopexies needed to achieve success were 2. Mean IOP at baseline and last postsurgical visit were 4.33 ± 2.27 mmHg and 8.25 ± 5.88, respectively (P=0.003). There was a statistically significant improvement in the mean visual acuity (VA) after surgical reparation of cyclodialysis clefts (P=0.001). The extension of the cyclodialysis cleft had moderate correlation with the presurgical (r=0.39, P=0.061) and post surgical IOP (r=0.43, P=0.04). We didn’t find a statistically significant association between the extent of the cleft and time of cyclodialysis presentation to surgical repair with the final VA.

Discussion
We found DC to be a very effective surgical procedure for the treatment of clefts that fail to respond to medical treatment, with approximately half of them being adequately repaired with one procedure. Even though we believe the use of trans-surgical UBM might increase the success rate of direct cyclopexy, as many of the failed procedures were associated with incomplete closure of the cleft. We also found a trend towards a more exact extension delimitation of the cleft with UBM than with conventional gonioscopy.

Conclusion
DC offers great results for the treatment of cyclodialysis clefts. A correct delimitation of the extent of the cleft is vital to create a good surgical plan and avoid several reinterventions. The routine use of UBM might help in this scenario. Interestingly, we found no association between the extent of de cyclodialysis cleft and the time of presentation with the final VA.

Reference
54 Ahmed versus Baerveldt Glaucoma Drainage Device in Uveitic Glaucoma

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Purpose/Relevance
To compare the efficacy and safety of Ahmed and Baerveldt glaucoma drainage devices (GDD) in uveitic glaucoma.

Methods
This retrospective comparative study was conducted on uveitic glaucoma patients (≥14 years old) who underwent Ahmed or Baerveldt GDD implantation from October 2006 to December 2018 with a minimum follow-up of 3 months. Success was defined as IOP ≥6 mmHg and ≤21 mmHg with (qualified success) or without (complete success) glaucoma medications, and without further glaucoma surgery or visual loss to NLP.

Results
A total of 137 eyes of 122 patients (67 in the Ahmed group and 70 in the Baerveldt group) were included. The mean baseline IOP, number of medications, visual acuity, and other demographic factors were comparable in both groups. The mean follow-up was 29.6 ± 3.6 months in the Ahmed group and 33.1 ± 3.8 months in the Baerveldt group. The baseline IOP and number of medications were 32.7±10.3 mmHg with 4.1 ± 1.3 medications and 32.1 ± 10.2 mmHg with 4.3 ± 1.3 medications in the Ahmed and Baerveldt groups, respectively. The IOP at last follow-up was 18.1 ± 9.8 mmHg with 2.1 ± 1.1 medications in Ahmed group and 12.7 ± 6.9 with 1.2 ± 1.2 medications in Baerveldt group. Ahmed group had less IOP reduction (44.5% vs. 60.3%), fewer complete successes (10.4% vs. 28.6%), and a higher failure rate (34.3% vs. 20%) compared to the Baerveldt group (P < 0.05). More complications (Figure 1) occurred in the Baerveldt group compared to the Ahmed group (44.3% vs. 20.9%, P = 0.013).

Discussion
The results of our study are in line with the pooled analysis of Ahmed Baerveldt Comparison Study and the Ahmed Versus Baerveldt Study on various types of glaucoma (9% of all participants had uveitic glaucoma). The Baerveldt group had a lower mean IOP and number of medications with higher success rate, but carried a higher risk of hypotony.1

Conclusion
A significantly greater reduction in mean IOP and number of medications, and a lower failure rate were observed in the Baerveldt group. The most common cause of failure was IOP elevation requiring further glaucoma surgery in the Ahmed group and hypotony in the Baerveldt group.

Reference

Figure 1: Kaplan-Meier survival curve (A) and list of complications for Ahmed and Baerveldt valves in uveitic glaucoma (B, p=0.013).
Progression to No Light Perception Vision Is Equally Likely with Valved and Non-valved Tube Shunts in Neovascular Glaucoma

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Purpose/Relevance
Neovascular glaucoma (NVG) can be associated with devastating visual outcomes, even when treated. The present study aims to determine the likelihood of visual changes after tube shunt surgery for NVG.

Methods
Retrospective review of consecutive patients at a single center. Inclusion criteria included implantation of Ahmed glaucoma valve (AGV) or Baerveldt glaucoma implant (BGI) for NVG, ≥6 months of follow-up, and age ≥18 years. Surgical failure was defined as IOP >21 mmHg at 6 months postoperatively, without a detectable difference between AGV and BGI groups. 7.5% of all eyes were NLP at 6 months postoperatively, and this increased to 19% at the final visit. AGV and BGI progressed to NLP equally (17% of AGV, 23% of BGI eyes; \( P = 0.439 \)) (B, Figure). NLP progression was associated with lower preoperative visual acuity (\( P = 0.047 \)), but not higher preoperative or final visit IOP. Etiology of NVG did not have a bearing on whether the NLP endpoint was reached.

Discussion
Tube shunt surgery can preserve vision in NVG; however, within 6 months of surgery, a significant proportion of eyes (7.5%) progress to NLP vision. Meeting this endpoint was more likely in eyes with worse preoperative VA, but not higher preoperative or final visit IOP, suggesting poor baseline VA and possibly a non-glaucomatous etiology for visual decline. Our study did not detect a difference between AGV and BGI groups in progression to NLP. This is in contrast to the Ahmed Baerveldt Comparison Study, which reported greater decline to NLP vision with the use of non-valved tubes at the five-year follow-up period. Limitations of the present report include its retrospective nature, lack of randomization, and limited follow-up duration.

Conclusion
Poor preoperative VA is associated with worse VA outcomes in NVG, despite surgical intervention. AGV and BGI are reasonable options for the treatment of NVG refractory to medical therapy.
Table 1

<table>
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<th>Ahmed Patients (n=64)</th>
<th>Baerveldt Patients (n=30)</th>
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<td>35.1 (30)</td>
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<td>(months)</td>
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</tr>
<tr>
<td>% Women</td>
<td>33 (32%)</td>
<td>22 (32%)</td>
<td>11 (32%)</td>
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<tr>
<td>Total Eyes (n=103)</td>
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<tr>
<td>Progression to NLP by</td>
<td>20 (19%)</td>
<td>12 (17%)</td>
<td>8 (23%)</td>
<td>0.439</td>
</tr>
<tr>
<td>Final Visit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical Failure at 6</td>
<td>25 (24%)</td>
<td>15 (22%)</td>
<td>10 (29%)</td>
<td>0.466</td>
</tr>
<tr>
<td>months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Eyes (n=103)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative VA (logMAR)</td>
<td>1.99 (0.9)</td>
<td>1.92 (1)</td>
<td>2.32 (0.8)</td>
<td>0.047</td>
</tr>
<tr>
<td>Preoperative IOP (mmHg)</td>
<td>40.8 (12)</td>
<td>40.0 (12)</td>
<td>43.8 (13)</td>
<td>0.213</td>
</tr>
<tr>
<td>Final VA (logMAR)</td>
<td>2.12 (1)</td>
<td>1.90 (1)</td>
<td>2.90 (0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Final IOP (mmHg)</td>
<td>17.1 (9)</td>
<td>16.4 (5)</td>
<td>19.9 (16)</td>
<td>0.13</td>
</tr>
</tbody>
</table>

A. **Baseline and follow-up characteristics.** All values are represented as mean (standard deviation) or mean (percent). VA = visual acuity. LogMAR = log of minimum angle of resolution. IOP = intraocular pressure. NLP = no light perception. NVG = neovascular glaucoma.

B. **Progression to NLP vision after tube shunt surgery for NVG.** Kaplan-Meier survival curve of cumulative surgical failure due to progression to no light perception vision by treatment group. Analysis has been censored for loss to follow-up. VA = visual acuity. NLP = no light perception.

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**Reference**

56 Surgical Outcomes Assessment of Glaucoma Tube Shunt Implantation: An Electronic Health Records Analysis

XINXING GUO¹, Bowen Li, Kerry Smith, David Friedman, Michael Boland
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Purpose/Relevance
To evaluate the surgical outcomes of tube shunt implantation using electronic health record (EHR) data.

Methods
In this retrospective analysis, demographics and clinical data were extracted from the EHR system for glaucoma patients who underwent tube shunt implantation between January 2016 and October 2018. The first eye that underwent tube shunt implantation was included for each patient. Main outcome measures included intraocular pressure (IOP), best documented visual acuity (VA), and numbers of clinic visits for the first 3 months postoperatively. Regression analyses were used to assess the factors associated with number of clinic visits and vision loss. Risk of hypotony, defined as IOP ≤5 mmHg at any postoperative visit, was assessed using survival analysis.

Results
The analysis included 628 tube shunt surgeries from 584 patients. Mean age was 64 ± 15 years, 48% were female, 44% were Caucasian, and 42% were African American. Open-angle glaucoma was diagnosed in 55% of patients. Pre-operative IOP was 24.5 ± 11.0 mmHg, with the target IOP of 15.9 ± 3.8 mmHg. Mean VA was 0.4 ± 0.34 logMAR (Snellen equivalent 20/50). At the 3-month follow-up, IOP was reduced to 15.7 ± 6.2 mmHg; 18% and 30% patients experienced hypotony and vision loss, respectively. Patients on average had 6 ± 4 clinic visits in the first 3 months, and 4% of cases needed additional surgical procedures. African American race was significantly associated with an increased number of clinic visits (β = 0.83, 95% CI: 0.12-1.54), but not higher odds of vision loss (OR = 1.14, 95% CI: 0.65-2.01) or higher hazard ratio of developing hypotony (HR = 0.96, 95% CI: 0.67-1.39).

Discussion
The IOP-lowering effect and the hypotony rate of the initial 3 months were comparable to previous studies. Refraction was not routinely performed by 3 months, and best corrected VA may not be captured. Patients who experienced vision deterioration could be more likely to follow up. On average patients had 6 clinic visits, but the number varied by surgeon. Data extracted from EHR can be powerful in evaluating clinical outcomes and physician practice patterns, but improved standardization and data quality are required.

Conclusion
While additional surgeries are rare, a significant proportion of patients undergoing tube shunt implantation lost vision over the initial 3 months. African American patients have more post-operative clinic visits but are not more likely to develop hypotony. Clinical data extracted from EHR is useful in monitoring clinical outcomes.

References
Poster Abstracts – Traditional Surgery

57 Safety and Efficacy Outcomes of Modern Trabeculectomy with Low-Dose Injected Mitomycin C with Planned Laser Suture Lysis

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Purpose/Relevance
To describe the outcomes of trabeculectomy utilizing advanced techniques.

Methods
A retrospective, single-site, multi-surgeon review of consecutive patients over 45 years old undergoing topical fornix-based trabeculectomy with low-dose (20-40 ug) injected mitomycin C with planned laser suture lysis.

Results
Overall, 196 eyes underwent surgery. From a preoperative baseline of 23.1 ± 8.9 mmHg using 2.9 ± 1.1 medications, mean IOP reductions of 8.5-10.0 mmHg were seen from Months 1-12 postoperatively (P ≤ 0.0001), with mean medication reductions of 1.2-2.5 medications (P ≤ 0.0001). At 1 year, adverse events requiring surgical intervention occurred in 7.6% of patients (3.0% bleb revision, 4.6% additional glaucoma procedures). 2.5% required bleb needling and 2.5% required cataract extraction. At 1 year maximum follow-up, Kaplan-Meier survival data indicates that ~55% of patients were still either complete or qualified successes requiring drop-lowering therapy.

Discussion
Our series demonstrates the efficacy of trabeculectomy surgery using modern techniques. Post-operative laser suture lysis after tight suturing at the operative time contributes to a lower complication rate. Over 50% of patients on a Kaplan Meier survival curve were either complete (no drops) or partial (on topical therapy) successes. Of the patients that were listed as failures, this proportion of patients is above expected, due in part to loss to follow-up. Patients were often referred to this tertiary care center for operative management and then were referred back to their primary ophthalmologist for ongoing care. This often led to follow-up duration that ended before the first 90 days. Patients that were referred back outside of the study time period may have had pressures that would have included them as successes; there was often not enough data to make adequate conclusions about their management in the interim.

Conclusion
Trabeculectomy performed with advanced techniques provides significant IOP reduction with relatively few adverse events. Modern advancements in surgical technique utilize the diffuse application of low-dose mitomycin C to augment the long-term success of trabeculectomy and minimize short-term complications by employing planned laser suture lysis of flap sutures. Our case series indicates that modern trabeculectomy surgery is an effective surgical modality for achieving low target pressures with relatively high efficacy and less short-term complications. Ongoing follow-up will help to determine the prolonged success and safety of this procedure.

Reference
Three-Year Outcomes of Trabecular Micro-Bypass Stents (iStent Inject) Stratified by Prior Glaucoma Surgery

FRITZ HENGERER¹, Jay Katz
¹ Department of Ophthalmology

Purpose/Relevance
A need exists for real-world data comparing long-term IOP and safety after implantation of second-generation trabecular micro-bypass stents (iStent inject®, Glaukos, San Clemente, CA) between surgically naïve eyes and eyes with prior glaucoma surgery. Stents were implanted either combined with cataract surgery or as a standalone procedure.

Methods
This prospective single-surgeon consecutive case series from Germany evaluates iStent inject implanted in 125 eyes either combined with cataract surgery or as a standalone procedure with a subset of 75 eyes followed out to 3 years. OAG was the principal diagnosis, with other glaucoma sub-types included. Eyes were stratified into two groups for analysis: Group A comprised surgically naïve eyes, while Group B had eyes with prior glaucoma surgery, including both incisional and laser procedures. Outcomes included mean IOP, mean medication use, proportional analyses, and safety.

Results
All eyes underwent successful implantation of iStent inject trabecular stents with good overall safety.

Preop mean IOP for Group A (n = 77) was 22.2 ± 6.2 mmHg on 2.5 meds; Group B (n = 48) 25.6 ± 5.7 mmHg on 2.9 meds. Postop mean IOP at Year 3 in Group A (n = 39) reduced to 15.0 ± 2.3 mmHg (32% reduction); Group B (n = 36) to 14.3 ± 1.7 mmHg (44% reduction). IOP ≤18 mmHg was achieved by 95% of Group A and 100% of Group B eyes. Medication use decreased 64% in Group A to 0.9, with 42% eyes med-free (from 1.3% preop), and 86% to 0.4 in Group B, with 69% eyes med-free (from 0% preop). Similar findings were noted for the consistent cohort of eyes with 3-year data and will be shared at the time of presentation.

Discussion
Trabecular micro-bypass stent implantation with iStent inject adds to the surgical treatment options currently available for eyes with glaucoma. Stenting safely spares conjunctiva and reduces medication usage. Data from this study adds to the existing body of clinical evidence demonstrating the benefits of iStent inject.

Conclusion
iStent inject implantation combined with cataract surgery or as a standalone procedure demonstrated clinically meaningful, long-term IOP and substantial medication reductions for both surgically naive eyes and those with prior glaucoma surgery. Overall safety was good out to three years.

Reference
59 Diplopia in Patients with Baerveldt 250 and 350, and Ahmed FP7 Glaucoma Drainage Devices

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¹ Mayo Clinic

Purpose/Relevance
To examine the rates of diplopia in patients with Baerveldt 250 (B250), Baerveldt 350 (B350), or Ahmed FP7 (FP7) GDDs using the Diplopia Questionnaire (DQ).

Methods
From Aug 2017 through July 2019, 137 adult patients with a GDD and 102 medically-treated controls were prospectively and consecutively enrolled. The DQ was administered ≥ 30 days post-operatively, upon enrollment to the controls. Diplopia was defined as “Sometimes,” “Often,” or “Always” in distance straight ahead and/or reading positions. All diplopic patients underwent orthoptic measurements, which were reviewed by a strabismus specialist. Patients with GDDs in quadrants other than superotemporal, multiple GDDs, or scleral buckles were excluded. Bonferroni correction was applied for pairwise comparisons.

Results
Overall, 23/137 (16.8%) GDD patients and 5/102 (4.9%) control patients (p=0.003) reported diplopia. Of the GDD patients, 8/37 (21.6%) had FP7, 2/35 (5.7%) had B250, and 13/65 (20.0%) had B350. There were significant differences between FP7 vs controls (p=0.017) and B350 vs controls (p=0.013). Diplopia was attributable to GDD in 2 FP7 (5.4%, 95% CI: 0.7-18.2), and 4 B350 (6.2%, 95% CI: 1.7-15.0) patients, without significant differences between the GDDs.

Discussion
Patients with the larger (B350) or the taller (FP7) GDDs were more likely to experience diplopia than controls, and diplopia was attributable to the GDD in approximately 6% of patients with either GDD.

Conclusion
Diplopia can be a disabling complication, so pre-operative counseling for GDD surgery should include a discussion of the risk.

References
60 The Requirement of Additional Glaucoma Surgery After Glaucoma Drainage Device Surgery in Patients with Open-Angle, Angle-Closure, Neovascular, and Pseudoexfoliative Glaucoma

FELIX KUNG, Catherine Knier, Armin Garmany, Camilo Mejia, Nouran Sabbagh, Cheryl Khanna

1 Mayo Clinic Alix School of Medicine

Purpose/Relevance
The use of glaucoma drainage devices (GDDs) is increasing. Although the TVT study suggests that 9% of patients require additional glaucoma surgery (AGS) after a single GDD, it is unknown if the type of glaucoma influences the need for AGS. Our goal is to compare the need for AGS after the placement of a single GDD for patients with open-angle (OAG), angle-closure (ACG), neovascular (NVG), and pseudoexfoliative (PXE) glaucoma.

Methods
Longitudinal study evaluating patients with OAG, ACG, NVG, or PXE who received a GDD between 1/1/1994 and 9/1/2019 at a single institution. The patients’ glaucoma type, GDD type, and types of AGS were recorded and analyzed.

Results
367 eyes of 309 patients were identified with ACG (n = 41), OAG (n = 205), NVG (n = 59), and PXE (n = 62). GDD type included: Baerveldt 350 (n = 217), Baerveldt 250 (n = 50), Ahmed FP7 (n = 68), Ahmed S2 (n = 25), and Ahmed B1 or Schocket (n = 7). 34 eyes required AGS after their first GDD. Of the eyes requiring AGS, 15 had B-350 GDD, 3 had B-250, 12 had A-FP7, 2 had A-S2, and 2 had A-B1 or Schocket. AGS after GDD included: GDD, iStent, Trabectome, 360 trabeculotomy, SLT, ALT, or LPI. Kaplan Meier (KM) estimate (see Figure 1) demonstrated no statistically significant difference in the time to AGS (P = 0.10). At 4 years, second surgery was performed in 9.6%, 8.0%, 16.4%, and 17.0%, of PXE, OAG, ACG, and NVG eyes, respectively. By 8 years, prevalence of second surgery was 9.6%, 11.0%, 16.4%, and 33.6% in each group (P = 0.02 at year 8 for NVG vs. others). The NVG group had a statistically higher use of A-FP7 compared to other glaucoma types (P < 0.001), and the rate of requirement of SGS after 4 years increased more than that of the other groups but did not reach statistical significance.

Discussion
KM analysis demonstrates that among eyes with OAG, ACG, NVG, and PXE, after receiving their first GDD, there is no statistically significant difference in the probability of needing AGS. The KM did show that after year 4, the curve continued to increase greatly for NVG while for the other 3 groups the probability virtually plateaued. A-FP7 was used statistically more in NVG. It is unclear if the late increase of SGS in the NVG group is related to the underlying glaucoma type, increased use of A-FP7, or other mechanisms not identified.
Conclusion
Among eyes with OAG, ACG, NVG, and PXE glaucoma that receive a GDD, there is no significant difference in the probability of needing second glaucoma surgery. The KM curve did show a higher probability for late GDD failure in the NVG group, which had statistically higher use of Ahmed FP7.

Reference
Higher Rates of Recurrent Tube Exposure with Anti-VEGF Therapy in Patients with Macular Degeneration

KATY LIU1, Maria Gomez-Caraballo1, Sanjay Asrani
1 Duke Eye Center

Purpose/Relevance
To determine the incidence of glaucoma tube shunt exposure in age-related macular degeneration (AMD) patients receiving anti-VEGF (anti-vascular epithelial growth factor) intravitreal injections.

Methods
A retrospective review from January 1, 1999, to January 1, 2019, identified all AMD patients who underwent tube revision for exposure at the Duke Eye Center. AMD patients with and without anti-VEGF injections were compared. Patients treated with steroid injections were excluded. Patient gender, age, race, ocular diagnoses, glaucoma tube types, and dates of glaucoma surgeries and anti-VEGF injections were collected. Outcome measures included number of tube exposures, time from anti-VEGF injection to tube exposure, and complications after tube revisions. Statistical analyses were performed by two-tailed Student’s t-test.

Results
158 AMD patients with anti-VEGF (receiving 321 tubes) and 268 AMD patients without anti-VEGF (469 tubes) were identified. Patients with anti-VEGF had a greater number of tube erosions than those without anti-VEGF: 25 (7.8%) tubes versus 19 (3.8%) tubes ($P < 0.012$, respectively). Of anti-VEGF patients with tube exposure, 8 (42%) were female, 11 (58%) Caucasian, and 8 (42%) African-American. The average age was 72 years. 10 (53%) tubes were Ahmed and 9 (47%) were Baerveldt devices, 14 (74%) plates were superotemporal, and all tubes were in the anterior chamber. 12 (63%) anti-VEGF patients had multiple tube exposure events (2.21 ± 1.65 events), which was greater than in non-anti-VEGF patients (1.33 ± 0.59, $P < 0.020$). 15 (79%) patients received anti-VEGF injections concurrent with tube exposure. The median time from anti-VEGF injection to exposure was 44 days (range 2 to 1416). Complications after tube revision included 7 tube explantations for recurrent erosions and one case of endophthalmitis. Mean follow-up time after tube exposure was 4 years.

Discussion
Reported glaucoma tube exposure rates range from 2% to 5%.1 Known risk factors for glaucoma tube exposure include younger age, inflammation, neovascular glaucoma, and possibly Hispanic race.2-3 Our results show a greater number of initial and recurrent tube exposures with anti-VEGF in AMD patients. Most patients had concurrent anti-VEGF therapy at the time of tube exposure. A potential mechanism for the effect of anti-VEGF on tube erosions is inhibition of angiogenesis and wound healing.

Conclusion
Our results suggest intravitreal anti-VEGF injections are linked to higher rates of glaucoma tube exposure and recurrence in patients with AMD.

References
Predictive Factors for Microcystic Macular Edema in Glaucoma

GOLNOUSH SADAT MAHMOUDI NEZHAD, Diana C. Salazar Vega, Esteban Morales, Yahid Mohammadzadeh, Agustina de Gainza, Jean-Pierre Hubschman, Kouros Nouri-Mahdavi, Joseph Caprioli

1 Jules Stein Eye Institute, David Geffen School of Medicine, University of California Los Angeles, Los Angeles, CA, USA

Purpose/Relevance
To identify clinical characteristics and risk factors for microcystic macular edema (MME) in patients with primary open-angle glaucoma (POAG).

Methods
Retrospective review of POAG patients who had macular Spectralis OCT (optical coherence tomography) at the Stein Eye Institute from 2010 to 2019 was performed. Eyes with retinal abnormalities except epiretinal membrane (ERM) were excluded. The inner nuclear layer was qualitatively assessed for the presence of MME. Visual field (VF) decay rates were measured with (mean deviation) MD and visual field index (VFI) rates. Univariate and multivariate logistic regressions were performed to determine baseline and longitudinal factors associated with the presence of MME.

Results
25 (7.7%) out of 323 eyes (196 patients) demonstrated MME. The mean (±SD) age of patients with and without MME were 56.7 (±8.5) years and 61.81 (±10.05) years, respectively. The mean (±SD) MD were −9.3 (±5.7) dB and −4.8 (±5.3) dB in eyes with and without MME. MME was detected only in the inferior retina in 21 eyes (84%). The baseline superior hemifield showed worse MD (−13.5 ± 8.8 dB) than the inferior hemifield (−5.6 ± 5.8 dB) in eyes with MME (P < 0.001), and worse MD than the superior hemifield of eyes without MME (−5.4 ± 6.8 dB, P < 0.001). MD decay rates (P = 0.53) and VFI decay rates (P = 0.12) were not significantly different between eyes with and without MME. On univariate analyses, baseline MD (P < 0.001), baseline PSD (P < 0.001), baseline VFI (P < 0.001), superior hemifield MD (P < 0.001), African-American ethnicity (P = 0.03), and younger age (P = 0.02) were significant predictors of MME. With a multivariate model, advanced glaucoma damage (MD) at baseline (P < 0.001) and younger age (P = 0.04) were associated with presence of MME. ERM was not associated with the presence of MME (P = 0.45) in our cohort.

Discussion
MME occurred most frequently in the inferior retina. Major predictors for the presence of MME were worse baseline MD and younger age. There seemed to be no difference in MD and VFI rates of decay between eyes with and without MME. Although an association of ERM and MME was reported, we did not find this association between MME and ERM in our cohort.

Conclusion
MME is associated with advanced glaucomatous damage and younger age. The confounding effects of MME on full-thickness measurements of the macula should be taken into account.

References
63 Risk Factors for Glaucoma Drainage Device Failure in the Pediatric Population

CHARLES MEDERT¹, Kara Cavuoto, Elizabeth Vanner, Ta Chang
¹ Bascom Palmer Eye Institute

Purpose/Relevance
In this study, we report a large cohort of children who have undergone Glaucoma Drainage Device (GDD) implantation to determine the factors associated with failure.

Methods
Records of all pediatric GDD implants between May 1997 and July 2019 were reviewed. Failure was defined as an intra-ocular pressure (IOP) >21 mmHg 3 months after implantation, IOP reduction <20% below baseline at 2 consecutive follow-up visits 3 months after implantation, IOP <5 mmHg at 2 consecutive follow-up visits 3 months after implantation, reoperation for glaucoma and/or loss of light perception vision. Hazard survival analysis was performed using Cox regression.

Results
Of the 150 GDD primary implants (150 eyes of 128 patients), 58 failed during the study period (38%). Mean follow-up was 5.4 years. Glaucoma associated with acquired conditions such as juvenile idiopathic arthritis and trauma had significantly increased risk for failure when compared to glaucoma secondary to non-acquired systemic diseases ($P = 0.006$), non-acquired ocular conditions ($P = 0.005$), and primary congenital glaucoma ($P = 0.04$). There was also a significantly increased risk for failure for primary tubes in younger patients, with a 23% reduction of failure with each 3-year increase in age ($P = 0.03$). There were 22 secondary GDD implants in the study, of which 11 failed (50%). Increased risk for failure was associated with concurrent anterior segment surgery at the time of implantation ($P = 0.008$) as well as a younger age ($P = 0.005$).

Discussion
In our study, the primary pediatric GDD failure rate was lower compared to adults in the Ahmed Baerveldt Comparison study. Pediatric patients whose glaucoma is from diseases such as uveitis or trauma were more likely to fail, suggesting an increased need for monitoring in these patient groups. The success of both primary and secondary tubes appears to be affected by age at the time of surgery, but secondary tubes are also influenced by concurrent anterior segment procedures at the time of implantation.

Conclusion
Primary pediatric GDD implantation failure is associated with age as well as the etiology of glaucoma. Secondary pediatric GDD implantation failure is associated with age as well as the need for concurrent anterior segment surgery at the time of surgery.

Reference
Purpose/Relevance
To evaluate and compare the biomechanical properties of hypotonous eyes with vertical anterior corneal striae (VACS) to those of hypotonous eyes without VACS.

Methods
Consecutive eyes of adult patients with an intraocular pressure (IOP) less than or equal to 10 mmHg and at least eight weeks after any type of glaucoma surgery were enrolled. Slit lamp exams and applanation tonometry were performed by two glaucoma specialists; optical coherence tomography, optical biometry, and ocular response analyzer were performed at enrollment. Data on glaucoma history, imaging, and ocular exams were abstracted via chart review.

Results
Ten eyes with VACS and 12 eyes without VACS were included for analysis. On average, eyes with VACS had a lower IOP (6 mmHg) than eyes without VACS (8 mmHg). The following trends were observed among eyes with VACS: higher pre-hypotony corneal hysteresis (CH) (8.85 mmHg with VACS vs. 6.9 mmHg without VACS), increased central corneal thickness (CCT) post-hypotony (536 um to 555 um with VACS vs. 533 um to 525 um without VACS), shorter axial length (24.12 mm with VACS vs. 24.58 mm without VACS), and greater extent of extrafoveal chorioretinal folds in VACS. However, these trends did not reach statistical significance. There was no difference in visual acuity or astigmatism between groups. Further eyes will be enrolled for analysis.

Discussion
VACS have been documented to frequently coincide with IOP less than or equal to 5 mmHg in clinical observations, yet the clinical significance of these VACS is not known. Our findings suggest that corneal striae may be more often found in hypotonous eyes with higher CH, increased CCT post-hypotony, and increased chorioretinal folds. There is no indication that VACS coincide with visually significant hypotony maculopathy, reduced visual acuity, or increased astigmatism.

Conclusion
VACS do not reduce visual acuity or indicate risk of visually significant hypotony maculopathy and should not be used as the sole indication to correct hypotony after glaucoma surgery.

Reference
**65 Effectiveness of a New Blebless Tube Shunt in Glaucomatous Eyes with Uncontrolled IOP**

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¹ WESMDPA Baptist Medical Center
Glaucoma Service

**Purpose/Relevance**
To examine the efficacy of the new commercial model of the blebless Sponsel A2B glaucoma tube shunt (AJL, Bilbao, Spain) in lowering intraocular pressure (IOP) after failure of all other IOP-lowering therapies (including antimetabolite filtering and standard tube shunt procedures). The silicone A2B anterior tubing is identical to that used in standard Ahmed, Baerveldt, or Molteno implants, but rather than a plate it has a poly-fenestrated large-bore posterior tube that delivers aqueous into the retrobulbar space, forming a lymphatic-like network of micro-canaliculi between the fat cells into the periorbita.¹³

**Methods**
Retrospective quality assurance chart review of all individuals who had undergone A2B shunt placement Jan-Oct 2019. IOP and medication change from baseline performed using paired t-test.

**Results**
21 eyes of 19 patients were assessed (mean age 37; 13M/8F). A mean of 4.2 prior incisional glaucoma procedures had been performed on each eye without sustained success, with mean IOP 35.6 ± 2.6 mmHg on a mean of 2.5 IOP-lowering drops. At 1, 7, 30, and 90 days after surgery, 95%, 81%, 87%, and 85% of patients maintained an IOP ≤ 21 mmHg, respectively. At these same time intervals, IOP with the A2B shunt dropped from the baseline value of 35.6 mmHg to 9.7 ± 1.8 (-25.9 mmHg, -73%), 17.4 ± 3.6 (-18.2 mmHg, -51%), 14.4 ± 1.5 (-21.2 mmHg, -59%), 16.7 ± 2.0 (-18.9 mmHg, -57%), respectively (P < 0.001). Change in medication at 30 and 90 days dropped from baseline of 2.52 to 0.29 ± 0.16 and 0.07 ± 0.07, respectively (P < 0.001).

**Discussion**
This surgical procedure involves a protocol similar to that of traditional tube shunts but requires only a fraction of the time, in part because it omits the scleral fixation of a plate. The risk of aqueous leakage or tube/Tutoplast exposure is limited because intrinsic properties of retrobulbar fat create a one-way valve system. Prior studies have indicated that redirecting aqueous humor into the retrobulbar space is followed by the formation of a retrobulbar lymphatic-like system between the fat cells, resulting in a highly effective means of lowering IOP.

**Conclusion**
The Sponsel A2B glaucoma tube shunt is an effective rescue therapy in patients who have manifestly failed other IOP-lowering procedures. It is now being evaluated in patients with moderate to severe glaucoma who have not undergone any prior procedures.

**References**
Needle Revision of Filtering Bleb with Mitomycin C: Outcomes and Safety Profile

NILEEMA PATEL
Saint Louis University School of Medicine

Purpose/Relevance
Standard trabeculectomy or Ex-PRESS shunt implant is the first major glaucoma surgery after failure of medical therapy where a new aqueous outflow path is created to form a bleb. If over time the bleb scars and fails to reduce intraocular pressure (IOP), it can be revived via a procedure called trans-conjunctival needle revision of bleb. There is limited data on long-term outcomes of bleb needling with anti-fibrotics such as mitomycin C (MMC). The purpose of this study is to assess the long-term efficacy and safety profile of bleb needling with MMC after failure of initial filtering procedure.

Methods
A retrospective chart review was performed on 42 glaucoma patients (48 eyes) who underwent bleb needling with MMC following a trabeculectomy or Ex-PRESS shunt implant at SLU Eye Institute since Jan 2012. The main outcome measures were IOP and number of IOP-lowering medications at 3 months, 1 year, and 3 years post-operatively, need for additional surgery, and complications such as hypotony (IOP ≤ 5 mmHg).

Results
Mean IOP was reduced from 20.05 mmHg pre-operatively to 14.76 mmHg at 3 months (P < 0.01), 13.85 mmHg at 1 year (P < 0.01), and 14.08 mmHg at 3 years (P = 0.07) post-operatively. Mean number of IOP-lowering medications was reduced from 2.46 pre-operatively to 0.46 at 3 months (P < 0.01), 0.73 at 1 year (P < 0.01), and 1.17 at 3 years (P = 0.11) post-operatively. Complications included early hypotony in 29 eyes (60.4%), bleb leak in 4 eyes (8.3%), and endophthalmitis in 0 eyes. Seventeen eyes (35.4%) required additional glaucoma surgery.

Discussion
A study by Tulidowicz-Bielak et al. demonstrates similar reduction in IOP and number of IOP-lowering medications after bleb needling, but our study reveals a higher rate of early post-operative hypotony compared to literature. This may be secondary to the limited nature of most hypotony cases, causing studies to underreport incidence.

Conclusion
Needle revision of filtering bleb with MMC appears to be reasonably successful in reducing IOP and number of IOP-lowering medications long term. The most common complication is hypotony, and infection risk is low. Since about 1/3 of patients required additional glaucoma surgery, patients should be informed of the likelihood of further interventions.

Reference
67 Intraocular Pressure Spikes After Cataract Surgery in Glaucoma and Non-glaucoma Patients

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1 Legacy Devers Eye Institute

Purpose/Relevance
We were interested in determining the incidence of intraocular pressure (IOP) spikes after cataract surgery in glaucoma and non-glaucoma eyes, and identifying baseline variables associated with a higher preoperative-postoperative IOP difference and spikes.

Methods
We performed a chart review of cataract surgery cases in the 2017-2019 period with a follow-up of at least 60 days. The authors measured the IOP preoperatively and on postoperative Day 1, Days 5-20 and Days 60-120. We defined IOP spikes as a postoperative Day 1 IOP ≥ than 21 mmHg and a preoperative-postoperative difference of at least 5 mmHg. We used mixed-effects models to identify variables associated with preoperative-postoperative IOP differences and generalized estimating equations (GEE) to identify variables associated with spikes.

Results
We reviewed a total of 193 eyes of 183 patients. Mean age was 70.5 (SD 8.87, range 43-90). 113 (61.4%) were female. 140 were Caucasian, 16 African-American, 14 Hispanic/Latino and 13 Other. 93 eyes (42.2%) had diagnosis of glaucoma.

On Day 1, 33 eyes showed an IOP spike. In the case of glaucoma and non-glaucoma patients, the incidence of spikes was 15.5% and 17.2%, respectively. IOP spikes on Day 1 were associated only with age (P = 0.05). There was no association with glaucoma status, race or gender (P > 0.1).

In all eyes, preoperative mean IOP was 14.93 mmHg (SD 4.39, 3-33), on Day 1 it was 18.7 (SD 6.7, 4-46), on Days 5-20 it was 15.34 (SD 4.06, range 3-34) and on Days 60-120 it was 13.67 (SD 3.21, range 4-36). In glaucoma eyes, preoperative mean IOP was 16.05 mmHg (SD 5.23, 3-33), on Day 1 it was 17.6 (SD 7.93, 4-46), on Days 5-20 it was 14.41 (SD 4.78, range 2-34) and on Days 60-120 it was 13.18 (SD 4.43, range 4-36). Day 1 postoperative IOP was significantly different from baseline in all (P < 0.001), glaucoma (P = 0.01) and non-glaucoma eyes (P = 0.04).

Univariate and multivariate analysis identified baseline IOP, age at procedure and gender to be associated with higher preoperative-postoperative IOP differences (P = 0.006, 0.04 and 0.08, respectively).

Discussion
Cataract surgery can cause acute postoperative IOP elevation. In susceptible eyes, such as in glaucoma, this rise can cause serious damage.1 We identified the incidence of IOP spikes to be around 15% and associated with age. We also identified factors associated with a higher postoperative IOP, which may help clinicians and surgeons consider prophylactic actions in such cases.

Conclusion
The incidence of IOP spikes on Day 1 after cataract surgery was around 15%. Baseline IOP, age and gender were associated with higher postoperative IOP. Only age was associated with IOP spikes.

Reference
The Steroid Response as a Contributor to the Hypertensive Phase After a Glaucoma Drainage Device Implant

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Purpose/Relevance
To compare the effects of corticosteroid (CS) de-escalation and concomitant non-steroidal anti-inflammatory drug (NSAID) use versus standard CS administration in managing hypertensive phase (HP) in patients after glaucoma drainage device (GDD) implant.

Methods
This was a retrospective chart review of patients undergoing GDD implant receiving CS de-escalation versus standard CS administration following onset of HP. CS de-escalation involved reduction of topical CS use with or without addition of NSAID. Patients with a history of GDD implantation over a four-year period at the Kittner Eye Center were included. Patients without at least six months’ follow-up were excluded, as were patients with a history of neovascular glaucoma or angle closure glaucoma. Patients were categorized as follows:

CS maintenance and escalation groups (I and II)
Group I: Continuation of CS regimen
Group II: Increasing CS regimen

CS de-escalation groups (III and IV)
Group III: Decreased or discontinued CS regimen
Group IV: Decreased or discontinued CS regimen and addition of NSAID.

Outcomes evaluated include onset and duration of first HP, IOP re-elevation, and the mean post-operative and 6-month IOP by each intervention group.

Results
Ninety-seven eyes of 269 patients met inclusionary criteria. 49% of GDD implant eyes evaluated experienced a HP. Twenty-six eyes were in group I, 5 in group II, 9 in group III, and 8 in group IV. The CS de-escalation groups experienced fewer re-elevations of IOP events as compared to the CS maintenance and escalation groups (Table 1). There was no difference in the IOP at HP onset across each of these groups—I, 31.46 (±7.38); II, 27.60 (±3.85); III, 28.22 (±8.86); IV, 30.63 (±7.89)—and no difference in six-month post-operative IOP—I, 14.60 (±5.22); II, 14.60 (±3.05); III, 12.89 (±4.76); IV, 15.86 (±4.12). The average duration of the HP was lowest for the NSAID group (IV, 18.50 days ±10.25), followed by CS regimen maintenance (24.08 days ±15.13), CS decrease or discontinuation (III, 28.89 days ±19.63), and CS escalation (II, 30.60 days ±19.45).

Discussion
Evidence on the use of NSAIDs to manage a HP is limited. Yuen et al used initial NSAID therapy to achieve better initial IOPs, but there were increased complications. Our study used initial standard CS therapy after GDD implantation but focused on the CS response as a possible major contributor of the hypertensive phase. The results of this study suggest the benefits of NSAID use in resolving a HP, and the importance of trabecular meshwork function in GDD implants.

Conclusion
Post-GDD implant patients experiencing a HP higher incidence of sustained release from HP with NSAID intervention than with continued CS use. These data suggest that the HP is likely a combination of transiently altered bleb permeability and CS-induced trabecular meshwork dysfunction.

Reference
Effect of Phacoemulsification on Intraocular Pressure in African American Versus Caucasian Patients with Primary Open Angle Glaucoma

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Purpose/Relevance
Various studies have shown a long-term reduction in the intraocular pressure (IOP) of POAG patients after phacoemulsification. Although it is known that POAG affects more African Americans, the impact of ethnicity on outcomes following phacoemulsification alone, in the absence of specific glaucoma intervention, has yet to be addressed. The purpose of this retrospective cohort study is to compare the long-term effects of phacoemulsification on IOP in African American and Caucasian patients with POAG.

Methods
58 Caucasians and 30 African Americans with POAG who underwent phacoemulsification at Edward Hines Jr. Veterans Affairs Hospital were reviewed. IOP at baseline and at postoperative months 1, 3, 6, and 12 were recorded for every case. Statistical analysis using independent samples t-test was conducted to assess differences in IOP between these two ethnic groups.

Results
Preoperative IOP was 14.8±3.4 and 13.3±3.8 mm Hg in Caucasian and African American patients, respectively. Postoperative month 1, 3, 6, and 12 IOPs for Caucasian patients were 13.9±4.4, 13.1±4.1, 12.9±2.9, and 12.7±3.1 mm Hg. African American postoperative month 1, 3, 6, and 12 IOPs were 13.5±4.3, 12.8±3.9, 14.1±3.5, and 12.6±3.4 mm Hg. There was no statistically significant difference in IOP at baseline or any postoperative visit between African Americans and Caucasians. There was a statistically significant decrease in IOP compared to baseline for Caucasian patients during postoperative months 3, 6, and 12, but no statistically significant decrease for African American patients during any postoperative month compared to baseline.

Discussion
There was no significant difference in IOP between African American and Caucasian patients after surgery. However, Caucasian patients had a significant decrease in postoperative IOP compared to baseline. This may suggest an ethnic difference in postoperative IOP control in POAG patients. Limitations of the study include retrospective review and small sample size.

Conclusion
It is important to understand how ethnicity may impact clinical outcomes in POAG patients undergoing phacoemulsification. Further research on the impact of patient ethnicity on POAG patients undergoing phacoemulsification is recommended.

References
Does Tube-Iris Touch Cause Anterior Chamber Inflammation in Patients with Ahmed Valve Implantation?

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Purpose/Relevance

The Ahmed glaucoma valve (AGV) has been used to decrease intraocular pressure (IOP) in glaucoma patients for decades. The tube is inserted into either the anterior chamber or ciliary sulcus with the goal of avoiding tube-iris touch, potentially causing inflammation. This study aims to detect whether significant anterior chamber inflammation and/or cystoid macular edema (CME) occurs in patients with tube-iris touch after AGV implantation.

Methods

A prospective observational study of consecutive patients undergoing AGV implantation between June and September 2019 was performed at University of California, San Francisco. Patients with any types of uveitis, corneal haze, or prior intraocular surgery (excluding uncomplicated cataract surgery) were excluded. Tube-iris touch was identified by slit lamp examination and confirmed with anterior segment optical coherence tomography (OCT). Anterior chamber (AC) inflammation was graded by a masked uveitis specialist using the Standardization of Uveitis Nomenclature (SUN) classification. Central foveal thickness (CFT) to identify CME was measured by spectral domain OCT. AC inflammation and CFT were compared between the patients with and without iris-tube touch.

Results

A total of 103 eyes (84 patients) were included. The tube was inserted into the anterior chamber in 33 eyes (32%) and the sulcus in 70 eyes (68%). Tube-iris touch was identified in 46 eyes: 11 (33%) with anterior chamber placement and 35 (50%) with sulcus placement ($P = 0.14$). Average post-operative follow up was $32 \pm 24$ months and $40 \pm 26$ months for patients with or without tube-iris touch, respectively ($P = 0.73$). There was no significant difference between the two groups in terms of pre-operative AC inflammation, post-operative vision, IOP, number of glaucoma drops, or use of anti-inflammation drops (all $P > 0.05$). Pigmented cells in the AC were found in 5 eyes (11%) with tube-iris touch and 3 eyes (5%) without tube-iris touch ($P = 0.65$). The presence of AC inflammation between groups was not significantly different ($P = 0.34$). Mean CFT was 245 and 250 microns for tube-iris touch and no tube-iris touch groups, respectively ($P = 0.59$).

Discussion

Overall, there is minimal post-operative inflammation in patients with AGV implantation following the immediate post-operative phase. Although there is a trend to have more tube-iris touch in patients with sulcus tube insertion, this is not significantly different from patients with AC tube insertion. There is no significant difference in AC pigmented cells, AC inflammation, or CFT between those with and without tube-iris touch.

Conclusion

Tube-iris touch following AGV implantation is not associated with increased post-operative AC inflammation or cystoid macular edema regardless of whether the tube is placed in the anterior chamber or ciliary sulcus.

References

71 PAUL Glaucoma Implant in the Surgical Management of Refractory Glaucoma: 12-Month Safety and Efficacy Outcomes of a Novel Aqueous Shunt Implant

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Purpose/Relevance
The PAUL® Glaucoma Implant (PGI) is a novel aqueous shunt designed to offer a surgical alternative to other established shunts in the management of glaucoma refractory to medical treatment. The device is made entirely of medical grade silicone, with a 342mm² end-plate and a tube portion that is smaller caliber than conventional shunts (internal diameter, 127um, external diameter, 467um). The PGI is CE marked and licensed also in Singapore and Australia. The purpose of this study is to report PGI safety and efficacy preliminary outcomes at 12 months.

Methods
A retrospective, non-comparative, interventional case series of patients undergoing PGI implantation for the treatment of uncontrolled glaucoma despite maximum medical treatment at 6 international centers during a 12-month period from October 2017 to September 2018. Intraocular Pressure (IOP) and number of IOP-lowering medications were noted at baseline, and at 1,3,6, and 12 months after surgery. The details of any complications during the follow-up were recorded.

Results
A total of 121 eyes underwent PGI implantation during the study period. The baseline IOP (mean ± SD) of 23.1 ± 8.1 mmHg, reduced to 14.4 ± 6.6, 14.1 ± 4.3, 13.1 ± 3.9, 13.1 ± 4.4, at post-operative month 1, 3, 6, and 12, respectively (p<0.01). The number of IOP-lowering medications reduced from 3.2 ± 0.9 at baseline, to 0.3 ± 0.7, 0.5 ± 0.7, 0.3 ± 0.6, 0.2 ± 0.4 at post-operative month 1, 3, 6, and 12, respectively (p<0.01). Overall, there was 3.4% rate of iris occluding the shunt, 2.7% of tube exposure, 9.4% of shallow anterior chamber due to hypotony, and 1 case (0.85%) of endophthalmitis leading to vision loss.

Discussion
The results of this case series show that efficacy and safety 12 months after PGI implantation are comparable to those seen in the Ahmed Baerveldt Comparison Study after 1 year of follow-up.¹ The smaller PGI tube diameter in comparison with other shunts offers a theoretical benefit over existing tubes in lower risk of corneal endothelial damage and exposure as well as reduced operating time due to simpler flow control.

Conclusion
Overall, PGI insertion shows good preliminary efficacy with a favorable safety profile for the surgical treatment of glaucoma refractory to medical treatment, comparable to existing aqueous shunts but with potential benefits due to the smaller diameter tube.
Reference

72 Surgical Outcomes of Neovascular Glaucoma

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Purpose/Relevance
Patients with neovascular glaucoma (NVG) may need urgent surgical management for control of elevated intraocular pressure (IOP). To determine the outcomes of surgical intervention, we reviewed the medical records of NVG patients.

Methods
In this retrospective comparative cohort study, we identified 612 patients from our electronic medical record with a new diagnosis of NVG from 1/1/2013 to 5/1/2019. Inclusion criteria were neovascularization of the iris or angle and an intraocular pressure (IOP) >21 mmHg. Ninety-one patients met inclusion/exclusion criteria. The University of Miami Institutional Review Board approved this study.

Results
Most patients presented with NVG secondary to proliferative diabetic retinopathy (PDR; 59%) or central retinal vein occlusion (CRVO; 17%). The remaining 24% were caused by branch/hemi-retinal vein occlusions, intra-ocular tumors, and ocular ischemia of various etiologies. Patients were treated with tube shunts (92%) or trans-scleral cyclophotocoagulation (tsCPC; 8%). Patients who underwent Baerveldt (BGI) implantation had mean preoperative visual acuity (VA) of 20/400 versus Ahmed (AGV) implants at counting fingers (CF), and tsCPC at hand motion (HM). Patients who received AGV had the highest preoperative mean IOP, 46 mmHg, versus tsCPC, who had the lowest at 38.8 mmHg. The mean presenting VA was CF, and IOP was 45 mmHg in the PDR group, compared to 20/600 and 39 mmHg in the CRVO group.

The mean 3-month post-operative VA was 20/600 for BGI, 20/800 for AGV, and CF for tsCPC. The mean 3-month IOP was 13.3 mmHg for BGI, 17 mmHg for tsCPC, and 18.5 mmHg for AGV. The mean 3-month VA was 20/600, and IOP was 17.2 mmHg for PDR patients, compared to CF and 17.5 mmHg for CRVO patients.

Discussion
Despite established practice guidelines for PDR and CRVO, patients still present with painful loss of vision from NVG. Preliminary data suggests that BGI may yield the best IOP and VA results at 3 months; however, the surgical outcome may reflect the underlying condition that caused NVG rather than the choice of surgical intervention. IOP outcomes were similar when comparing PDR with CRVO at 3 months, but VA may be better in the PDR group.

Conclusion
Patients with NVG have poor prognoses, but there may be differences in outcomes between different etiologies and surgical interventions.

Reference
73 Outcomes of Glaucoma Surgery Combined with Scleral Fixation of an Intraocular Lens Using Gore-Tex Suture

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Purpose/Relevance
Crystalline or intraocular lens dislocation can be associated with uncontrolled intraocular pressure. Little is known about outcomes of secondary intraocular lens placement combined with glaucoma surgery.

Methods
Single-surgeon retrospective study. All patients underwent scleral fixation of a Bausch and Lomb enVista MX60 intraocular lens (IOL) using Gore-Tex (polytetrafluoroethylene) suture combined with an operative procedure intended to decrease intraocular pressure (IOP). The outcome measures included IOP, number of IOP-lowering medications, change in visual acuity, and postoperative complications with a minimum of 30 days of follow-up. Summary statistics are listed as mean ± standard deviation. Paired Student’s t test was used for statistical analysis.

Results
Our series included 16 eyes of 16 patients (8 male, 8 female) with a mean 722 ± 453 days of follow-up. The mean age was 65 years, ranging from 24 to 92. Indications for secondary IOL included dislocated IOL associated with uveitis-glaucoma-hyphema syndrome (UGH) (8), aphakia (5), and crystalline lens either dislocated or with inadequate support for insertion of a standard posterior chamber IOL (3). Glaucoma subtypes included UGH (8; 3 of whom also had exfoliation glaucoma), traumatic glaucoma (3), phacomorphic glaucoma (2), open-angle glaucoma (2), and steroid-induced glaucoma (1). Glaucoma procedures performed include aqueous shunt (11), ab-interno trabeculotomy (3), tube revision (1), and endocyclophotocoagulation (1). IOP improved from 26 ± 15 mmHg preoperatively to 13.6 ± 7.1 mmHg at last follow-up (P = 0.013), and the number of glaucoma medications decreased from 2.9 ± 1.2 to 1.0 ± 1.4 (P = 0.0003). Best corrected visual acuity remained stable at 1.6 ± 0.9 logMAR (20/800 Snellen) preoperatively to 1.3 ± 1.1 (20/400) postoperatively (P = 0.158). Complications included temporary hypotony (2), hypotony requiring insertion of ophthalmic viscosurgical device (1), cystoid macular edema (3), and bullous keratopathy requiring endothelial graft (1).

Discussion
Combining glaucoma surgery with secondary IOL fixation has been previously reported,1,2 and our series demonstrates a similar safety profile. Ours is the first combined series that used Gore-Tex suture for IOL fixation, which has had acceptable short-term outcomes.3

Conclusion
Our experience with combined glaucoma surgery and scleral-fixation of an IOL using Gore-Tex suture had good success at IOP control and vision preservation.

References
Efficacy and Safety of Standalone Ab Interno Gelatin Microstent Implantation with MMC vs. Trabeculectomy with MMC: Three Years Follow-up

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Purpose/Relevance
To compare efficacy and safety of standalone ab interno gelatin microstent versus trabeculectomy 3 years post-operative. There is currently no published long-term data on XEN, nor long-term comparative data versus trabeculectomy.¹,²

Methods
Primary outcome was time to failure (IOP outside of 6-17 on no medications) on two consecutive visits despite in-clinic maneuvers (including needling). Secondary outcomes included IOP cutoffs of 14 and 21, interventions, complications, and reoperations.

Results
41 eyes in 38 patients received trabeculectomy, and 51 eyes in 47 patients received microstent. HR for trabeculectomy relative to microstent was 1.13 (95% CI, 0.63-2.01); proportional success at 1/2/3 years were 0.76 (0.07), 0.66 (0.07), 0.58 (0.08) for trabeculectomy and 0.77 (0.06), 0.69 (0.07), 0.63 (0.07) for microstent. There were 50 and 32 interventions (44% and 35% had needling), and 52 and 31 complications (most were transient), respectively. 7% and 2% received reoperation.

Discussion
Standalone ab interno gelatin microstent has similar success rate as standalone trabeculectomy at post-operative year 1, 2, and 3, with similar complications, interventions, and reoperations rate.

Conclusion
Standalone ab interno gelatin microstent showed excellent success rate and safety profile at 3 years post-operative follow-up, comparable to standalone trabeculectomy.

References
Quantitative Evaluation of Natural Drug Therapy Options for Glaucoma: A Systematic Review and Meta-analysis

KAREN ALLISON

Purpose/Relevance

Multiple natural products have been tested for the treatment of glaucoma. The lack of head-to-head randomized controlled trials makes choosing between them difficult for patients, clinicians, and guideline developers. The goal of the project is to establish and compare their relative efficacy and tolerability.

Methods

We searched MEDLINE, PubMed, Embase, and Cochrane for randomized controlled trials of natural substances used to treat glaucoma. We performed a network meta-analysis to identify direct and indirect evidence comparing them with one another. We combined this with hierarchical cluster analysis to consider multiple outcomes related to efficacy and tolerability in combination for each treatment.

Results

Eight randomized controlled trials containing 533 patients with natural drug therapy for glaucoma patients and 368 patients with placebo were included. Our analysis revealed that the improvement in ocular blood flow and intraocular pressure after natural drug therapy was significant. In addition, natural drug therapy produced a statistically significant increase in blood flow in all retrobulbar blood vessels compared to placebo. After treatment, IOP was significantly decreased to $10.9 \pm 3.0$ mmHg in the treatment group.

Discussion

Natural products have been used for many years in traditional medicine to treat eye diseases. A number of studies have strongly suggested the role of natural products in glaucoma, and there is increasing evidence that some of the natural anti-oxidants have an important role in macular degeneration. Some of the natural spices and herbs, ingested through diet and supplements, have been shown to be beneficial in terms of reducing the risk of multiple ocular diseases, including age-related macular degeneration and cataracts. All-natural products used in the analysis have been shown to have very low toxicity in vivo studies.1

Conclusion

Our findings suggest that natural remedies are an effective and safe option for preventing and treating glaucoma. The appropriate dose, duration, and the long-term safety of the products need to be assessed in large trials.

Reference

76 Development of an Injectable, Space-Filling Thermosensitive Hydrogel as a Subconjunctival Bleb Scaffold and Sustained Release Drug Depot

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Purpose/Relevance
The subconjunctival injection of anti-metabolites prior to glaucoma microstent insertion has become a popular technique. Essentially, this “pre-forms” the filtration bleb, allowing the insertion of the microstent into the bleb, ab interno.¹,² Currently, aqueous preparations of mitomycin C are used. However, aqueous solvents cause rapid dispersion of drugs and provide no lasting physical support to the bleb walls. Thermosensitive chitosan hydrogels transform from an injectable liquid state into a gelled state at temperatures approximating the subconjunctival space.³ The purpose of this study was to engineer a thermosensitive hydrogel for injection into the subconjunctival physiological environment to serve as a depot for sustained drug delivery after glaucoma surgery.

Methods
High molecular weight chitosan was solubilized at various concentrations in 1% acetic acid. Next, the solution was dialyzed against 300 volumes of double-distilled H₂O to remove the remaining acetic acid. Beta-glycerophosphate (β-GP) was then added dropwise, on ice, until a pH of 7, 7.1, and 7.2 was reached, and samples were collected. Tube inversion tests within a heated water bath were used to assess gelation time vs. temperature. Acetylsalicylic acid (ASA) was loaded into the chitosan gels and exhibited a delayed release profile upon perfusion. Cytotoxic effects of the gel on human Tenon’s capsule fibroblasts were minimal.

Results
ASA-loaded thermogels were capable of holding their shape within minutes of being subjected to near-body temperatures. Human Tenon’s capsule fibroblasts were not harmed when cultured together with the gels. Delayed-release profile suggests release of ASA over several weeks after injection.

Conclusion
Chitosan and beta-glycerophosphate hydrogels possess thermosensitive characteristics and can deliver small molecule therapeutics such as ASA in a delayed-release manner. These properties would make chitosan-based drug delivery systems highly desirable for glaucoma surgery, specifically for bleb formation and stabilization.

References

Figure 1
Topical, Injectable, and Implantable Slow-Release Drug Delivery Platforms for Glaucoma Patients

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Purpose/Relevance
To report the development of topical, injectable, and implantable slow-release drug delivery system in the management of glaucoma patients.

Methods
Polymer-based implantable (biodegradable, 14 micron thin poly(lactic acid-co-glycolic acid)-mitomycin C (PLGA-MMC) (0.65 u) + fluorouracil (5-FU) (0.45 mg) slow-release antifibrotic systems (release profile: 3-4 weeks) were created using “breath figure” technology. In vivo and in vitro studies were performed. Hyaluronic acid (HA) particle-based injectable MMC slow-release version (up to 30 days) was developed specifically for Xen and InnFocus and for bleb revision (see Figure 1). HA particle-based both injectable and topical antibiotic systems were developed to prevent and treat postoperative infections. In vivo and in vitro studies were performed to validate the drug delivery mechanism.

Results
Rabbit model studies suggest 70% reduction in post-operative fibrosis following Ahmed glaucoma valve implantation and a honey comb bleb following trabeculectomy with significant at 3 months with PLGA-MMC+ 5-FU model. In all rabbit cases, the PLGA wafer disappeared between 2 and 3 months. HA particle-based injectable MMC slow-release system resulted in 70% kill curve in cultured fibroblast model study. HA particle-based injectable antibiotic systems (vancomycin and ciprofloxacin) achieved therapeutic concentrations with release curves for 7 days and achieved 100% kill curve comparable to standard antibiotic sticks.

Discussion
Glaucoma filtration surgeries (trabeculectomy, GDD, Xen, and InnFocus) fail secondary to postoperative fibrosis. One-time application of MMC improved the success rate. It also resulted in avascular cystic blebs and increased incidence of infection. One-time application of MMC has no value during glaucoma drainage device surgery. Application of slow-release, low-dose antifibrotic system can improve the surgical success rate following glaucoma filtration surgery and needling of bleb, while minimizing the risk of avascular cystic bleb formation. Infection control either during or after surgery is another serious issue that can benefit from slow-release antibiotic system.

Conclusion
We have successfully created a biodegradable PLGA-based antifibrotic system that reduced postoperative fibrosis following both Ahmed glaucoma valve and trabeculectomy in rabbit models. We further developed a HA particle-based system with injectable antibiotics to reduce postoperative infections and injectable MMC and 5-FU to reduce postoperative fibrosis. FDA approval followed by human trials are awaited.

References
78 Intraocular Pressure Goals in Severe Secondary Glaucoma

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Purpose/Relevance
Secondary glaucoma can be caused by a diverse group of ocular pathologies that lead to elevated intraocular pressure (IOP). The Advanced Glaucoma Intervention Study (AGIS) demonstrated that a group of patients with advanced primary open angle glaucoma had no mean visual field progression if the mean intraocular pressure was 12.4 mm Hg and all clinic visits had an IOP less than 18 mm Hg.1 This study evaluates IOP control in patients with severe secondary glaucoma in light of the findings from AGIS to investigate if eyes with severe secondary glaucoma have a similar association between IOP control and visual field progression.

Methods
The study design is a retrospective chart review of patients at the University of Texas Southwestern Medical Center Ophthalmology Clinic (2010-2019) who have been diagnosed with severe secondary glaucoma. Patients with a diverse array of pathologies were included in the study: post-penetrating keratoplasty, post-pars plana vitrectomy, uveitic, traumatic, pigmentary, pseudoexfoliation, steroid induced, and neovascular. IOP data was collected. Humphrey visual fields were analyzed for glaucomatous progression as defined by the visual field scoring protocol in AGIS.2

Results
IOP and Humphrey visual field data were analyzed for 58 patients with a total of 71 eyes. Mean follow-up was 5.1 years. It was found that patients demonstrating visual field progression had a mean IOP of 24.55 mm Hg. Patients without visual field progression had an average IOP of 14.97 mm Hg. When grouping the patients into groups of mean IOP <15 mm Hg, 15-18 mm Hg, and >18 mm Hg over all clinic visits, the only group that showed statistically significant worsening for AGIS visual field score over time was the group with an IOP >18 mm Hg (average IOP 19.32 mm Hg).

Discussion
In the classic AGIS study with a population of advanced POAG patients, the average visual field score worsened over time if the average IOP across all clinic visits was 14.7 mm Hg or greater.1 In this study focusing on severe secondary glaucoma, the group showing a mean worsening of visual field score over time had an average IOP of 19.32 mm Hg. Additionally, severe secondary glaucoma patients who individually demonstrated visual field progression had an average IOP of 24.55 mm Hg. These findings suggest that eyes with severe visual field loss from secondary glaucoma may tolerate a higher IOP without experiencing visual field progression than eyes with similar visual field loss from POAG.

Conclusion
IOP goals in patients with severe secondary glaucoma may not need to be as low as patients with severe POAG.

References
Purpose/Relevance
In a phase 1/2 trial, a single administration of bimatoprost sustained-release implant (Bimatoprost SR; BimSR) managed IOP in a subset of glaucoma patients (pts) for 24 months without use of rescue topical medication. This analysis evaluated the early IOP response in these pts.

Methods
Phase 1/2, prospective, 24-month, paired-eye trial in open-angle glaucoma pts. BimSR was administered intracamerally in the study eye; the fellow eye received topical bimatoprost 0.03% QD. Subgroup analysis evaluated IOP in pts who had long-term IOP control in the study eye without rescue or implant retreatment (reTx) vs. all other pts. IOP through 12 weeks was defined as average IOP from Day 8 through Week 12.

Results
Of 75 enrolled pts, 19 (25%) were evaluated at Month 24 and had not received rescue/reTx in the BimSR-treated eye. These pts demonstrated early and sustained IOP control after BimSR administration, with mean (SEM) IOP through 12 weeks of 15.8 (0.3) mmHg (see figure). Patients with rescue/reTx or early exit had a mean (SEM) IOP through 12 weeks of 18.0 (0.5) mmHg ($P < .001$ vs. pts with no rescue/reTx). Baseline mean IOPs were 23.4 and 25.8 mmHg, respectively. Because of the baseline IOP imbalance between the groups, we examined the subgroup of the rescue/reTx/early exit pts who had the same baseline IOP range as the pts with no rescue/reTx (range: 22-26 mmHg; baseline mean IOP of 23.6 mmHg); the mean (SEM) IOP through 12 weeks for this subgroup was 16.8 (0.3) mmHg ($P = .033$ vs. pts with no rescue/reTx).

Discussion
Early response to treatment can potentially be used to predict later response and guide clinical decision-making. For example, initial clinical responses of pts with diabetic macular edema to intravitreal anti-VEGF therapy in the first 3 months of treatment have been shown to be predictive of long-term benefits and may signal a need for additional therapy. The present phase 1/2 study results suggest an association between IOP at early timepoints after BimSR administration and long-term IOP lowering without additional treatment. Modeling is being done to quantify the association between the early response and long-term IOP lowering.

Conclusion
In this phase 1/2 study, IOP response through 12 weeks after BimSR administration predicted sustained IOP reduction without rescue/reTreutment.

Reference
Factors Associated with Laser Trabeculoplasty Efficacy and Failure: IRIS Registry Analysis

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Purpose/Relevance
Laser trabeculoplasty (LTP) is one of the most frequently performed ophthalmic interventions [1,2]. We analyzed a large cohort using the Intelligent Research in Sight (IRIS) Registry [3] to assess potential predictive factors of treatment outcomes.

Methods
Between March 24, 2014 and August 31, 2018, IRIS Registry data were extracted if the eye had a procedural code for LTP and a glaucoma diagnosis. Eyes were excluded if LTP laterality could not be determined, no recorded pre-LTP baseline IOP, or angle closure diagnosis was present. Pre-treatment baseline IOP was defined as the average of the immediate two IOP readings prior to LTP. Following LTP, “nonresponders” were those with < 20% IOP reduction after 8 weeks, while responders were those with ≥ 20% IOP reduction. For responders, any subsequent post-LTP IOP that was above 80% of baseline IOP was considered a failure. Eyes were censored if IOP-lowering medication and/or a procedure was performed, or the eye reached the end of follow up. Univariate and multivariate logistic regression was used to evaluate response vs. nonresponse. The survival analyses for time-to-failure used univariate and multivariate Cox regression.

Results
A total of 263,480 eyes were included: 74.72% aged ≥ 65 years (mean 71.4 +/- 11.74 years); 56.0% female; 64.8% white, 11.8% black. 73.1% of diagnoses were primary open angle glaucoma and 18.6% were glaucoma suspect. Mean baseline pre-LTP IOP was 19.1 +/- 5.0 mmHg, mean number of pre-LTP medications was 2.1 +/- 1.5. There were 97,148 (36.9%) responders and 166,332 (63.1%) nonresponders. Angle recession, uveitis, and aphakia increased the odds of a nonresponse (odds ratios 5.97, 1.89, 1.79, respectively, all P < 0.0001) in univariate analyses. Among responders, young age (18-39 years) and uveitis increased the risk of failure (hazard ratios 1.46 and 1.78, respectively, both P < 0.0001). The effects of glaucoma severity, surgeon experience and practice type were not clinically significant.

Discussion
The effectiveness of LTP to reduce IOP is less than efficacy reported in trials, which may be due to lower baseline IOP. LTP may have been performed to decrease medication burden rather than to decrease IOP. Future studies are needed to elucidate practitioner utilization pattern.

Conclusion
In the IRIS Registry, ≥ 20% IOP reduction occurred in only about one-third of LTP patients’ eyes, with angle recession, uveitis, and aphakia associated with increased odds of nonresponse.

References
81 Effect of Bimatoprost SR on IOP in Patients Previously Treated With 0, 1, or ≥2 Topical IOP-Lowering Medications: Results of Phase 3 Study at Primary Database Lock

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Purpose/Relevance
To evaluate the intraocular pressure (IOP) lowering provided by an intracameral, biodegradable, sustained-release bimatoprost implant (Bimatoprost SR, BimSR) in patients with open-angle glaucoma (OAG) or ocular hypertension (OHT) previously treated with 0, 1, or ≥2 topical IOP-lowering medications.

Methods
In 2 identical, masked, 20-month, phase 3 studies (n = 594 and 528), patients with OAG or OHT were randomized to study eye treatment with BimSR 10 or 15 µg (day 1, weeks 16, 32) or topical timolol 0.5% BID. Previous IOP-lowering medications were washed out before baseline. Primary database lock occurred when the last patient completed the week 12 visit. IOP lowering at Hour 0 and use of rescue medication were evaluated using the pooled study dataset in patient subgroups stratified by number of IOP-lowering medications (0, 1, or ≥2) used in the study eye at screening before washout.

Result
BimSR 10 and 15 µg met the primary endpoint of noninferiority to timolol in IOP lowering through week 12. IOP lowering from baseline with both BimSR 10 and 15 µg was similar among patient subgroups on 0, 1, or ≥2 medications at screening. During follow-up through week 48, mean percentage IOP lowering from baseline for patients on ≥2 IOP-lowering medications at screening ranged from 22% to 33% with BimSR 10 µg and 22% to 34% with BimSR 15 µg, from mean baseline (SD) IOP of 24.6 (2.4) and 25.4 (3.0) mmHg, respectively. Probability of patients requiring no rescue medication for 360 days after the third administration was high and similar for patients on 0, 1, or ≥2 medications at screening (see figure).

Discussion
In clinical practice, many patients with OAG and OHT need to use >1 topical medication to control their IOP.1 In this phase 3 evaluation, IOP lowering with BimSR was similar in patients who previously required ≥2 topical IOP-lowering medications and patients who previously used no or 1 medication. The duration of IOP control with BimSR was similar regardless of number of medications used at screening.

Conclusion
BimSR effectively reduced IOP. IOP lowering provided by BimSR 10 and 15 µg was similar in patients regardless of whether they used 0, 1, or ≥2 IOP-medications at screening before the study. The results show the potential for BimSR to effectively control IOP in patients previously requiring polypharmacy.

Reference
Sources of Variability in Mean Intraocular Pressure (IOP) in Nonhuman Primates Instrumented with Continuous Telemetry

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Purpose/Relevance
Prospective studies have identified mean IOP (measured clinically with snapshot devices) as a major risk factor in glaucoma, although there is a wide range of eye-specific susceptibility to mean IOP. IOP is most commonly measured intermittently during clinical examination using devices that provide only mean measurements of IOP at a single point in time. Thus, there is limited information about the true variation in IOP over short- and long-term timescales for most patients with glaucoma. The purpose of this study was to determine the sources of variability in mean IOP (1-hour averages) in nonhuman primates (NHPs) implanted with a wireless IOP telemetry system.

Methods
Six NHPs aged 4-6 years were implanted with IOP telemetry systems (3 bilateral, 3 unilateral; Konigsberg Instruments¹), and IOP was continuously monitored at 500 Hz for periods of 16-441 days, depending on the animal. IOP transducers were calibrated every two weeks via anterior chamber manometry; all data were adjusted for drift between calibrations and for barometric pressure in real time. A nested, linear mixed effects model was used to assess the following sources of variance in hourly mean IOP data: day-to-day, hour-to-hour, NHP-to-NHP, and eye-to-eye within NHPs, for the 24-hour data, and the waking (06:00-18:00) and sleeping (18:00-06:00) periods separately.

Results
The day-to-day component of mean IOP variability was highest, accounting for 54% of the total IOP variability, while NHP-to-NHP variability accounted for 28% of the total variance, hour-to-hour accounted for 14%, and eye-to-eye variance within NHPs accounted for only 3% of the total IOP variance (see figure).

Discussion
Day-to-day variance in IOP is much greater than the hour-to-hour variance in IOP, which suggests sampling IOP over many days is much more important than sampling IOP at many times during the same day. There is little variability in IOP between the two eyes from the same NHP (3% of total IOP variability), and NHP-to-NHP variability is much larger (28% of total IOP variability).

Conclusion
This result shows that experimental designs to study IOP in which one eye is treated (e.g., to induce chronic IOP elevation and experimental glaucoma) and the contralateral eye serves as an internal control should be efficient since there is little IOP variability between eyes within the same animal and therefore measured IOP differences will likely be due to treatment effects.
Reference

83 PROSE Devices in Glaucoma Patients
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Purpose/Relevance
The prosthetic replacement of the ocular surface ecosystem (PROSE, Boston Foundation for Sight) device is an FDA-approved fluid-ventilated custom-fit scleral lens that provides a lubricating environment for the cornea in patients in severe ocular surface disease (OSD). The purpose of this study was to examine PROSE device fit in glaucoma patients at Weill Cornell Medicine (WCM).

Methods
Retrospective chart review of patients who underwent PROSE device fitting. Records were culled for demographic information and ophthalmic variables including history of glaucoma or glaucoma suspect, glaucoma treatments and surgeries, exam findings, and PROSE device fit comments. Descriptive analyses were performed.

Results
Between 2011 and 2017, 320 patients underwent PROSE device fitting at WCM, of whom 48 patients (15%) had a glaucoma or glaucoma suspect diagnosis. Secondary glaucoma (19 patients, 39.6%) was most common, followed by glaucoma suspect (14 patients, 29.2%). Six patients had a history of incisional glaucoma surgery in the eye undergoing PROSE device fitting: 3 valved glaucoma drainage implants and 3 trabeculectomies. Three of these eyes were successfully fit with PROSE devices, two of which had trabeculectomies.

Discussion
PROSE device patients at WCM had a higher prevalence of glaucoma than in the general population. This may be related to topical steroid use in patients with severe OSD,1 such as from burns or Stevens-Johnson syndrome. Additionally, glaucoma patients are at higher risk for OSD due to aging and the deleterious effect of topical glaucoma therapies. Finally, scleral lens wear itself has been hypothesized by some groups to cause changes to intraocular pressure.

Among patients with incisional glaucoma surgery, PROSE device fitting was challenging, with a 50% failure rate.

Conclusion
PROSE device patients may be at increased risk of glaucoma. Prior incisional glaucoma surgery is a risk factor for failure of adequate PROSE device fit.

Reference
84 Engineering a Bioartificial Tenon’s Capsule Tissue Model for High Throughput Drug Testing

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Purpose/Relevance
Mitomycin C is widely used to reduce aggressive scarring in bleb-forming glaucoma surgery. It is poorly titratable, leading to indiscriminate lethal effects that result in significant complications. There is a need for novel wound modulating adjuvants. The aim of this research is to validate a more physiologically translatable drug testing platform that can assess potential anti-fibrotic candidates for their capacity to alter resistance to outflow in a novel 3D perfused human Tenon’s capsule mimetic culture system.

Methods
Human Tenon’s capsule fibroblasts (HTCFs) were cultured within 3D collagen matrices inside a flow chamber slide. Cell culture media was then perfused through the flow chamber slide at a physiological aqueous turnover rate (2.6 µL/min). Hydrostatic pressure afferent to the flow chamber slide was continuously measured over the course of several days. To validate the model, the effects on system pressure were investigated in cells treated with transforming growth factor-beta 1 (TGFβ1) against vehicle control.

Results
Confocal microscopy confirmed the presence of a 3D matrix containing HTCFs suspended within and throughout the flow chamber. Treatment of cells with TGFβ1 led to an increase in system pressure of 5-7 mmHg over the course of 4 days compared to vehicle control.

Discussion
In keeping with the known effects of elevated levels of transforming growth factor beta in glaucomatous eyes, this bioartificial system was able to demonstrate a conversion of fibroblasts to myofibroblasts and an alteration in measurable hydraulic properties. The structural and functional parameters that can be captured may allow this system to be an ideal model for testing of potential therapeutic targets that are downstream, and more specific, than the upstream effects of TGFβ1.

Conclusion
HTCFs treated within our model have features consistent with aberrant in vivo wound healing. Now that this model has been validated, it is possible to begin testing novel therapeutic drugs that target the downstream effects of TGFβ1.

References
Purpose/Relevance
Reduction in intraocular pressure (IOP) is the only proven treatment to prevent progression of vision loss associated with POAG. Topical eye drops for POAG are limited by poor patient compliance and low drug bioavailability/residence time on the corneal surface. GBV-6249-192 is an injectable prodrug formulation of a beta-adrenergic antagonist designed to enable sustained IOP reduction for ≥4 to 6 months with a single IVT administration. This study evaluates the in vitro and in vivo performance of the prodrug formulation including pharmacokinetics, ocular safety, and IOP-lowering efficacy in preparation of a Phase 1/2a first-in-human clinical study.

Methods
GBV-6249-192 prodrug was synthesized by conjugation of hydrophobic linkers to the parent compound to enhance particle encapsulation. Drug-loaded biodegradable microparticles (MP) were produced and surface-modified to facilitate particle aggregation in vivo to prevent possible interference with the visual axis. The particle size, drug loading, and particle aggregation were assessed in vitro. Pharmacokinetics were evaluated in Dutch-belted rabbits at two dose levels following a single IVT injection of the MP formulation. Target ocular tissues and blood samples were collected at various timepoints, and drug concentrations were quantified by liquid chromatography/mass spectrometry (LC/MS/MS). Experimental ocular hypertension (OHT) was induced by injecting hypertonic saline via the episcleral veins in the left eye of brown Norway rats twice over a period of two weeks. The MP formulation was administered by a single IVT injection in the left eye at two dose levels. IOP was measured in both eyes prior to the MP injection and on Days 2, 7, 14, 21, and 28 using a Tono-Pen. Both eyes in all animals were examined and scored using a Draize/McDonald-Shadduck scoring system and ocular histology.

Results
GBV-6249-192 achieved high drug loading, encapsulation efficiency, and tunable sustained drug release kinetics owing to the modified physiochemical properties over the parent compound. The pro-drug linker of GBV-6249-192 degrades by hydrolysis, allowing full conversion of the inactive prodrug to the active parent compound. In vitro drug release lasted over a period of approximately 180 days. The MP coalesced into a solid, discrete depot upon injection. Pharmacokinetic studies revealed significant quantities of parent drug at target tissues (iris-ciliary body) from day 1 and sustained past 3 months with concentrations exceeding 3000-fold greater than the \( K_i \) at 3 months. No drug was detected in plasma at any timepoint. Significant IOP reduction in OHT rats was observed at 1 week post injection and was sustained for over 1 month with a maximal IOP reduction of ~28% over OHT control. The formulation was well tolerated, without any signs of ocular toxicity.

Discussion
GBV-6249-192 is an injectable biodegradable MP formulation of a beta-adrenergic antagonist prodrug that may potentially provide sustained reduction of IOP for up to 4 to 6 months with a single IVT dose and may lead to a new long-term treatment in patients with POAG.

Conclusion
A Phase 1/2a first-in-human study is planned.

Reference
**Comparison of Extraocular and Intraocular Pressure Transducers for Measurement of Transient IOP Fluctuations Using Continuous Wireless Telemetry**

**JESSICA JASIEN¹, Sonia Asif, Lindsay Rhodes, Brian Samuels, J Crawford Downs**

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**Purpose/Relevance**

We have developed and validated three wireless implantable telemetry systems; two that measure IOP continuously using a tube inserted into the anterior chamber (AC) connected to an extraocular (EO) pressure transducer mounted in the orbital wall (Konigsberg Instruments EO [IOVS 2011; 52(10):7365-7375] or TSE-Systems Stellar EO), and a third where a pressure transducer was implanted directly into the AC (TSE-Systems Stellar AC). The purpose of this study was to compare transient IOP fluctuations measured with the extraocular and intraocular pressure transducer.

**Methods**

Transient IOP fluctuations were measured and quantified in 9 eyes of 6 male rhesus macaques (NHPs) using the Konigsberg EO system and 16 eyes of 12 male NHPs with pressure transducers inserted directly in the AC (Stellar AC). In 10 eyes of 7 NHPs for which Stellar AC data were acquired, transient IOP fluctuations were also quantified using the Stellar EO system after a second surgical implantation. In all three approaches, IOP transducers were calibrated every two weeks via anterior chamber manometry, and data were adjusted for drift between calibrations and for barometric pressure in real time. The frequency and magnitudes of transient IOP fluctuations above momentary baseline were quantified using an automated finite impulse response filtering system (IOVS 2019;60(7):2572-2582). The Konigsberg EO system measured IOP continuously at 500 Hz, whereas the Stellar EO and AC systems measured IOP at 200 Hz at a 10% duty cycle (15 s out of every 150 s); all Stellar data were interpolated to estimate continuous sampling for direct comparison to the previously published Konigsberg data.

**Results**

Both tube-based EO systems measured 8,000-12,000 transient IOP fluctuations per hour >0.6 mmHg above momentary baseline during waking hours and 5,000-6,500 fluctuations/hour during sleeping hours. These transient IOP fluctuations represented 8-16% of the total IOP energy the eye must withstand during waking hours, and 4-8% during sleeping hours.

**Discussion**

In the 12 NHPs for which direct IOP measurements were captured using an IOP sensor in the AC, transient IOP fluctuation magnitude and frequency were comparable to those captured with the EO tube-based systems.

**Conclusion**

For the purposes of IOP telemetry, transient IOP fluctuations can be accurately captured using either a pressure sensor placed directly in the eye, or with a transducer mounted remotely and connected to the eye via a fluid-filled tube.
Figure. Data comparison between the Stellar intraocular (left) and extraocular (right) transducers. (Top) The daily mean number of transient IOP fluctuations per hour over 0.6 mmHg in magnitude during waking hours (6AM-6PM) plotted over the entire data acquisition period in each eye. Each data point represents one day of data, presented as the mean number of transient IOP fluctuations per hour during the 12 waking hours. The eye must withstand ~10,000 transient IOP fluctuations every hour during waking hours. (Middle) The mean hourly frequency distribution of transient IOP fluctuation magnitude during waking hours for each eye binned by the magnitude for all data collected (error bars are standard deviation). (Bottom) Mean hourly IOP transient impulse, plotted as percentage of total IOP impulse, for all eyes of all animals. The plotted values are a measure of the amount of energy the eye must withstand from transient IOP fluctuations relative to the total IOP energy the eye must absorb. Waking hours are highlighted.

Reference
Evaluation of Long-term Visual Field Function in Patients Undergoing Glaucoma Drainage Device Implantation

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Purpose/Relevance
To determine the change in global and regional Humphrey visual field (VF) after glaucoma drainage device (GDD) implantation in glaucomatous eyes over 3-year follow-up.

Methods
Design: Retrospective chart review. Subjects: Patients undergoing placement of an Ahmed, Baerveldt, or Molteno implant from 2010-2015 at the University of California, San Francisco. Methods: Patients who underwent GDD placement with reliable pre-operative and yearly post-operative VF measurements were included in this study. Clinical parameters were compared between pre-operative and follow-up visits, including visual acuity, intraocular pressure (IOP), number of glaucoma medications, global VF metrics (mean deviation (MD), pattern standard deviation (PSD), Collaborative Initial Glaucoma Treatment Study (CIGTS) score on total deviation probability (CIGTS_TDP), and pattern deviation probability (CIGTS_PDP)), and regional metrics (regional total deviation [TD], regional pattern deviation [PD], and regional CIGTS_TDP and CIGTS_PDP). Univariate and multivariate regression analyses were performed to determine risk factors for VF worsening after GDD implantation surgery. Main Outcome Measures: Changes in global and regional VF metrics after GDD implantation over 3-year follow-up.

Results
A total of 106 eyes from 95 patients were included in the study with an age (mean ± standard deviation) of 65.9 ± 15.9 years. Sixty-seven (63.2%) eyes were pseudophakic at presentation. IOP (mean ± standard deviation) was reduced from 23.1 ± 8.5 mmHg to 12.7 ± 3.1 mmHg at 3-year follow-up (P < 0.001). Mean preoperative MD, PSD, CIGTS_TDP, and CIGTS_PDP were -11.7 ± 7.8 dB, 7.8 ± 3.8, 12.8 ± 6.2, and 8.2 ± 6.0, respectively. MD, PSD, and global CIGTS_PDP showed no statistically significant changes in follow-up, whereas global CIGTS_TDP showed mild progression, from 10.7 to 12.8 at 3-year follow-up (P = 0.01). No regional metrics showed worsening in follow-up. Defects in the superior hemifield was more common than in inferior hemifield at baseline and follow-ups for all regional metrics. Pre-operative number of glaucoma medications was found to be associated with worsening on CIGTS_TDP.

Discussion
In summary, this is the first large study on HVF changes after GDD implant. We found that GDD implantation provides effective IOP control and prevents visual field progression in global and regional analysis over the 3-year follow-up period. Analysis using CIGTS scoring on total deviation showed mild worsening in visual field, possibly related to media opacities, with pre-operative number of glaucoma medications the only significant risk factor associated with this progression. In regional analysis, the superior hemifield was more severely affected in baseline and follow-up fields, consistent with prior studies.

Conclusion
Overall, GDD implantation surgery is effective at reducing IOP and stabilizing VF function in glaucomatous eyes over 3 years of follow-up. The superior hemifield is affected more severely compared to the other regions. The number of pre-operative glaucoma medications is associated with mild VF progression measured by CIGTS_TDP.

Reference
Patient Experience With Intraocular Pressure Measurement by Tono-Pen and Icare

Patent Experience With Intraocular Pressure Measurement by Tono-Pen and Icare

**Purpose/Relevance**

To assess patients’ experience with intraocular pressure (IOP) measurement by the Tono-Pen XL (Reichert Technologies) and Icare TA01i (Icare, USA).

**Methods**

IRB-approved, prospective study of 40 English-speaking volunteer patients at community eye screenings between June and September 2019. Informed consent was obtained from each subject. IOP measurement of both eyes was performed with the Icare, followed by instillation of an anesthetic drop and measurement with the Tono-Pen. Patients then completed a Likert scale questionnaire to assess comfort, anxiety, pain, and referral likelihood.

**Results**

Forty subjects who had their IOP measured completed the questionnaire. Overall, subjects found that both the Icare and Tono-Pen were comfortable, induced little to no anxiety, and caused minimal pain. Subjects were likely to recommend both techniques to others. Frequency distributions of responses are shown in Figure 1. While both techniques were well tolerated, results tended to favor the Icare. Five percent of patients found the Tono-Pen to be very uncomfortable, while no patients found the Icare to be so. More patients found the Icare to be very comfortable (12.5% vs. 7.5%). Extreme anxiety was more common for the Tono-pen (7.5% vs. 2.5%). More patients were less likely to refer the Tono-Pen than the Icare (12.5% unlikely or very unlikely vs. 2.5%). The median value of Likert scale responses of patients who had previously undergone IOP measurement (62.5%) and those who had not (32.5%) did not show any differences.

**Discussion**

Both Tono-Pen and Icare IOP measurements have been shown to have good reproducibility and correlation with applanation across a range of IOP. Our results suggest that both the Icare and Tono-Pen are well tolerated, with the Icare tending to be more comfortable, less anxiety inducing, and more likely to be referred by patients. Both devices appear to be as well tolerated for first-time patients as for experienced patients.

**Conclusion**

Tonometry comfort and preferences have important implications for community and global screenings. Our findings suggest that while the Icare may be slightly better tolerated, patients tolerate both devices very well.
Reference
The Effects of Hypotension and Steep Trendelenburg Positioning on Optical Coherence Tomography Testing

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Purpose/Relevance
Trendelenburg positioning (T) for surgical procedures increases intraocular pressure (IOP) while blood loss and the use of anesthetics lead to systemic hypotension. The difference between these two variables, or ocular perfusion pressure (OPP), may play a role in development of open angle glaucoma (OAG); this study investigates the impact of decreased OPP on optical coherence tomography (OCT) testing.

Methods
Patients without glaucoma who were scheduled for a T-positioned surgery were enrolled prospectively. OCT testing with retinal nerve fiber layer (RNFL) and ganglion cell complex (GCC) thicknesses was performed pre- and post-operatively. Intra-operative IOP measurement was performed with the Tono-Pen AVIA tonometer. Subjects were classified by the nadir of their intraoperative mean arterial blood pressure (MAP): below 65 (hypotensive), and equal to or greater than 65 (normotensive). Data for the right eyes of subjects was used, and P value set at 0.05.

Results
Of 48 subjects, 14 had MAP <65, and 34 had MAP ≥65 (P < 0.0001). Mean IOP was similar between groups pre-induction and at the end of T-positioning (P = 0.77 and 0.41, respectively), and the IOP of both groups significantly increased due to T-positioning (P < 0.0001 for both). In hypotensives, average, superior, and inferior RNFL, and average, superior, and inferior GCC thicknesses were not significantly different pre- and post-operatively (P = 0.93, 0.95, 0.89, 0.89, 0.94, 0.85, respectively). Focal loss volume (FLV) and global loss volume (GLV) were not significant either (P = 0.89 and 0.99, respectively). Similar findings for normotensives were present (avg. RNFL P = 0.77, sup. RNFL P = 0.78, inf. RNFL P = 0.79, avg. GCC P = 0.76, sup. GCC P = 0.52, inf. GCC P = 0.84, FLV P = 0.34, GLV P = 0.58).

Discussion
Systemic blood pressure impacts OPP, and abnormal vascular autoregulation and acute changes in OPP have been linked to the pathogenesis of glaucoma.1 OAG has developed in patients following low blood pressures,2 and head-down positioning can be associated with RNFL thinning.3 Two causes of low OPP, intraoperative hypotension and elevated IOP in T-positioning, were examined but did not result in OCT changes 3 months post-operatively. With prolonged follow-up time, OCT changes may be detected.

Conclusion
Decreased OPP did not result in significant OCT changes; however, it is important to consider its role and monitor patients for the development of OAG.

References
Profile of IOP Response to Bimatoprost Sustained-Release Implant (Bimatoprost SR) Before Added Treatment with Topical Medication: Phase 3 Study Results

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Purpose/Relevance
To evaluate intraocular pressure (IOP) and the rate of IOP return to baseline in patients (pts) with open-angle glaucoma (OAG) or ocular hypertension (OHT) who required topical IOP-lowering medication (med) after receiving 3 administrations of Bimatoprost SR (BimSR).

Methods
In 2 identical-design, masked, 20-month, phase 3 studies, OAG/OHT pts were randomized to study eye treatment with BimSR 10 or 15 µg (Day 1, Wks 16, 32) or topical timolol 0.5% BID. Added med was allowed if the investigator judged that IOP was inadequately controlled. Efficacy measure was IOP. Database locks (when last enrolled pt completed visit) were Wk 52 (Study 1) and Wk 12 (Study 2). All available pooled study data after third administration were analyzed.

Results
The probability of not having added med at 360 days after the third administration was 82% and 86% in the BimSR 10- and 15-µg arms, respectively. For pts not adding med, the mean average IOP after the third administration was 17.6 mmHg (BimSR 10 µg, n = 253) and 17.3 mmHg (BimSR 15 µg, n = 232). Figure shows study eye mean IOP after the third administration, prior to and at med start, for the 81 pts who required med. Mean (SD) IOP was 26.0 (2.8) and 25.5 (2.6) mmHg at baseline, and 25.4 (5.6) and 25.1 (8.3) mmHg at med start, in the 10- and 15-µg arms, respectively. In the 10-µg arm, mean IOP ranged from 20 to 21 mmHg at 4-12 weeks before med start, from 18 to 19 mmHg at 16-24 weeks before med start, and was ≤18 mmHg at ≥28 weeks before med start. Mean IOP in the 15-µg arm was 21 mmHg at 4 weeks before med start and 19 mmHg at most time points ≥8 weeks before med start.

Discussion
In a phase 1/2 study, a single BimSR dose provided sustained IOP lowering beyond the time of drug availability predicted by animal pharmacokinetic studies. In phase 3 evaluation, a long duration of effect was also apparent, with a minority of pts needing added med for 1 yr after the third administration. The return to baseline IOP in pts who required added med after the third administration generally was not abrupt.

Conclusion
After the 3rd BimSR administration, most pts required no added med for 1 yr, and the BimSR effect on IOP diminished slowly for pts who required added med. On average, IOP was >20 mmHg 4 weeks before adding med; pts with IOP >20 need closer follow-up to determine need for added med.
Reference


Figure 1
Safety and Effectiveness of Argon Laser Peripheral Iridoplasty in a Large Group of Narrow Angle Patients Who Failed Laser Peripheral Iridotomy

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Purpose/Relevance
To report the long-term outcomes of patients with persistently narrow angles after laser peripheral iridotomy (LPI) treated with argon laser peripheral iridoplasty (ALPI).

Methods
A retrospective chart review was performed on 40 eyes of 40 patients who underwent ALPI at the Massachusetts Eye and Ear Infirmary between 2015 and 2018. Data collected included patient demographics, best-corrected visual acuity (BCVA), intraocular pressure (IOP), number of IOP-lowering medications, gonioscopic examination, the presence of peripheral anterior synechiae (PAS) or inflammation before and after the procedure, and any subsequent procedures. Study visits included the pre-ALPI visit and follow-up visits 1-2 weeks, 6 weeks, 3-6 months, 1 year, and 2 years. Demographic and baseline data were analyzed by mean (± SD) or frequency. Snellen BCVA was converted to logMAR. Paired t-tests were used to compare changes in IOP, the number of IOP-lowering medications, and visual acuity.

Results
The mean follow-up period was 36.8 ± 26.2 months. Of the 40 eyes, 37 underwent gonioscopic examination at the first or second follow-up post-ALPI. Of these, 81.1% established a successful opening of the angle where posterior trabecular meshwork was seen in at least two quadrants, while 18.9% did not. Mean IOP was not significantly different from baseline at any time point ($P > 0.05$), nor were there differences in the number of IOP-lowering medications or BCVA at any time point ($P > 0.05$). New PAS developed in 7.5% of patients. Mild inflammation was seen in 2.5% of patients at the first post-ALPI visit, but this spontaneously resolved. Approximately 28% of patients eventually required cataract extraction to open the angle, but most of the surgeries happened >1 year after the ALPI. Approximately 5.0% of patients required glaucoma filtration surgery, 2.5% underwent selective laser trabeculoplasty, and 2.5% required an additional ALPI treatment.

Discussion
This is one of the largest studies examining the outcome of ALPI, and more data will be included for the official poster presentation. Our results are similar to those reported elsewhere, suggesting that ALPI is effective in further opening angles that have failed LPI.1,2 These effects may not be indefinite, as progressive re-narrowing of the angle requiring other interventions was observed in 27.5% of patients. However, the majority of these patients did not need cataract surgery to re-open the angle until more than 1 year post-ALPI, suggesting its effectiveness in at least the short term in a majority of patients.

Conclusion
ALPI is an effective and safe procedure that helps establish successful opening of the angle in a majority of patients.

References
92 Real-World Use of Latanoprostene Bunod 0.024% in Patients with Glaucoma or Ocular Hypertension Naïve to Pharmacotherapy

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¹ Virginia Eye Consultants

Purpose/Relevance
Latanoprostene bunod 0.024% (LBN, Vyzulta®) is a nitric oxide-donating prostaglandin F₂α analog indicated for the reduction of intraocular pressure (IOP) in patients with open-angle glaucoma (OAG) or ocular hypertension (OHT). The purpose of this study was to evaluate the real-world efficacy and safety of LBN in patients with OAG or OHT naïve to IOP-lowering pharmacotherapy.

Methods
This is an ongoing, multicenter, retrospective chart review. Patients were ≥18 years of age with no prior IOP-lowering therapy or glaucoma surgery. Patients had to have at least two follow-up visits (spanning ≥2 months) following initiation of LBN treatment. Data extracted from the charts included age, sex, race, cup-to-disc ratio, central corneal thickness, adverse events (AEs), IOP, and visual acuity (BCVA). IOP comparisons between baseline and follow-up visits were performed using paired t-tests.

Results
Sixty-three patients were included in this interim analysis. Mean (SD) age was 59 (15) years, and the majority (73.4%) were female. Mean (SD) IOP at baseline in the study eye (the eye with the highest IOP) was 21.7 (6.0) mm Hg; the median days to the first and second follow-up visit was 29 and 130 days, respectively. Treatment with LBN led to a reduction of 7.1 (4.7) and 7.3 (5.1) mm Hg at the first and second follow-up visit, respectively (P < 0.001 for both vs. baseline) or a decrease of 30.5% and 30.6% from baseline. Among patients with elevated IOP (>21 mm Hg) at baseline (n = 29), LBN led to a reduction of 10.0 (4.6) and 11.1 (4.6) mm Hg at the first and second follow-up visit, respectively (P < 0.001 for both vs. baseline) or a decrease of 37.1% and 40.8% from baseline. There were no apparent changes from baseline in BCVA. The most common AEs were blurred vision and irritation. Ocular redness was reported by one patient in one eye.

Discussion
Prior LBN clinical studies in subjects with OAG or OHT demonstrated a mean diurnal IOP reduction of 32% at 3 months in subjects with a baseline IOP of 26.7 mm Hg (J Glaucoma. 2018;27(1):7-15), and 22.0% at 4 weeks in Japanese subjects with a baseline IOP of 19.6 mm Hg (Adv Ther. 2016;33:1612-27). Results herein expand on the documented IOP-lowering efficacy of LBN to real-world OAG/OHT patients new to pharmacotherapy.

Conclusion
Based on this interim analysis of an ongoing retrospective chart review, treatment with LBN produced a robust IOP reduction in patients with OAG or OHT naïve to pharmacotherapy, with few AEs.

References
Incorporation of the First Nitric Oxide Donating Prostaglandin, Latanoprostene Bunod, into Clinical Practice

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Purpose/Relevance
To assess early utilization, efficacy, and side effects of latanoprostene bunod 0.024% (LBN), a new class of drug for lowering IOP, in clinical practice. LBN was approved by the US FDA in November 2017 and became available for clinical use in January 2018.

Methods
Retrospective EMR review identified all open angle glaucoma (OAG) and ocular hypertensive (OHT) patients placed on LBN by 4 glaucoma specialists (JS, DG, NS, and JT) at Icahn School of Medicine at Mount Sinai Faculty Practice from January to October 2018. IOP and medications were recorded for each patient’s 2 visits before starting LBN, for their first visit on LBN, and for their most recent visit on LBN until the end of 2018. Statistical analysis including paired t-test was performed using Excel. IRB approval was obtained.

Results
Medical records of 95 eyes were reviewed for 53 patients: 27 M and 26 F; 18 white, 5 black, 1 Asian, 1 Native American, 2 multiracial, 26 unknown/other; age (mean ± SD) 68.5 ± 11.9. There was a mean IOP increase of 1.7 mmHg before patients were prescribed LBN. At visit prior to starting LBN, IOP was 16.6 ± 3.8 mmHg. At the most recent visit, post-treatment IOP was 14.4 ± 4.1 on 3.6 medications; mean IOP reduction on LBN was 2.2 mmHg (P < .001). IOP was reduced ≥2 mmHg (on 3.3 meds) in 51%, by ≥3 mmHg (on 3.4 meds) in 41% and by ≥4 mmHg (on 3.4 meds) in 31% of eyes. Treatment duration was 121 ± 77 days. 32 patients remained on LBN throughout the follow-up period. 8 were discontinued for lack of efficacy, 4 for adverse effects including pain and itching, and 4 for financial reasons.

Discussion
During the first year of clinical use of LBN at Mount Sinai, IOP reductions were clinically and statistically significant, (mean 2.2 mmHg; P < .001), with 31% of patients having IOP reductions of ≥4 mmHg. These results suggest LBN was additive to other medications, as patients having IOP reductions of ≥2 mmHg, ≥3 mmHg, and ≥4 mmHg were on similar numbers of medications (3.3-3.4). Our results contrast with those of a study at the University of Michigan, which reported that patients had an IOP reduction of only 0.67 mmHg on LBN.1 Further research on LBN’s efficacy in lowering IOP in real-world settings is warranted.

Conclusion
Most patients treated with LBN had clinically and statistically significant reductions in IOP. The drug was well tolerated in most patients treated. LBN represents an effective, tolerated, and useful addition to the treatment of patients with elevated IOP.

Reference
Convolutional Neural Networks for Fast and Accurate Ophthalmic Medication Bottle Classification

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1 UC Irvine School of Medicine

Purpose/Relevance
Fine print on eyedrop bottles can be illegible, especially for glaucoma patients with visual deficits.3 Reliance on bottle cap color for medication identification gives inconsistent results.1 One study showed that among 65% of patients who found bottle cap color necessary to differentiate between their medications, only 80% were able to do so accurately.2 Moreover, the lack of specificity in verbalized color description often leads to a disconnect between physicians and patients.1 These errors increase the risk of noncompliance and highlight a need for accurate medication identification. Transfer learning with convolutional neural networks (CNNs), a class of deep learning neural networks commonly applied to image analysis, offers a viable solution through multi-class image classification. We compared 7 popular CNNs to determine the strongest candidate to address this problem space.

Methods
Seven CNNs pretrained on ImageNet, a large-scale image database, were retrained using our 2250 mobile-phone captured images to classify 5 commonly prescribed ophthalmic eyedrops—latanoprost, brimonidine tartrate, moxifloxacin, dorzolamide, and prednisolone acetate. Model efficiency and accuracy were evaluated using average image processing time of 228 images and k-fold cross-validation (k = 10), respectively. Data were expressed in mean ± standard deviation.

Results
Outperforming the other CNN architectures, MobileNet v2 yielded a k-fold cross-validation accuracy of 97.21 ± 2.76% and the shortest average image processing time at 3.45 ± 0.16 s/photo.

Discussion
This study optimized and evaluated the ideal CNN model for identifying glaucoma medications. With accuracy >97%, MobileNet v2 model outperformed the accuracy of cap color-based identification previously reported.2 One limitation of our trained CNN models is that all images were acquired with the eyedrop bottle laying on a flat surface and not hand-held, although our training dataset was diversified with images taken at multiple camera distances, angles, blurriness, contrast, color temperature, background, brightness, and rotation to more realistically reflect the image quality captured by patient’s own mobile devices.

Conclusion
Our findings demonstrated the efficacy of CNNs for bottle identification especially among glaucoma eyedrops. Further studies will cover a larger set of medications and integration of the trained MobileNet architecture into a camera-equipped mobile device for real-time identification.
Figure 1

References


95 Impact of Video Education on Patient Knowledge, Anxiety, and Satisfaction in Selective Laser Trabeculoplasty

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Purpose/Relevance
To assess the effect of an educational video on patient 1) knowledge of glaucoma and selective laser trabeculoplasty (SLT), 2) anxiety prior to SLT, and 3) perceptions of visit/provider quality.

Methods
Prospective survey study. Patients of three glaucoma specialists at a single academic medical center completed a survey at their procedure visit for SLT. One group viewed an educational video about SLT and its role in glaucoma treatment, while the other group did not. All patients received their specialist’s typical counseling for SLT. Patient knowledge about glaucoma and SLT was assessed with a 10-item questionnaire. The six-item State-Trait Anxiety Inventory scale (STAI-6) assessed patient anxiety with a score > 40 used to define significant anxiety. Perceptions of visit quality were assessed using a Likert scale.

Results
Twenty-two patients were divided into video (n=11) and control (n=11) groups. Patients who viewed a video did not score higher on SLT knowledge assessment than the control group (83.6% control vs 82.7% video group, p = 0.635). None of the patients had significant anxiety (max STAI-6 score 40, range 20-40, average 29) and anxiety scores were similar between groups (p = 0.385). Patients from both groups had positive perceptions of visit quality (91% strongly agree), understanding of the procedure (97% strongly agree), and satisfaction with their provider’s counseling (94% strongly agree). There was no difference between the groups in perception of visit quality or provider counseling (p = 0.999).

Discussion
Patients presenting for SLT had high levels of knowledge of glaucoma and SLT, low levels of pre-procedural anxiety, and high levels of satisfaction. Our specialists’ typical counseling for SLT was sufficient and a supplementary video did not improve patient education or decrease patient anxiety, contrary to previous work in glaucoma.1 We hypothesize that an educational video may be useful in clinic settings where patients receive less robust counseling.

Conclusion
Use of an educational video as part of the SLT visit may not influence patient knowledge, anxiety, or satisfaction when these metrics are high at baseline.

Reference
Aqueous Humor Proteomic Changes Correlated with Visual Field Index Parameters in Glaucomatous Optic Neuropathy

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Purpose/Relevance
Glaucoma is characterized by progressive optic neuropathy and ensuing visual field losses.¹ The purpose of this study was to discover the aqueous humor (AH) proteomic changes associated with visual field indices in glaucoma suspects and patients.

Methods
Aqueous humor samples from 27 patients were analyzed using liquid chromatography-tandem mass spectrometry (LC-MS/MS). Visual field parameters including mean deviation (MD), pattern standard deviation (PSD), visual field index (VFI) and glaucoma hemifield test (GHT) were obtained from electronic medical records. Correlation analyses were performed to discover the relationship between the aqueous humor protein levels and visual field measures.

Results
In total we identified 1126 proteins in 27 AH samples. A total of 44 proteins were significantly correlated with PSD. The top 5 proteins with significant positive correlation with PSD are: SERPINF2 ($P = 0.775$), GC ($P = 0.770$), AGT ($P = 0.744$), SERPINA1 ($P = 0.734$), and SERPINA3 ($P = 0.68$). Eighteen proteins were correlated with MD, including SRC ($P = 0.635$), IGHV-30 ($P = -0.652$), TAT ($P = -0.624$), GC ($P = -0.622$), and SNC73 ($P = -0.611$). We discovered 6 proteins positively associated with the global measure of visual function, VFI, including three isoforms of SERPINF1 ($P = 0.598, 0.522, 0.509$). Proteins negatively associated with VFI include DGKH ($P = -0.650$), NT5C3B ($P = -0.615$), and SERPINA3 ($P = -0.589$). Logistic regression analysis revealed that ten proteins were elevated in patients with glaucoma hemifield outside normal limits (ONL) as compared to those within normal limits (WNL), including SERPINA3 (OR = 112.73), beta-2-microglobulin (OR = 60.32), CP (OR = 39.01), CFI (OR = 28.51), and RARRES2 (OR = 15.19).

Discussion
We identified several proteins associated with each of the visual field parameters. PSD increases as glaucoma progresses, indicating focal losses. As glaucoma progresses, MD becomes more negative, indicating diffuse losses in the visual field. VFI indicates a spectrum of visual function, from a normal of 100% to blindness at 0%. Several members of the SERPIN superfamily were identified in our analyses. SERPINF1 was positively associated with VFI, while SERPINA3 was associated with ONL and poor PSD and VFI prognosis.

Conclusion
Proteins related to immune responses, including SERPINS and complement factors, were identified to be associated with abnormal visual field parameters. These findings provide targets for future studies investigating precise molecular mechanisms and new therapies for glaucomatous optic neuropathy.

Reference
**Targeted Delivery via Intracameral Administration Versus Topical Dose of 14C-Latanoprost in Animal Models**

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1 Allergan

**Purpose/Relevance**

To compare the delivery of 14C-latanoprost to the target tissue for IOP lowering by a single intracameral (IC) administration versus repeated topical ocular administration in animals.

**Methods**

Beagle dogs (n = 6) and cynomolgus monkeys (n = 2) received radiolabeled 14C-latanoprost, after which cryo-sections of the eyes were collected and processed for autoradiography. Beagle dogs (n = 3) received bilateral topical eyedrops of 14C-latanoprost once daily for 5 days and were euthanized at 1, 4, and 24 hours post the final dose. Another group of dogs (n = 3) received a single bilateral intracameral (IC) dose of 14C-latanoprost and were euthanized at 1, 2, and 4 hours post dose. Serial sagittal 40-µm sections of eyes with surrounding tissues were collected and processed for autoradiography. Monkeys received a single bilateral IC dose and were euthanized at 0.5 and 4 hours post dose, and serial sagittal 20-µm sections of eyes with surrounding tissues were collected and processed for autoradiography. 3D reconstructions using Amira software were made to visualize the monkey images.

**Results**

After IC administration, levels of radioactivity were concentrated in the anterior chamber and were not observed in the eyelid or orbit of dogs. Similarly, the 3D reconstruction of the monkey at 0.5 hour showed that radioactivity was primarily in the anterior chamber and the superior ophthalmic vein. At 4 hours, radioactivity could be seen only in the anterior chamber of the monkey. In contrast, with topical administration in the dog, radioactivity was distributed more diffusely in other anterior ocular tissues, including the eyelids and orbit.

**Discussion**

Intracameral administration of 14C-latanoprost resulted in targeted delivery to primarily the anterior segment in both monkey and dog. In contrast, topical administration in dogs demonstrated drug exposure to the eyelids and orbital tissues. The lack of radioactivity in the eyelids and orbit after IC administration potentially reduces off-target adverse effects.

**Conclusion**

IC administration of glaucoma medication can achieve greater targeted tissue drug delivery to the site of action of the drug compared with topical administration. It has the potential to reduce ocular surface and periorbital adverse effects associated with topical administration, such as conjunctival and eyelid hyperemia, eyelash growth, and periorbital fat atrophy, due to the localized drug delivery.

**Reference**

Efficacy and Safety of Netarsudil 0.02% in Patients with Chronic Angle-Closure Glaucoma Versus Primary Open-Angle Glaucoma

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Purpose/Relevance
To compare the efficacy and safety profile of netarsudil 0.02% ophthalmic solution in chronic angle closure glaucoma (CACG) patients and primary open angle glaucoma (POAG) patients.

Methods
This retrospective chart review study was conducted on patients seen at the Wills Eye Hospital Glaucoma Service who received netarsudil 0.02% between March and September 2018. Intraocular pressure (IOP) comparisons between study visits and CACG vs. POAG group were performed using two-way analysis of variance (ANOVA). Side effect rates were assessed using Fisher’s exact test.

Results
Nineteen eyes of 15 CACG patients and 238 eyes of 160 POAG patients were included. Changes in IOP after netarsudil treatment are shown in Table 1. At each time point, there were no significant differences in IOP between groups. In the CACG group, significant IOP reduction from baseline was achieved at the 3-month follow-up visit ($P = .045$). In the POAG group, significant IOP reduction from baseline was achieved at the 1-month follow-up visit ($P < .0001$). No significant changes in IOP were observed after these respective time points. Eleven (65%) CACG patients and 112 (47%) POAG patients experienced side effects at some point during the study period, and 4 (21%) CACG patients and 29 (12%) POAG patients reported conjunctival hyperemia at some point during the study period. These differences were not statistically significant ($P = .21$ and .281, respectively).

Discussion
Netarsudil 0.02% yielded a significant IOP reduction in both CACG and POAG patients, albeit later in CACG patients. There was no significant difference in the frequency of side effects between the two groups. Overall frequency of conjunctival hyperemia was lower than previously reported rates (50-53% at 3 months), likely due to reporting of subclinical hyperemia in prospective studies.

Conclusion
Despite the mechanism of action of netarsudil primarily involving the trabecular outflow pathway, patients with CACG are eventually able to achieve IOP-lowering effects similar to those in patients with POAG, with a tolerable side effect profile.

References

Table 1. Mean intraocular pressure (mmHg) by visit: chronic angle-closure glaucoma patients versus primary open-angle glaucoma patients receiving netarsudil 0.02%

<table>
<thead>
<tr>
<th>Patients with CACG</th>
<th>IOP, mmHg (mean±SD)</th>
<th>N</th>
<th>Patients with POAG</th>
<th>IOP, mmHg (mean±SD)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>20.84±4.83</td>
<td>19</td>
<td>18.84±5.18</td>
<td>238</td>
<td></td>
</tr>
<tr>
<td>1-month</td>
<td>17.82±6.77</td>
<td>17</td>
<td>15.59±5.21</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td>3-month</td>
<td>15.08±4.74</td>
<td>12</td>
<td>14.69±4.98</td>
<td>101</td>
<td></td>
</tr>
<tr>
<td>6-month</td>
<td>14.50±3.06</td>
<td>12</td>
<td>14.69±4.45</td>
<td>78</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: chronic angle-closure glaucoma, CACG; primary open-angle glaucoma, POAG; intraocular pressure, IOP; standard deviation, SD
The Efficacy and Safety Profile of Latanoprostene Bunod 0.024% in Glaucoma Treatment: Real-World Outcomes

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1 Wills Eye Hospital

Purpose/Relevance
To evaluate the efficacy and safety of latanoprostene bunod 0.024% ophthalmic solution in glaucoma patients.

Methods
This retrospective study was conducted on Wills Eye Hospital glaucoma patients prescribed with latanoprostene bunod between January and September 2018. All data, including side effects, were gathered from the electronic medical records.

Results
206 eyes of 131 patients were included. When adding latanoprostene bunod to the existing drug regimen, the mean ± SD IOP decrease at 1-, 3-, and 6-month follow-up were 5.16 ± 6.65, 6.94 ± 6.55, and 6.60 ± 9.56 mmHg, respectively (baseline IOP was 22.19 ± 7.63 mmHg); and 1.77 ± 5.12, 1.56 ± 4.70, and 1.75 ± 2.88 mmHg when substituting for a prostaglandin analog, respectively (baseline IOP was 18.85 ± 5.24 mmHg). All decreases were statistically significant (P < 0.05). There was no significant difference in IOP change between patients taking <3 or ≥3 glaucoma medications (P > 0.05; for all). The most common side effects at 1-month follow-up were burning sensation after drop instillation (13.6%), conjunctival hyperemia (2.2%), and lacrimation (2.2%), respectively. Burning sensation after drop instillation decreased to 1% at the 3-month follow-up.

Discussion
Latanoprostene bunod successfully reduced IOP when added in patients using multiple eye drops, and the amount of decrease was similar to that of using latanoprostene bunod alone.1 Burning sensation after drop instillation was higher in our patients than in those using only latanoprostene bunod.1 Also, patients who discontinued the medication before the first visit were not included, and this may exclude some side effect reports.

Conclusion
With a tolerable side effect profile, latanoprostene bunod significantly decreases IOP regardless of the number of concurrent glaucoma drugs.

Reference
1. Weinreb RN, Sforzolini BS, Vittitow J, Liebman J. Latanoprostene bunod 0.024% versus timolol maleate 0.5% in subjects with open-angle glaucoma or ocular hypertension. Ophthalmology 2016;123:965-73.
Purpose/Relevance
Intraocular pressure (IOP) informs the decision-making process for prognosis, treatment choice, and frequency of follow-up for glaucoma. Many clinics rely on ancillary personnel to measure IOP using Goldmann applanation tonometry although the accuracy of measurements is largely unknown. We examined Goldmann IOP measurement agreement between technicians and physicians, and the impact of an educational intervention on the short and long-term accuracy of IOP measurement among technicians at a university-based glaucoma clinic.

Methods
We defined IOP disagreement in two ways- as a difference in IOP of >2 and >3 mmHg. At baseline (phase 1), we assessed IOP measurement disagreement between two physicians (to establish a standard for the disagreement to which to hold the technicians) and, subsequently, between physicians and technicians. In phase 2, we implemented an educational intervention for the technicians to improve agreement with physicians and reassessed IOP measurement disagreement immediately after and 6 months post-intervention. Fifteen patients (30 eyes) were recruited for each set of comparisons.

Results
At baseline, physicians disagreed 17% and 7% of the time when measuring IOP using >2 and >3 mmHg cut-offs to define disagreement, respectively, while the average disagreement between 6 technicians and the physicians was 25% and 13%, respectively. The disagreement ranged from 16-40% at >2 mmHg and from 3-17% at >3 mmHg among technicians. Overall, disagreement was greater at IOP’s over 20 mmHg. No significant changes were noted in the frequency of disagreement in IOP measurements between technicians and physicians immediately- or 6-months- post intervention (Figure).

Discussion
Goldman applanation intraocular pressure measurement disagreed frequently when comparing measurements of intraocular pressure by technicians to those by physicians. An educational intervention had little impact on the accuracy of technician-measured intraocular pressure. Physicians also often disagreed with each other by 3 mmHg, a clinically meaningful amount.

Conclusion
These findings highlight an important limitation of Goldman applanation tonometry. Caution should be exercised when using IOP to guide treatment decisions, especially those involving substantial risk such as surgery. Additionally, reducing person-to-person variability in IOP measurement could improve clinical decision making and further work is needed to identify best practices for ensuring accurate measurements.

References
**101 Bimatoprost Sustained-Release Implant (Bimatoprost SR) Responder Rates in Patients with Glaucoma or Ocular Hypertension: Phase 3 Study Results at Primary Database Lock**

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**Purpose/Relevance**
To evaluate rates of intraocular pressure (IOP)-lowering response to a biodegradable, intracameral implant (Bimatoprost SR), which provides slow release of bimatoprost, in patients with open-angle glaucoma (OAG) or ocular hypertension (OHT).

**Methods**
Two identical, masked, 20-month, phase 3 studies with (n = 594 and 528) patients with OAG or OHT were randomized to study eye treatment with Bimatoprost SR 10 or 15 µg (Day 1, Weeks 16 and 32) or topical timolol 0.5% BID. Primary database lock occurred when all patients completed the Week 12 visit. Primary endpoint was IOP lowering through Week 12. Percentages of patients achieving at least 20%, 25%, 30%, 35%, and 40% IOP lowering at Hour 0 were evaluated at Weeks 2, 6, and 12 in the pooled study dataset.

**Results**
Both dose strengths met the primary endpoint of noninferiority to timolol in IOP lowering through Week 12. IOP reductions through Week 12 were numerically larger with Bimatoprost SR 10 and 15 µg vs. timolol in both studies. At each follow-up visit through Week 12, responder rates for the achievement of at least 20%, 25%, 30%, 35%, and 40% IOP lowering from baseline were consistently numerically higher with Bimatoprost SR compared with timolol (see figure). The most common adverse events (conjunctival hyperemia, foreign body sensation, eye pain) were consistent with having undergone a sterile intraocular procedure.

**Discussion**
The proportion of patients who responded with clinically significant IOP lowering for at least 12 weeks after a single implant administration was high. The responder rate for ≥20% IOP lowering with Bimatoprost SR in this study (74–75% at Week 12) was comparable to the 79% responder rate at 6 months previously reported with topical once-daily bimatoprost 0.03%.1

**Conclusion**
The primary endpoint was met in both studies. Responder rates with Bimatoprost SR were high and comparable to rates reported with topical bimatoprost. Safety of the implant was acceptable.

**Reference**
The Effect of Topical Difluprednol on Intraocular Pressure in Patients with Uveitis

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National Eye Institute/NIH

**Purpose/Relevance**
To evaluate the effect of topical difluprednate ophthalmic emulsion 0.05% on intraocular pressure (IOP) in patients with uveitis.

**Methods**
Demographic and clinical data were collected retrospectively from the charts of the patients who received difluprednate for uveitis. IOP was measured with Goldmann applanation tonometry.

**Results**
Eighty-nine eyes of 59 patients with no previous glaucoma surgery and no steroid implant in the eye were included. Mean duration of treatment was 12.6 ± 10.8 weeks (median 8, range 1-44). The mean baseline IOP before difluprednate treatment was 14.8 ± 3.6 mmHg (range 4-25). The mean peak IOP was 22.9 ± 8.45 mmHg (range 10-56) and was significantly high from baseline ($P < 0.001$). Mean time to development of peak IOP was 8.7 ± 8.6 weeks (median 4, range 1-44). More than 10 mmHg IOP increase was more common in children (57.1%) than in adults (26.7%) ($P = 0.024$). No significant difference in IOP change was observed when patients were stratified according to gender, previous ocular hypertension/glaucoma history, concurrent oral steroid use, or diabetes history ($P > 0.05$ for all). All patients who had high IOP responded well to the cessation of the drug and/or anti-glaucomatous medications. None of them required surgery.

**Discussion**
Topical difluprednate 0.05% is a synthetic steroid that has 56 times increased receptor-binding affinity compared to topical prednisolone acetate 1% eye drops, which gives physicians a good alternative to control ocular inflammation with a less frequent application. For the same reason difluprednate may cause significant IOP rise, especially in children, which necessitates proper monitoring of the IOP during treatment. Our study shows that IOP rise is not permanent and responds well to the cessation of the drug and/or anti-glaucomatous medications.

**Conclusion**
Topical difluprednate causes significant IOP rise in uveitis patients. The effect of IOP rise is usually reversible with the cessation of the treatment.

**Reference**
103 Tear Film Characteristics in Patients on Topical Glaucoma Therapy

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¹ University of Maryland School of Medicine

Purpose/Relevance
Glaucomatous optic neuropathy is the leading cause of irreversible blindness. Management of glaucoma is centered around reducing intraocular pressure, with most patients undergoing some type of topical hypotensive therapy. However, this treatment is reliant on patient compliance, which in turn can be reduced by adverse ocular surface symptoms. Recent studies have shown that patients initiating topical glaucoma therapy have a persistence rate one-year post initiation of 19-64%, with 39% of patients reporting mild or greater dry eye symptoms as a reason for stopping treatment. On a cellular level, extracellular matrix turnover and matrix metalloproteinase 9 (MMP-9) activation regulate trabecular meshwork function, and it has been shown that inflammation-associated MMP-9 overactivation is implicated in glaucoma. We aim to elucidate the relationship between glaucoma medications and surgical treatments, ocular surface symptoms, and MMP-9 overactivation to better help practitioners manage glaucoma therapy and reduce ocular adverse effects.

Methods
Our study includes patients ages 18-93 diagnosed with glaucoma who have been prescribed ocular hypotensive therapy for at least 4 weeks and have not had ocular surgery in the past 4 weeks. We assess ocular surface symptoms with the Ocular Surface Disease Index (OSDI), a validated survey commonly used to grade dry eye disease by placing patient symptoms on a scale of 0-100. We test for elevated MMP-9 levels in the patient’s tear film via Quidel InflammaDry, a non-invasive rapid test that samples tear fluid from the patient’s palpebral conjunctiva.

Results
Our study assessed 78 eyes from 48 individuals (average age: 67.6) and found that 43.6% of patients were MMP-9 positive. Patients who were MMP-9+ had significantly higher OSDI scores and had more procedures performed (incisional and laser) than MMP-9- patients. MMP-9+ patients also tended to be prescribed more hypotensive medications (Table 1). Patient-reported ocular surface discomfort increased linearly with more procedures performed ($R^2 = 0.8184$).

Discussion
We found that MMP-9 overexpression is significantly correlated with ocular surface discomfort, suggesting that the ocular surface symptoms in these patients may have an inflammatory etiology, which is further exacerbated by surgical procedures.

Conclusion
Understanding the relationship between MMP-9 and ocular surface discomfort in patients treated for glaucoma is important for improved medication design and treatment. Decreasing MMP-9 levels in these patients may help improve ocular symptoms, maintain medication compliance, and influence the overall prognosis of glaucoma.

References
104 Changes in Intraocular Pressure and Angle Structures After Pupillary Dilation in Patients with Primary Angle Closure Suspect and Visually Significant Cataract

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¹University of California, San Francisco

Purpose/Relevance
Pupillary dilation is a concern in patients with narrow angles. Previous studies have demonstrated the safety of dilation in patients with primary angle closure suspect (PACS) without visually significant cataract (VSC); however, this question has not been evaluated in patients with PACS and VSC. Additionally, no study has quantitatively examined the dilation-related changes in angle structure in these patients.

Methods
This is a prospective study of patients with PACS and VSC and no prior laser or intraocular surgery. PACS was defined as at least 180° of iridotrabecular contact without PAS, elevated IOP, or glaucomatous optic neuropathy. VSC was defined as best corrected visual acuity worse than 20/40 due to cataract. Subjects were dilated with 0.5% tropicamide eye drops. Detailed ophthalmic evaluation including biometry, swept-source anterior segment optical coherence tomography (SS-OCT), and intraocular pressure (IOP) was performed prior to dilation as a baseline. IOP and SS-OCT measurements were repeated at 1 hour and 6 hours after pupil dilation (PDH1, PDH6). IOP, angle opening distance at 500 µm (AOD500), trabecular iris area at 500 µm (TISA500), angle recess area at 500 µm (ARA500), and anterior chamber depth (ACD) at horizontal SS-OCT scan were measured and compared between time points using a paired t-test.

Results
A total of 30 eyes from 30 patients with an average age of 69.8 ± 8.0 years were included in the study with 73% females. Pupil size was 3.32 ± 0.69 mm at baseline, 6.33 ± 1.02 mm at PDH1, and 5.94 ± 0.59 mm at PDH6. Mean IOP increased from 14.22 ± 2.59 mmHg at baseline to 15.52 ± 3.36 at PDH1 (P = 0.02) and decreased to 13.95 ± 2.11 at PDH6 (P = 0.92, from baseline). All angle structure measurements (AOD500, TISA, ARA) showed a significant increase at PDH1 and even more at PDH6 (Table 1). ACD deepened significantly following dilation (2.12 ± 0.33 mm at baseline, 2.20 ± 0.32 mm at PDH1, 3.19 ± 0.31 mm at PDH6). Three patients demonstrated an IOP elevation of more than 5 mmHg, though none developed acute angle closure.

Discussion
IOP after dilation was elevated at PDH1 but back to baseline at PDH6. There was no incidence of acute angle closure attack in this study with limited sample size. More patients are being recruited. The changes in parameters of anterior chamber are interesting and reflect the posterior displacement of lens-diaphragm.

Conclusion
It is safe to dilate patients with PACS and VSC using 0.5% tropicamide, which relaxes the ciliary muscle leading to posterior displacement of the lens-iris diaphragm and deepening of the anterior chamber.

Reference
VF, Imaging, Diagnostics, Social/Financial/Personal Determinants of Health

105 Medication Load and Comorbidities in Glaucoma

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Purpose/Relevance
The aim of this study is to characterize the role of medication load and comorbidities in patients with primary open angle glaucoma (POAG), including ocular hypertension and mild, moderate, and severe glaucoma.

Methods
In this IRB-approved retrospective study, 100 patients with POAG and 25 non-glaucoma controls over the age of 18 years with no history of ocular surgery within the past 3 months were identified at a university eye clinic. The following information was collected through chart review: age, race, gender, BMI, systemic diseases, stage of glaucoma damage (based on the Hodapp-Parrish-Anderson scoring system), glaucoma-specific eye medications and drops (a), non-glaucoma eye medications and drops (b), number of prescribed medications for systemic disease (c), and number of eye and systemic supplements (d). One-way ANOVA and chi-squared test were used to identify any significant differences between the groups.

Results
Patient demographic information is shown in Table 1 and medication load analysis in Figure 1.

The mean number of glaucoma medications (a), total eye medications (a+b), and total medication load (a+b+c+d) increased across the categories of glaucoma progression ($P = 8.97 \times 10^{-23}$, $P = 7.44 \times 10^{-17}$, and $P = 0.00153$, respectively). In this sample, we did not find any statistically significant differences in the individual medication loads (b), (c), or (d) alone between patient groups.

Discussion
The results indicate that increasing glaucoma severity is linked to increasing medication load (ocular and systemic combined). In addition, although no statistically significant values were found in comparison of patient comorbidities in this sample, assessment reveals that patients with severe glaucoma more often suffer from type 2 diabetes mellitus (48%) than any of the other patient groups, and patients with moderate or severe glaucoma suffer from hypertension (76%) more often than their less severe or non-glaucoma counterparts ($P = 0.148$, $P = 0.306$).

Conclusion
Our study has shown that patients are burdened with an increasing total medication load as glaucoma progresses. Accordingly, this information should be a profound reminder for clinicians to better understand, counsel, and treat their patients.
Table 1: Demographic information of patient sample

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Entire Cohort N=125 (%)</th>
<th>Control N=25 (%)</th>
<th>OHTN N=25 (%)</th>
<th>Mild N=25 (%)</th>
<th>Moderate N=25 (%)</th>
<th>Severe N=25 (%)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>68 (54.4)</td>
<td>14 (56.0)</td>
<td>14 (56.0)</td>
<td>17 (68.0)</td>
<td>10 (40.0)</td>
<td>13 (52.0)</td>
<td>0.397</td>
</tr>
<tr>
<td>Male</td>
<td>57 (45.6)</td>
<td>11 (44.0)</td>
<td>11 (44.0)</td>
<td>8 (32.0)</td>
<td>15 (60.0)</td>
<td>12 (48.0)</td>
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<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>13 (10.4)</td>
<td>4 (16.0)</td>
<td>2 (8.0)</td>
<td>5 (20.0)</td>
<td>2 (8.0)</td>
<td>0</td>
<td>0.189</td>
</tr>
<tr>
<td>African American</td>
<td>45 (36.0)</td>
<td>5 (20.0)</td>
<td>8 (32.0)</td>
<td>9 (36.0)</td>
<td>10 (40.0)</td>
<td>18 (52.0)</td>
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</tr>
<tr>
<td>Hispanic</td>
<td>10 (8.0)</td>
<td>0</td>
<td>3 (12.0)</td>
<td>1 (4.0)</td>
<td>3 (12.0)</td>
<td>3 (12.0)</td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>56 (44.8)</td>
<td>16 (64.0)</td>
<td>12 (48.0)</td>
<td>9 (36.0)</td>
<td>10 (40.0)</td>
<td>9 (36.0)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1 (0.8)</td>
<td>0</td>
<td>0</td>
<td>1 (4.0)</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>70.2 ± 10.7</td>
<td>68.4 ± 11.2</td>
<td>66.4 ± 12.5</td>
<td>67.7 ± 9.9</td>
<td>75.9 ± 6.3</td>
<td>72.5 ± 10.1</td>
<td>0.007</td>
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<tr>
<td>BMI</td>
<td>26.19</td>
<td>24.64</td>
<td>25.5</td>
<td>28.3</td>
<td>24.58</td>
<td>27.92</td>
<td>0.230</td>
</tr>
</tbody>
</table>

Clinical Characteristics

<table>
<thead>
<tr>
<th>Condition</th>
<th>Entire Cohort N=125 (%)</th>
<th>Control N=25 (%)</th>
<th>OHTN N=25 (%)</th>
<th>Mild N=25 (%)</th>
<th>Moderate N=25 (%)</th>
<th>Severe N=25 (%)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>82</td>
<td>16 (64.0)</td>
<td>15 (60.0)</td>
<td>13 (52.0)</td>
<td>19 (76.0)</td>
<td>19 (76.0)</td>
<td>0.306</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>69</td>
<td>13 (52.0)</td>
<td>13 (52.0)</td>
<td>11 (44.0)</td>
<td>17 (68.0)</td>
<td>15 (60.0)</td>
<td>0.499</td>
</tr>
<tr>
<td>Type 2 Diabetes Mellitus</td>
<td>35</td>
<td>6 (24.0)</td>
<td>7 (28.0)</td>
<td>7 (28.0)</td>
<td>4 (16.0)</td>
<td>12 (48.0)</td>
<td>0.148</td>
</tr>
<tr>
<td>Average # of systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>involved in disease</td>
<td>3.46 ± 1.8</td>
<td>3.28 ± 2.1</td>
<td>3.28 ± 1.6</td>
<td>3.32 ± 2.2</td>
<td>3.68 ± 1.4</td>
<td>3.72 ± 1.6</td>
<td>0.784</td>
</tr>
</tbody>
</table>

Note: ANOVA was used to obtain P-values for age, BMI, and average # of systems involved in disease; other P-values were obtained using chi-squared test.

Figure 1: Mean medication load in patients

References


Glaucomatous Neurodegeneration in Schizophrenia: Morphometric Analysis of the Retinal Ganglion and Photoreceptor Complexes Using Optical Coherence Tomography In Vivo

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Purpose/Relevance
Reported associations between glaucoma and disorders such as Alzheimer’s disease (AD) and Parkinson’s disease (PD) suggest that glaucoma may involve a neurodegenerative pathogenetic mechanism.1 Epidemiologic studies conducted by our laboratory have shown a higher prevalence of glaucoma in Schizophrenia (SZ),2 a severe brain disorder that shares similar neurological features with AD and PD. The purpose of this study was to evaluate SZ patients for thickness changes of the inner and outer retina using optical coherence tomography (OCT) in vivo.

Methods
We performed a prospective study assessing retinal thickness in 39 SZ patients (mean age: 38.2 ± 12.1 years) relative to 27 age-matched healthy controls (mean age: 39.0 ± 15.2 years; \( P = 0.7 \)). The thicknesses of the retinal nerve fiber layer (RNFL), ganglion cell-inner plexiform layer (GC-IPL), and outer retinal layers comprising the photoreceptor complex (PRC) were measured and compared between the two cohorts using OCT. Multivariable mixed modeling adjusted for age and gender was used for statistical analysis.

Results
SZ patients exhibited significant retinal thickness changes relative to controls. The RNFL was markedly thinner in SZ, with thickness reduction most pronounced in the temporal quadrant (9.1% thickness reduction; \( P < 0.04 \)). There was no significant difference in GC-IPL thickness (\( P > 0.05 \)). The PRC was significantly thinner in SZ patients, specifically in the superior-temporal (4% thickness reduction; \( P < 0.05 \)), inferior-temporal (4.5% thickness reduction; \( P < 0.01 \)), and inferior quadrants (3% thickness reduction; \( P < 0.01 \)). Anterior segment parameters including axial length, anterior chamber depth, IOP, and central corneal thickness were not statistically different between cohorts (\( P > 0.3 \)).

Discussion
We provide a quantitative, morphometric analysis of retinal thickness in SZ. Aside from the temporal RNFL thickness changes characteristic of glaucoma, our outer retinal findings are consistent with previous reports in advanced disease stages.3

Conclusion
Remarkably, our study demonstrated significant thinning of the inner and outer retinal layers in SZ. Taken together, these findings suggest that risk factors other than elevated intraocular pressure are likely associated with glaucoma pathogenesis and may involve neurodegenerative etiologies.

References
107 Peripapillary Region OCT-A of Patients with POAG and CACG

STEVEN BEIGELMAN¹, John Cheng, Jaemyoung Sung, Sandra Johnson
¹ USF Morsani College of Medicine

Purpose/Relevance
The efficacy of circumpapillary vessel density (cpVD), when compared to retinal nerve fiber layer (RNFL) thickness, has only recently begun to be investigated,¹ and it is still unknown how effective cpVD is at differentiating between different types of glaucoma. We aimed to investigate the capability of cpVD, when compared to RNFL thickness, to detect structural damage in glaucoma patients. We also aimed to investigate whether OCT-A alone can detect structural differences between open and closed angle glaucoma.

Methods
This is a cross-sectional prospective study where 95 eyes of 95 patients were scanned. Patient groups were age matched with 24 healthy controls, 22 narrow-angle glaucoma suspects (NAS), 23 chronic angle closure glaucoma (CACG), and 26 primary open-angle glaucoma (POAG). We obtained cpVD using OCT-A (Optovue AngioVue), and RNFL thickness using SD-OCT (Heidelberg Spectralis). We obtained global and regional values for cpVD and RNFL thickness: 4 region—superior (S), nasal (N), temporal (T), and inferior (I) and 8 region—SN, NS, NI, IN, IT, TI, TS, ST. Statistical analysis included either a one- or two-way ANOVA with a post-hoc Tukey’s HSD.

Results
RNFL thickness (P < .001, SE = 2.310) and cpVD (P < .001, SE = .870) can be used to detect glaucomatous damage in CACG and POAG patients when compared to healthy individuals overall and each quadrant. In CACG and POAG patients, RNFL thickness showed no differences overall (P = .968, SE = 3.60) or in quadrants (P = .883, SE = 2.246). cpVD also detected no differences in the entire scan (P = .199, SE = 0.853), but when analyzed by the eight regions, the difference was significant (P = .014, SE = 0.583).

Discussion
The lack of a difference between CACG and POAG patients in their RNFL thickness means that while it is useful in detecting glaucomatous damage it is unable to detect differences between different types of glaucoma. However, the significant difference seen when comparing CACG and POAG patients when using cpVD suggests potential differences in glaucoma types. It is possible that the anatomical differences between eyes prone to narrow-angle glaucoma versus open-angle glaucoma also include vessel density characteristics.

Conclusion
This study should be followed up with other studies with a larger sample size to determine if this finding is related to small sample size or if this is a relevant result. If this trend is indicative of the diagnostic ability of OCT-A, this could prove a useful secondary diagnostic tool.

Reference
Purpose/Relevance

Previous work has established that dysregulation of retinal blood flow (RBF) may precede retinal ganglion cell loss in glaucoma. We hypothesize that glaucoma patients may demonstrate impaired blood flow regulation in response to mild vasoconstriction by supplemental oxygen. The purpose of this study is to describe the use of erythrocyte-mediated angiography velocimetry (EMAv) to precisely quantify and compare erythrocyte speed in glaucomatous and non-glaucomatous eyes in room air and supplemental oxygen conditions.

Methods

Thirteen subjects (10 glaucoma eyes, 11 non-glaucoma eyes) were imaged by EMAv while breathing room air then while breathing with 3L/min supplemental oxygen delivered by nasal cannula. Forty-eight vessels were analyzed using a previously described MATLAB protocol to determine erythrocyte speed in room air and after oxygen supplementation. Change in erythrocyte speed and percent change from baseline room air were calculated. Welch’s t test was used for statistical analysis.

Results

Of the 13 subjects, 10 (77%) were female, 8 (62%) were African American. Mean age was 54.5 ± 11.8 years. Change in mean erythrocyte speed between air and oxygen conditions varied significantly between glaucoma and non-glaucoma subjects (-0.52 ± 1.29 mm/s vs. 0.34 ± 0.90 mm/s, P < 0.01). Percent change from baseline also demonstrated an average increase of 6.75 ± 15.6 % from baseline for non-glaucoma subjects compared to an average decrease of 5.39 ± 16.14 % from baseline for glaucoma subjects (P < 0.01).

Discussion

We noted significant impairment in autoregulation of retinal blood flow in glaucoma patients compared to non-glaucoma individuals when tested with supplemental oxygen (hyperoxemia).

Conclusion

EMAv is a novel technology that may be used to precisely quantify RBF and improve our understanding of the role of defective autoregulation in glaucoma.

References

109  Effects of Non-Insulin Dependent Diabetes Mellitus on Primary Open-Angle Glaucoma and Peripapillary Microvasculature Density (VD)

JOHN CHENG1, Steven Beigelman, Jaemyoung Sung, Sandra Johnson
1 USF Health Morsani College of Medicine

Purpose/Relevance
Current literature on the effects of non-insulin dependent diabetes mellitus (DM) on primary open-angle glaucoma (POAG) is controversial regarding peripapillary VD and retinal nerve fiber layer (RNFL) thinning.1,2 The purpose of this study is to evaluate quantitative characteristics of the radial peripapillary capillary (RPC) plexus and RNFL thickness for normal eyes, eyes with DM, and glaucomatous eyes both with and without DM, using optical coherence tomography angiography (OCT-A, Optovue, Fremont, CA) and spectral domain OCT (Heidelberg, Carlsbad, CA).

Methods
This cross-sectional prospective study included 95 eyes from 95 patients (25 healthy eyes, 26 POAG eyes, 26 DM eyes, and 18 eyes with DM/POAG) scanned using OCT-A and OCT. DM was defined by Hb A1c of >6.5% and use of antidiabetic medication. Eyes with retinal pathologies were excluded. Statistical analysis was done using one- or two-way ANOVA with post-hoc Tukey’s HSD test.

Results
Eyes with POAG (71.1 µm ± 3.35 SE) and DM/POAG (60.2 ± 3.49) exhibit reduced mean RNFL thickness on OCT compared to healthy (96.5 ± 2.46) and DM (98.0 ± 2.65) eyes (every P < .001). Sub-analysis of RNFL in four quadrants shows a difference in RNFL thickness between POAG and DM/POAG eyes (P < .01).

POAG (42.9% ± 1.90 SE) and DM/POAG (37.1% ± 2.03 SE) eyes exhibit reduced mean RPC peripapillary VD on OCT-A compared to healthy (51.5 ± 0.91) or DM (50.0 ± 0.88) eyes (every P < 0.001). DM/POAG eyes show decreased mean VD compared to POAG eyes alone (P < 0.001); however, no difference in VD is seen between healthy and DM eyes (P = 0.35). Sub-analysis of RPC in four quadrants shows that DM/POAG patients have reduced mean VD compared to POAG in nasal (34.2% ± 1.80 SE vs. 40.3% ± 1.46 SE) and superior (34.1 ± 1.65 vs. 40.8 ± 2.05) quadrants (every P < 0.05), but no difference between inferior (36.1 ± 2.33 vs. 41.4 ± 2.11) or temporal (44.0 ± 1.33 vs. 49.1 ± 1.43).

Discussion
While healthy eyes do not appear to differ significantly from DM eyes with respect to peripapillary VD or RNFL, our results indicate that DM pathology may act on the microvasculature of POAG patients in a synergistic manner within the superior and nasal quadrants. This may be due to increased impairment of vascular regulation in patients with both DM and POAG, as Shoshani proposed.3

Conclusion
Our small study suggests that eyes with a combination of DM and POAG exhibit worse RNFL and RPC measurements than POAG or DM alone.
References


Does Short Term Treatment in the Ocular Hypertension Treatment Study (OHTS) Improve the Visual Field?

SALMAN DAR1, Gustavo De Moraes, George Cioffi, Dana Blumberg, Sabine Khan, Jeffrey Liebmann, Michael Kass, Mae Gordon

1 Columbia University

Purpose/Relevance
It remains unclear whether intraocular pressure (IOP) reduction can lead to improvement of visual function1. We investigated whether there was any improvement in visual field (VF) mean deviation (MD) after randomization to treatment compared to observation in the OHTS.

Methods
We performed a secondary analysis of a randomized clinical trial. Participants had normal optic discs and VFs, but statistically elevated IOP at baseline. We only included reliable VFs performed during two baseline qualifying visits before randomization and the first two follow-up visits after randomization (6 and 12 months). We compared the average MD change (after - before “clusters”) between treatment and observation groups.

Results
3,196 eyes of 1,600 participants (1,590 eyes in the observation group and 1,606 in the treatment group) were included. The mean differences between the average of the two “clusters” after vs. before randomization were -.15 dB (95% CI: -.20 to -.10) and -.014 dB (-.20 to -.08), respectively (P= 0.826, mixed effects model).

Discussion
Studies have shown improvement in specific points on VF testing after IOP reduction.1 Our analysis of global VF function, defined as mean MD, did not reveal significant improvement after IOP reduction compared to observation.

Conclusion
Our results do not support an improvement in global visual function after initiation of IOP-lowering therapy in eyes with ocular hypertension and normal VF tests.

References
Pseudo-Glaucomatous Cupping and Impaired Visual Processing in Cerebral Palsy

MEGHAL GAGRANI1, Jacy Vermaas, Max Kurz, Sachin Kedar, Deepta Ghate

1 University of Nebraska Medical Center

Purpose/Relevance
Cerebral palsy (CP) is characterized by perinatal onset neurologic damage with global physical and neurologic dysfunction. We have previously shown that optic nerve head (ONH) cupping and pallor can serve as biomarkers for motor deficit and ambulatory status.1 The main objective of this exploratory cross-sectional study was to evaluate the association of ONH changes (hypoplasia, retinal nerve fiber layer (RNFL) loss and cupping) and visual perception in CP.

Methods
We studied 9 consecutive patients (5 females) with perinatal onset CP. Patients with media opacity or preexisting diagnosis of glaucoma were excluded. Measurements included visual acuity, intraocular pressure (IOP-Icare, Finland), OCT imaging (Heidelberg, Germany), fundus photographs (Optos®, USA), and the Test of Visual Perception Skills (TVPS version 4).2 2 masked ophthalmologists independently reviewed fundus photographs to document cup-disc ratio (CDR). A subject was classified as “large cup” if both observers labelled the CDR ≥0.5. ONH was labelled hypoplastic if the horizontal disc diameter to the horizontal disc to macula distance ratio was <0.3.

Results
Mean age was 15 years (range 11.8-21.2). All the children were ambulatory with or without assistance. The mean best corrected visual acuity in the worse eye was 0.09 log MAR units (range 0-0.3). The mean population percentile score on the TVPS was 31±20. No subject had hypoplastic discs. CDR>0.5 was observed in 7/9 (77%) patients with a mean CDR of 0.7±0.15 in the worse eye. Inter rater reliability was good with a disagreement on cupping between the observers in one case. Only 1 subject had IOP>21 mm Hg but had no signs of glaucoma (CDR<0.5). The mean RNFL thickness in the worse eye was 90 µ (range 40-123). The percentile TVPS score correlated well with the CDR (r^2 =0.6) [Figure]

Discussion
ONH cupping, RNFL loss and visual perception abnormalities are very common in CP and may reflect global hypoxic neuronal damage. We propose that ONH cupping is a marker for visuospatial cognitive deficits in children with CP.

Conclusion
CP should be recognized as a cause of pseudo-glaucomatous cupping and RNFL loss in children to limit unnecessary examinations under anesthesia. CP patients with ONH cupping should have visual perception testing to guide rehabilitation.
References


112 Pictorializing What People with Glaucoma Perceive in Regions of Visual Field Loss: Results From a Novel iPad App

DEEPTA GHATE¹, Meghal Gagrani, David Anderson, Lynette Smith, Robin High, Zachary Fowler, Deepak Khazanchi, Vikas Gulati, Sachin Kedar
¹ University of Nebraska Medical Center

Purpose/Relevance
Glaucoma patients with peripheral vision loss subjectively describe their field loss¹ as “blurred/missing parts” or “no vision compromise.” We developed an iPad app for patients to self-characterize perception within areas of glaucomatous visual field loss. We correlated subjective responses with parameters on the Humphrey visual fields (HVF).

Methods
Glaucoma patients with visual acuity ≥20/40 in each eye and stable and reliable HVF over 2 years were enrolled. An iPad app was designed to allow subjects to modify “blur” or “dimness” on a sliding scale (Figure 1). Subjects were instructed to fixate centrally on a 2x2 m wall-mounted scene (45° of field from center at 1 m) and compare each area of the poster to the image on the iPad at 33 cm (central preserved field). Subjects then modified the iPad image to match their perception of the wall poster. Subjects were tested monocularly and binocularly. Monocular HVF were used to calculate an integrated binocular visual field index (VFI). iPad output was degree of blur/dim: normal, mild (0-5) and severe (5-10) noted on the iPad image at the 54 retinal loci tested by the HVF 24-2. This was compared to the corresponding threshold sensitivity values on the HVF 24-2. Right eye (OD), left eye (OS), and binocular (OU) data sets were analyzed separately.

Results
36 HVF and iPad responses from 12 subjects (mean age 70 ± 8 years) were analyzed. The mean HVF-VFI was 77 ± 21 OD, 76 ± 21 OS, 83 ± 15 OU. The iPad responses at the retinal loci tested were categorized as normal (75% OD, 80% OS, 90% OU), mild blur (14% OD, 8% OS, and 4% OU), and severe blur (12% OD, 12% OS, and 6% OU). No subject reported dim or blackening response. For retinal loci with ≤10 db on HVF, most subjects reported blur (64% OD, 61% OS, 51% OU). For retinal loci with >20 db on HVF, most subjects reported normal vision (87% OD, 91% OS, 96% OU). ROC curve analysis determined that the optimal cut-off HVF retinal sensitivity threshold value at which subjects reported “blur” in their visual field was 23 db (OD), 23.4 db (OS), and 23.3 db (OU).

Discussion
Glaucoma subjects pictorialized their field defects as blur; never dim or black as depicted in glaucoma simulations. A threshold value of 23 dB or lower resulted in visual blur.

Conclusion
Our innovation allows translation of HVF data to simulate real-life visual experiences of patients with glaucomatous field defects. This will enhance patient and family understanding of disease, lay the foundation for novel rehabilitation strategies, and raise awareness for glaucoma diagnosis.
Subject compares poster with iPad image and modifies the iPad image till it matches their perception of the poster.

Figure 1:

Subject response: monocular and binocular iPad responses were compared to the spatially corresponding threshold sensitivity values on the HVF 24-2: For eg: the basketball corresponds to 24-27° of visual angle horizontally to the right and 4-7° inferiorly (the inferior nasal step in the left eye)

References:
113 Differences in Outflow Channels Between Two Eyes of Unilateral Primary Congenital Glaucoma

VINEY GUPTA¹, Ishan Pandya, Shikha Gupta, Tapas Nag
¹ Dr RP Centre for Ophthalmic Sciences, AIIMS

Purpose/Relevance
Primary congenital glaucoma (PCG) occurs in only one eye in some patients. We aimed to characterize anatomical features of the angle and Schlemm’s canal (SC) in vivo among fellow eyes of patients with unilateral primary congenital glaucoma.

Methods
Both eyes of 33 children with unilateral PCG and 30 healthy children, old enough to cooperate were analyzed using high resolution anterior segment spectral domain (SD) OCT. Subgroup analysis was done for presence/absence of angle dysgenesis as defined by presence of abnormal tissue/hyper-reflective membrane within angle recess and/or absence of SC. Other anatomical landmarks differentiating the fellow normal eyes from the eyes with glaucoma were also evaluated and compared with healthy subjects.

Results
The presence of abnormal tissue at the angle and/or a hyper-reflective membranous structure covering the meshwork were seen in all affected PCG eyes (100%), and in 21 (63%) unaffected fellow eyes; p=0.001. The SC could be seen in 8 (24%) affected in comparison to 29 (88%) fellow unaffected eyes; p=0.001. The ASOCT scans of 54 (90%) healthy eyes and 3 (9%) fellow PCG eyes revealed a direct communication of anterior portion of the SC with the anterior chamber. Among the fellow eyes, a communication of the supraciliary space with anterior chamber could be discerned in 26 eyes (79%).

Discussion
The angle dysgenesis was visualized on ASOCT as presence of abnormal tissue or a hyper-reflective membrane (Gupta et al. 2017) (Gupta et al. 2017). This membrane appeared to be similar to what Barkan had described in PCG (Barkan 1955) and was later commented upon by Luntz (Luntz 1979) as an angle cicatrization that portends a poorer success with goniotomy. Apart from angle dysgenesis seen in the fellow eyes, there was also absence of SC in some. Non visualization of SC was observed in three fourths of the affected eyes and in one tenth of the fellow eyes of these children with unilateral PCG. Tandon et al in their UBM study also noted absence of SC in 50% of patients with pediatric glaucoma (Tandon et al. 2017). This may have implications on the surgical management of such eyes, that would not respond to angle procedures like goniotomy, as only removing the abnormal tissue from the angle would not ensure drainage due to the dysgenesis/agenesis of SC and such eyes may do better with external filtration procedures.

We observed direct communications of the supraciliary space and Schlemm’s canal with the anterior chamber that offered an alternate pathway of aqueous outflow in fellow eyes, with angle dysgenesis, preventing them from developing raised IOP. These pathways could have become the primary conduit for aqueous drainage in the presence of abnormal tissue occluding the conventional outflow through the trabecular meshwork.

Conclusion
Despite angle dysgenesis, outflow channels such as the uveoscleral or a direct communication of SC with the anterior chamber play a role in preventing the development of glaucoma in fellow eyes of unilateral PCG.

References
Access to Medications Among Patients with Glaucoma

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¹ Duke Eye Center

Purpose/Relevance
The management of patients with glaucoma includes the use of ophthalmic medications. Adherence to medical treatment is known to be poor due to a variety of factors.¹ One of these factors is the cost of medications. In this study we assess barriers to medication access related to cost in U.S. patients with glaucoma.

Methods
We used data from participants 18 years and older from the National Health Interview Survey (NHIS) from years 2016 and 2017. The NHIS questions assessed cost-related barriers to medication adherence over the previous 12 months. We used bivariable logistic regression to determine if glaucoma diagnosis was associated with access to medications. Multivariable models were adjusted for age, race, ethnicity, education, and employment.

Results
Overall, 59,770 participants were included in the study; 1,996 (weighted %: 2.6) had glaucoma and 57,687 (weighted %: 97.4) did not. The adjusted predicted proportion of respondents prescribed medications was 90.0% (95% CI, 88.2% - 91.9%) for those with glaucoma compared to 63.2% (95% CI, 62.4% - 63.9%) in those without glaucoma. Participants with glaucoma were more likely to affirm they couldn’t afford a prescribed medication ($P = 0.002$) and that they asked a doctor for lower cost medication to save money ($P = 0.001$). In the adjusted models, participants with glaucoma were also more likely to skip medication doses to save money ($P = 0.019$), take less medicine to save money ($P = 0.008$), delay filling a prescription to save money ($P < 0.001$), and use alternative therapies to save money ($P = 0.001$).

Discussion
Individuals with glaucoma had greater difficulty affording medications and asked their doctors for lower cost medications. They are also more likely to skip, delay, or look for alternative therapies due to the cost of medications.

Conclusion
Individuals with glaucoma are more likely to have cost-related barriers to medication use than individuals without glaucoma.

Reference
115 Asymmetry of Macular Vessel Density in Bilateral Early Primary Open-Angle Glaucoma with Unilateral Central 10-2 Visual Field Loss

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1 Zhongshan Ophthalmic Center, Sun Yat-sen University

Purpose/Relevance
To investigate the inter-eye and intra-eye asymmetry of macular vessel density assessed by optical coherence tomography angiography (OCTA) in bilateral early primary open-angle glaucoma (POAG) with unilateral 10-2 visual field loss.

Methods
Thirty-two eyes of 16 patients with bilateral early POAG and unilateral 10-2 visual field loss and 13 eyes of 13 healthy participants were consecutively enrolled. All subjects underwent 30-2, 10-2 visual fields, OCT and OCTA examinations. Inter-eye differences were compared between the perimetrically affected eye and the unaffected eye in the same patient. Intra-eye differences were compared between the affected hemifield and the unaffected hemifield in the same eye with single-hemifield 10-2 visual field loss.

Results
Macular whole image vessel density of the perimetrically unaffected eyes was lower than the healthy eyes, and was larger than the affected eyes \( (P < 0.05) \). Parafoveal vessel densities of the perimetrically affected eyes were comparable to the unaffected eyes \( (P > 0.05) \). While average and inferior perifoveal vessel densities of the perimetrically affected eyes were lower than the unaffected eyes \( (P = 0.023, 0.004; \text{respectively}) \), similar results were found in macular ganglion cell complex (mGCC). In glaucomatous eyes with single-hemifield loss, perifoveal vessel density and mGCC of the affected hemifields were worse than the unaffected hemifields \( (P < 0.05) \).

Discussion
To the best of our knowledge, this is the first study investigating the intra-eye and inter-eye asymmetry of macular vessel density in bilateral early POAG eyes with unilateral 10-2 visual field loss. In the current study, we found that macular vessel density was significantly decreased even in 10-2 perimetrically unaffected glaucoma eyes. The inter-eye and intra-eye analyses showed that significant damage of macular vessel density was present in perifoveal but not parafoveal area in early POAG. In addition, the damage of macular vessel density spatially corresponded to mGCC damage and visual field damage.

Conclusion
Significant macular microvascular damage was present before detectable 10-2 visual field damage. The damage of perifoveal vessel density, especially in inferior quadrant, was more significant in early glaucoma. Macular microvascular damage spatially corresponded with functional and structural damage.

References
116 Health Literacy in Glaucoma: The Singapore Glaucoma Health Literacy Scale

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¹ Singapore National Eye Centre

Purpose/Relevance
Poor health literacy (HL) has been associated with non-compliance to treatment and poorer disease outcomes in glaucoma. Current measures of HL are generic and only measure numeracy and vocabulary. The aim of this pilot study is to develop and validate a glaucoma-specific HL instrument—the Singapore Glaucoma Health Literacy Scale (SGHLS). This would be the first scale to comprehensively assess HL in glaucoma patients.

Methods
Literature review was performed to develop item content across 3 HL scales: (1) Knowledge, (2) Beliefs, and (3) Understanding and Access to Eye Care Services. Focus group sessions with glaucoma patients (N = 16) and semi-structured interviews with glaucoma specialists were conducted to create the initial SGHLS. 100 English-speaking glaucoma patients were administered the SGHLS in addition to another generic HL tool—the NVS—and an unrelated tool—the PHQ-9. Subjects’ responses in scale 1 were compared against that of glaucoma specialists to assess discriminant validity. Rasch analysis was performed to validate the 3 scales.

Results
71% of the respondents were male. Mean age was 66 years. 77% of the subjects had a monthly income level of more than S$2000. 85% of the subjects had open angle glaucoma or ocular hypertension. 15% of the patients had angle closure disease. Rasch analysis revealed adequate precision for scales (1) and (3) but not scale (2). All 3 scales correlated well with the NVS scores (good convergent validity), but scales (2) and (3) also correlated well with PHQ-9 (inadequate divergent validity). Three questions in scale (1) pertaining to angle closure disease revealed inconsistent response patterns.

Discussion
The pilot study helped validate 2 of the 3 scales for HL assessment. PHQ-9 measuring depression may not be a good tool to assess divergent validity, as patients with advanced glaucoma may be depressed. Patients with angle closure responded differently compared to those without angle closure to certain questions in the Knowledge scale, suggesting that angle closure disease may need to be assessed distinctly from open angle glaucoma. The group had a large proportion of individuals in the higher socioeconomic stratum.

Conclusion
The pilot study has validated components of this novel tool for assessment of HL in glaucoma patients. This is a good starting point for future multi-linguistic and cross-cultural validation work to better assess HL across various patients with glaucoma globally.

Reference
Assessing Glaucoma Knowledge in Patients Visiting the Glaucoma Clinic Compared to Other Ophthalmology Clinics

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1 Bascom Palmer Eye Institute, University of Miami Miller School of Medicine

Purpose/Relevance
Glaucoma-related knowledge is a major factor in patient compliance.1 However, glaucoma knowledge assessments are not frequently performed in the clinic, and little data exist on whether glaucoma providers (compared to other ophthalmic providers) educate their patients sufficiently as to increase the glaucoma knowledge. In this study, we compared glaucoma knowledge levels between patients in various subspecialty ophthalmic clinics using a validated questionnaire instrument.

Methods
We prospectively administered the EIT-8G questionnaire to patients in glaucoma, cornea, retina, and comprehensive ophthalmology clinics in order to assess the level of knowledge regarding glaucoma in each patient population.2 Patient demographics, family history of glaucoma, income, and zip code were collected. We analyzed patient responses using the weighting system described by Labiris et al. and identified Spearman correlation coefficients between glaucoma awareness score (GAS) and variables collected.3 GAS ranges from 1-100, with 100 being perfectly knowledgeable about glaucoma.

Results
225 participated in the study (91 [40.4%] glaucoma, 44 [19.6%] cornea, 45 [20.0%] retina, and 45 [20.0%] comprehensive). Age, gender, family history of glaucoma, zip code, and income level did not affect GAS. Patients visiting the glaucoma clinic had significantly higher GAS, on average, than those visiting non-glaucoma clinics (Mean Difference [MD] = 9.77, P = 0.0002). Glaucoma clinic patients also had a higher mean GAS than cornea (MD = 8.84, P = 0.0117), retina (MD = 9.41, P = 0.0069), and comprehensive ophthalmology (MD = 11.04, P = 0.0016) patients individually.

Discussion
Patients visiting the glaucoma clinic have more glaucoma knowledge than those in the other clinics, which suggests that encounters with glaucoma providers aids in acquisition of glaucoma knowledge. Family history of glaucoma, socioeconomic background, and home address did not correlate with glaucoma knowledge.

Conclusion
Patients in the glaucoma clinic have more glaucoma knowledge than those of other clinics. This knowledge instrument can be used in the future to assess the effect of educational programs on disease mechanisms.

References
118 Marijuana and Glaucoma: A Social Media Content Analysis

JING JIA¹, Nikki Mehran, Daniel Lee, Jonathan Myers, Natasha Kolomeyer
¹ Lewis Katz School of Medicine at Temple University, Wills Eye Hospital

Purpose/Relevance
With increasing promotion and popularity of medicinal cannabis (MC) products, patients have access to a variety of information sources across multiple social media platforms. This study aims to analyze the content quality and characteristics of the most popular and highly ranked search results on the internet related to glaucoma and MC.

Methods
Google and two social media platforms, Facebook and YouTube, were utilized to identify online information most accessible to patients. Search criteria included “glaucoma” AND “marijuana” or “cannabinoid” or “CBD.” The top 20 Google search and YouTube results for each search term and the posts from the top 9 patient-based glaucoma Facebook groups were aggregated and analyzed using the search criteria. The quality of the content was graded by two independent graders using a previously validated Sandvik score and reported risk score (details in Table 1). The differing values were resolved by a final grader. Additional analysis included whether the source was professional (by physician or medical organization) or shared an opinion on MC use in glaucoma.

Results
The above-described search resulted in an aggregate of 52 websites on Google, 129 posts from Facebook groups, and 37 videos on YouTube (Table 1). The average Sandvik score and risk score was 10.8, 9.97, 10.5, and 0.28, 0.61, 0.97, respectively, for Google, Facebook, and YouTube. ANOVA analysis showed statistically significant difference in Sandvik (P = 0.01) and risk scores (P < 0.0001) across the three platforms. Character of Facebook posts were questions (68%), personal story (15%), information sharing (9.4%), general discussion (7.0%), and commercial (0.8%). The YouTube videos had a mean of 17,956 views, 49.4 comments, 199.8 likes, and 15.4 dislikes.

Discussion
Professional online content offers higher content quality and lower risk for patients. Overall, Google searches led to the highest number of professional sources, content quality, and lowest risk. Facebook posts had the lowest content quality, likely due to its lack of authorship credentials and medical sources. YouTube had the highest risk score due to content promoting opinions, anecdotes, and commercial products.

Conclusion
This study highlights the spectrum of content and quality of information available on the internet in regards to MC and glaucoma. It remains important to advise patients about the evidence and potential risks of MC and direct them to higher quality sources.
### Table 1. Comparison of professional and non-professional online content regarding glaucoma and MC across platforms

<table>
<thead>
<tr>
<th></th>
<th>Google - P</th>
<th>Google - NP</th>
<th>P value</th>
<th>Youtube - P</th>
<th>Youtube - NP</th>
<th>P value</th>
<th>Facebook - NP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=26 (50%)</td>
<td>n=26 (50%)</td>
<td></td>
<td>n=15 (40%)</td>
<td>n=22 (60%)</td>
<td></td>
<td>n=129 (100%)</td>
</tr>
<tr>
<td>Sandvik score</td>
<td>11.31 ± 1.38</td>
<td>9.96 ± 2.73</td>
<td>0.03</td>
<td>11.93 ± 1.22</td>
<td>9.18 ± 1.37</td>
<td>&lt; 0.001</td>
<td>9.97 ± 1.59</td>
</tr>
<tr>
<td>(M ± SD)</td>
<td></td>
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<tr>
<td>Risk score</td>
<td>0 ± 0</td>
<td>0.60 ± 0.64</td>
<td>&lt; 0.001</td>
<td>0.33 ± 0.82</td>
<td>1.41 ± 0.67</td>
<td>&lt; 0.001</td>
<td>0.61 ± 1.19</td>
</tr>
<tr>
<td>(M ± SD)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recommend MC use in glaucoma (%)</td>
<td>19%</td>
<td>35%</td>
<td>0.21</td>
<td>27%</td>
<td>82%</td>
<td>&lt; 0.001</td>
<td>21%</td>
</tr>
</tbody>
</table>

**Scoring Definitions**:  
- **Sandvik score** (0-2 points each, 14 max): ownership, authorship, source, currency, interactivity, navigability, balance. 0-5 points were defined as poor; 6-10 points, medium; and 11-14, excellent.  
- **Risk score** (1 point each, 4 max): a) discourage clinician advice b) discourage use of conventional medicine 3) use opinions and experiences d) provide commercial details  
- **P (Professional – physician or medical organization), NP (Non-professional), MC (medical cannabis)**

### Reference

Impact of the Support, Educate, Empower (SEE) Personalized Glaucoma Coaching Program Pilot Study on Eye Drop Installation Technique and Self-Efficacy

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¹ Kellogg Eye Center, University of Michigan

Purpose/Relevance
To determine if the SEE personalized coaching program improved: (1) eye drop technique and (2) eye drop installation self-efficacy for glaucoma patients.

Methods
A prospective pre-post pilot study of the impact of the SEE personalized glaucoma coaching program on eye drop instillation technique and self-efficacy. Participants ≥ age 40, diagnosed with glaucoma or ocular hypertension, taking ≥1 glaucoma medication, and with poor self-reported glaucoma medication adherence were included. Eye drop administration was video recorded before the first SEE coaching session and after the final session six months later. Videos were assessed by a masked observer. During the first session, eye drop instillation techniques were taught using a motivational interviewing-based approach. The main outcome was change in eye drop instillation techniques as measured by (1) instilling one drop into the eye on first attempt, (2) accuracy as defined by reduced number of drops landing on skin outside the eye, (3) number of attempts needed to instill a drop to the eye, and (4) decreased bottle contamination. McNemar’s test was used to assess differences in technique. Eye drop instillation self-efficacy was assessed with the Eye Drop Technique Self-Efficacy Scale (EDTSES)¹ at baseline and two months after the SEE program had ended, and a change score was calculated.

Results
Out of 32 subjects, there was a 15.7% increase in ability to instill one drop on the first attempt from pre to post intervention (P = 0.1). Accuracy improved by 12.5% (P = 0.16). The percent of participants who needed just one attempt to instill their eye drops increased from 84.4% to 93.8% pre to post intervention (P = 0.25). Subjects demonstrated significant improvement in not touching the eyelashes (P = 0.02), touching the skin (P = 0.03) or the ocular surface (P = 0.05) following the SEE program. There was a significant increase in eye drop instillation self-efficacy from 2.61 (±0.32) to 2.81 (±0.21) after the SEE program (P = 0.007).

Discussion
There were trends towards improved eyedrop instillation accuracy that did not reach statistical significance, likely because of our limited sample size in this pilot study.

Conclusion
Participants in the SEE program demonstrated significantly decreased bottle contamination and increased eye drop instillation technique self-efficacy.
Eye Drop Technique Self-Efficacy Scale

<table>
<thead>
<tr>
<th>Question</th>
<th>Pre Very Confident N (%)</th>
<th>Post Very Confident N (%)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Squeezing your eye drop bottle(s)?</td>
<td>29 (96.7%)</td>
<td>30 (100%)</td>
<td>0.80</td>
</tr>
<tr>
<td>2) Getting the medication drop(s) in your eye?</td>
<td>25 (80.7%)</td>
<td>31 (100%)</td>
<td>0.11</td>
</tr>
<tr>
<td>3) Consistently getting the right amount of eye drop medication in your eye each time you use it?</td>
<td>12 (41.4%)</td>
<td>18 (6.2%)</td>
<td>0.13</td>
</tr>
<tr>
<td>4) Correctly angling your head to accurately apply the eye drops?</td>
<td>21 (70.0%)</td>
<td>24 (80.0%)</td>
<td>0.85</td>
</tr>
<tr>
<td>5) Delivering the required amount of your eye drops to the eye without missing or applying too much medication?</td>
<td>11 (35.5%)</td>
<td>20 (64.5%)</td>
<td>0.04</td>
</tr>
<tr>
<td>6) Not touch your eye with the eye drop bottle?</td>
<td>22 (70.9%)</td>
<td>24 (77.4%)</td>
<td>0.78</td>
</tr>
</tbody>
</table>

Mean score Mean (SD) 2.61 (±0.32) 2.81 (±0.21) 0.007

Note: Scores Ranged from 1 - 3 corresponding to "Not at all confident", "Somewhat confident", and "Very confident" respectively.
Individual Questions were analyzed using McNemar-Bowker test of symmetry and the mean score of all the questions was analyzed using a paired t-test.

Reference
**Purpose/Relevance**

Facial recognition impairment can have significant impact on social interactions and quality of life.\(^1\) We have previously reported that glaucomatous macular damage is correlated with diminished facial recognition and that disability may be particularly striking in patients with diffuse 10-2 visual field (VF) loss.\(^2\) The purpose of this study is to examine the direct relationship between glaucomatous macular damage as demonstrated by spectral domain optical coherence tomography (SDOCT) and impaired facial recognition.

**Methods**

This is an observational cohort study that included 69 participants (138 eyes) with a diagnosis of open-angle glaucoma. Patients were required to have visual acuity of at least 20/40 in each eye and no co-existing eye disease or cognitive impairment. Macular damage was assessed using OCT and VF and was categorized as focal, diffuse, mixed, or none. Severity was assessed based on average (avg) ganglion cell layer + inner plexiform layer (GCIPL) values. Facial recognition was assessed using the Cambridge Face Memory Test (CFMT). Univariable and multivariable linear regression analyses using ordinary least squares were conducted to determine the association among macular OCT in better and worse eyes and CFMT scores.

**Results**

Based on OCT in the better eye, 14 eyes (20.6%) had no macular damage, 23 (33.8%) had focal damage, 23 (33.8%) had diffuse, and 8 (11.8%) had mixed focal and diffuse patterns. Worse eyes had no damage in 5 (7.4%), focal damage in 23 (33.8%), diffuse in 28 (41.2%) and mixed in 12 (17.7%). In the univariable analyses, average GCIPL values were significant predictors of CFMT score ($P < 0.0001$ for better and worse eye avg). Better and worse eye avg remained significant even after adjusting for 10-2 VF mean deviation (better avg $P = 0.003$, worse avg $P = 0.002$). Based on OCT findings alone, there was no significant difference in the pattern of damage predicting CFMT scores.

**Discussion**

Our previous work has shown that 10-2 VF can be correlated with facial recognition.\(^2\) In this study, GCIPL thickness is a significant independent predictor of facial recognition in better and worse eyes, regardless of pattern of damage and even after adjusting for 10-2 VF. This suggests that an office-based structural test may translate to a test of everyday visual performance.

**Conclusion**

OCT is a useful predictor of facial recognition in eyes with glaucomatous macular damage and can provide an objective method for determining the impact of glaucoma on functional status.

**References**

The Effectiveness of Resident Use of OHTS Criteria in Treatment of Ocular Hypertension Patients

FARID KHAN1, Lauren Lim, Taryn Jurgensen, Chen Victor
1 Tulane School of Medicine

Purpose/Relevance
To review management patterns and rate of progression to glaucoma in patients diagnosed with ocular hypertension in resident-run general ophthalmology clinics. Studies have shown that trainee use of preferred practice patterns in ophthalmology vary greatly. Our goal is to review the management pattern and treatment outcomes of ocular hypertension patients and the use of Ocular Hypertension Treatment Study (OHTS) criteria among residents for patient management and trainee education quality improvement.

Methods
Retrospective chart review of patients seen in resident clinics diagnosed with ocular hypertension with at least 3 years of follow-up. Data obtained included age, race, family history, visual acuity (VA), intraocular pressure (IOP), gonioscopy, central corneal thickness (CCT), IOP-lowering medications, laser trabeculoplasty, surgical treatment of ocular hypertension, visual field results and optical coherence tomography (OCT) results. Patients were followed to the last available follow-up, or at least 1 year following diagnosis. The OHTS calculator was used to calculate each patient’s calculated risk at the time of initial diagnosis.

Results
150 eyes were included in this study. Average age at diagnosis was 64.6 years. 73% were treated after initial workup. The most common initial treatment was prostaglandin analogues, started in 70% of patients. The average OHTS risk score was 12.1 in treated eyes and 10.0 for untreated eyes. 22.2% of treated patients progressed to glaucoma. 14.2% of untreated patients progressed to glaucoma. <5% of charts included a calculated OHTS score. A significant number of patients did not have documented gonioscopy or CCT.

Discussion
This study utilized an EMR to retrospectively analyze outcomes of patients who had been identified as ocular hypertensives at a resident-run clinic. Similar rates of progression to glaucoma were found as seen in OHTS in the untreated group. Higher OHTS score as well as individual glaucoma risk factors were associated with initiation of IOP-lowering treatment. Noncompliance to drops as well as initiation of treatment in higher-risk patients may contribute to a high rate of progression (than those found in OHTS) in the treatment group.

Conclusion
This study showed residents were effective in use of OHTS criteria to identify patients who would benefit from treatment. However, improvement in resident education is needed, as gonioscopy and CCT were underreported and sometimes never documented. The OHTS score calculator was also not commonly used or mentioned by resident physicians. We intend to design a quality improvement program to emphasize OHTS criteria to improve patient outcome.

References
Glaucoma Patient Perceptions of Marijuana Use for the Treatment of Glaucoma

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1 University of Colorado

Purpose/Relevance
To characterize glaucoma patient perceptions of medical marijuana, estimate the percentage of patients who have heard of or would consider marijuana as a treatment for glaucoma, and characterize demographic factors which may be associated with these opinions.

Methods
An anonymous survey was distributed to glaucoma patients after their scheduled glaucoma clinic visit at the University of Colorado. The survey collected demographic data in addition to assessing patient knowledge of marijuana for glaucoma treatment and their perceptions around it.

Results
Of the 231 respondents, 52.6% were female, 73.2% Caucasian, 16.0% African American, and the average age was 70 years. Even though 58.9% of patients had heard about the possible use of marijuana for glaucoma, only 2.6% of 226 respondents admitted to personal use of marijuana for glaucoma, and 8.0% had used marijuana for other medical conditions. 36.9% reported using marijuana (even once) for recreational purposes. Patients with a graduate degree were less likely (P = 0.02) to believe that marijuana has fewer side effects than conventional glaucoma therapies and reported less difficulty paying for glaucoma medications (P = 0.01). Respondents who had heard of the marijuana as therapy for glaucoma or have previously used it for recreational purposes were more likely to believe it is safe (P < 0.001 and P = 0.002, respectively), effective (P < 0.001 for both), decreases eye pressure (P < 0.001 for both), and had more interest in using it (P < 0.001 for both).

Discussion
The American Glaucoma Society (AGS)1 issued a statement in 2010 recommending against the use of marijuana in the treatment of glaucoma given its short duration of action, documented adverse effects, and lack of scientific evidence supporting efficacy. Despite this, most glaucoma patients have heard of marijuana as a treatment for glaucoma, suggesting a potential opportunity to educate patients on the realities of this treatment option in comparison to conventional treatments.

Conclusion
A majority of glaucoma patients have heard of the possibility of marijuana for treatment of glaucoma, though only a small percentage admitted to use for a therapeutic purpose. Patients who previously used marijuana, even for recreational purposes, are more likely to believe marijuana is a safe, effective alternative to their current glaucoma medications and surgical options.

Reference
Surgical Cancellations in Glaucoma Practice: Causes, Delays, and Effect on Patient Care and Revenue

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1 Wills Eye Hospital

Purpose/Relevance
To assess the incidence of glaucoma surgery cancellations, as well as underlying reasons and estimated lost potential reimbursement at a tertiary eye hospital.

Methods
Retrospective observational study of planned surgical procedures of four glaucoma specialists at an urban eye hospital from 05/2018 to 05/2019. Demographic, clinical, and surgical information was recorded from the electronic medical record. A brief phone survey was implemented to identify the underlying reason for cancellation if a reason was undocumented.

Results
80 (9.4%) surgical cases (mean age ± SD, 71 ± 15 years, 55% male) were cancelled over the one-year period. 35% of cancellations were related to patients not arriving on the day of surgery. 60% of cancellations were made within 1 day of planned date of surgery, and 99% were within 7 days. Reasons for cancellations were the following: patient health issue (24%), not cleared by physician (20%), transportation (8%), patient/family hesitation or questions (6.2%), lack of timely medical clearance (6.2%), lack of insurance authorization (3.8%), family illness (2.5%), patient conflict (2.5%), physician postponement (2.5%), patient ate (2.5%), indication for surgery resolved (1.2%), incarcerated (1.2%), unknown (20%). A majority of the surgeries were eventually performed: to date (70%). Mean (± SD) delay in surgery was 50.8 (± 68.6) days (range, 1-426). Assuming Medicare reimbursement rates, the estimated total potential lost reimbursement (excluding anesthesia lost reimbursement) was $276,537.

Discussion
This study highlights a significant number of cancellations in glaucoma practice, a majority of which occurred within one day of planned surgery and resulted in significant surgical delay. These delays may lead to worse outcomes in urgent cases as well as lost revenues. The causes of delays suggest the potential for mitigation.

Conclusion
Minimizing preventable causes of cancellations could decrease the likelihood of surgical delays as well as potential lost reimbursement. Investment of additional resources to proactively manage at-risk cases may be warranted.

Reference
Mental Stress Influence on Intraocular Pressure and Visual Field

SHIMON KURTS¹, Shay Keren, Michael Waisbourd, NIR Gomel, Yael Cohen, Shimon Kurtz
¹ Tel Aviv Medical Center

Purpose/Relevance
Intraocular pressure (IOP) is dependent on multiple physiological and mental aspects. Mental stress has been shown to elevate IOP, in contrast to physiological stress, which lowers it. Many patients in the glaucoma clinic are in mental stress before the IOP measurement and the visual field (VF) test which requires much concentration.¹,² We aimed to test the effects of stress on IOP measurements and on VF parameters.

Methods
We enrolled patients from the glaucoma clinic with bilateral open angle glaucoma and no other ocular pathology except for cataract. The patients underwent a standard IOP examination and VF test. After the initial examinations, patients completed a computerized Stroop test, which has been proven to increase mental stress. After test completion, the subjects underwent a second IOP measurement and VF testing.

Results
Forty eyes of 20 patients were included. Mean age 69.9 ± 9.12 years (range 51-84 years). The mean baseline IOP was 15.04 mmHg and after the Stroop test, 15.4 mmHg with no significant change (P = 0.35). VFI changed from 83.8 to 85.06 (P = 0.9), MD from 6.36 to 6.92 (P = 0.43) and the PSD from 5.46 to 5.32 (P = 0.75). No other VF parameters showed any significant change.

Discussion
Though mental stress is believed to have a significant influence on IOP measurements and VF parameters, such change was not seen in our cohort. This may be attributed to the fact that the baseline IOP and VF examinations were stressful and that a second examination, knowing what values to expect, were less stressful. It can also be attributed to the rather small sample size.

Conclusion
Mental stress does not seem to cause any significant changes in IOP measurement and VF parameters, in the setting of an outpatient clinic.

References
The Effectiveness of Resident Diagnosis and Follow-up of Glaucoma Suspect—A Retrospective Review

LAUREN LIM1, Farid Khan, Taryn Jurgensen, Victor Chen, Ze Zhang
1 Tulane University

Purpose/Relevance
To review management patterns and rate of progression to glaucoma in patients diagnosed as glaucoma suspects in a resident-run general ophthalmology clinic. Studies show that trainee use of preferred practice patterns in ophthalmology vary greatly. Our goal is to review the management pattern and treatment outcomes of glaucoma suspect patients by resident physicians for patient management and trainee education quality improvement.

Methods
A retrospective chart review of patients seen at resident clinics diagnosed as glaucoma suspects. Data obtained included age, race, family history, visual acuity (VA), intraocular pressure (IOP), gonioscopy, cup:disc ratio, central corneal thickness, IOP-lowering medications, laser trabeculoplasty, surgical treatment of ocular hypertension, visual field results, and optical coherence tomography (OCT) results. Patients were followed to the last available follow-up, or at least 1 year following initial diagnosis.

Results
133 patients were included in this study, of which 132 (99%) were male. 70% were African American, 30% were white. Average age at diagnosis was 62 ± 8 years. On average, patients had first been diagnosed as glaucoma suspects 8.5 years ago, with range in time since initial diagnosis of 1 to 19 years. Average initial IOP was 16 ± 2.6 mmHg. Average CCT was 540 ± 30 microns. 40% of patients lacked a CCT measurement within the first year of diagnosis. Average cup:disc ratio was 0.5 ± 0.2. Average visual field pattern standard deviation was 2.7 ± 1.5 dB. 57% of charts lacked documented gonioscopy within one year of diagnosis. 7% did not ever have documented gonioscopy.

Of patients who had been identified as glaucoma suspects within the last 5 years, 17% progressed to glaucoma.

Discussion
This study utilized an EMR to retrospectively analyze rates of progression to glaucoma among all patients who had been identified as glaucoma suspects at a resident-run clinic. A significant percentage of study patients progressed to glaucoma.

Conclusion
Sub-optimal rates of gonioscopy, visual field testing, and measurement of central corneal thickness are consistent with previous reports of resident performance in the care of glaucoma suspects. Better trainee education is necessary for effective glaucoma suspect workup and management, especially considering high rates of progression to glaucoma in this patient population. We plan to create a targeted quality improvement program to improve patient outcomes.

References
Purpose/Relevance

Peters’ anomaly is a kind of rare and severe ocular dysgenesis, with a high blindness rate. Glaucoma is one of the leading causes of blindness in children with Peters’ anomaly. The efforts to lower intraocular pressure (IOP) are usually unsatisfactory, due to multiple anterior segment abnormalities. This study was to investigate the anterior segment features of Peters’ anomaly using ultrasound biomicroscopy (UBM).

Methods

Forty-one (67 eyes) children (0-3 years old) with Peters’ anomaly/Peters Plus syndrome (PPS)-like phenotype were enrolled. All eyes were examined under sedation with chloral hydrate, including IOP measurement, slit-lamp examination, anterior segment photography, horizontal corneal diameter measurement, and A-scan and B-scan ultrasonography. The extent of ocular involvement was graded using UBM and hand-held slit-lamp microscope. The enrolled eyes were divided into glaucoma and non-glaucoma groups. UBM was used to evaluate the anatomic characteristics of the anterior segment. And Peters’ anomaly was graded according to previously published criteria.3

Results

The percentage of patients with bilateral involvement was 63.4% (26/41). And 46.5% (31/67 eyes) suffered from secondary glaucoma. UBM results (36 cases, 58 eyes) showed mild type (corneal opacities with posterior defect) in 3 eyes (5.2%), moderate type (corneal posterior defect with iridocorneal adhesion) in 45 eyes (77.6%), and severe type (corneal posterior defect with corneolenticular adhesion) in 10 eyes (17.2%). In 45 eyes with moderate type, the pattern of iridocorneal adhesion could be subdivided into two types: peripheral (see Figure 1, A) and mid-peripheral (Figure 1, B) under UBM. The incidence of glaucoma was 69.2% (9/13 eyes) in peripheral type, significantly higher than that in mid-peripheral type (28.1%, 9/33 eyes) (P < 0.05). There were no significant differences in central corneal thickness (CCT) and central anterior chamber depth (CACD) between glaucoma group and non-glaucoma group (P > 0.05).

Discussion

The pathogenesis of glaucoma in Peters’ anomaly mainly involves trabeculodysgenesis and congenital anterior synechia of iris. UBM can provide detailed images of ocular anterior segments, especially in Peters’ anomaly patients with corneal opacities. Our study showed that in the peripheral type of moderate disease of Peters’ anomaly, the adhesion of the iris starts from the anterior chamber angle, showing more disturbance of aqueous outflow than the mid-peripheral type, and the incidence of secondary glaucoma is higher.

Conclusion

The pattern of iris adhesion, which was observed by UBM, plays an important role in the pathogenesis of glaucoma in Peters’ anomaly. UBM is helpful for evaluation of glaucoma secondary to Peters’ anomaly. This may be useful for determination of pathogenesis of glaucoma and decisions about surgical intervention.

References

Prevalence of Autoimmune Diseases in Primary Open Angle Glaucoma (POAG) Patients Undergoing Ophthalmic Surgeries

MALTISH LORENZO1, Lucy Shen, Julia Devlin, Eleftherios Paschalis, Dong Feng Chen, Rafaela Nascimento e Silva, Sherleen Chen, Milica Margeta, Courtney Ondeck, David Sola-Del Valle, James Chodosh, Joseph Ciolino, Roberto Pineda, Louis Pasquale, David Friedman

Purpose/Relevance
To assess the prevalence of autoimmune diseases in patients with primary open angle glaucoma (POAG) undergoing ophthalmic surgery compared to control subjects undergoing cataract surgery.

Methods
A retrospective study was performed in patients with POAG and controls without glaucoma undergoing ophthalmic surgery at the Massachusetts Eye and Ear from April to August 2019. Control subjects were scheduled for cataract surgery and excluded if they carried the diagnosis of glaucoma, glaucoma suspect, or have a family history of glaucoma. The presence of autoimmune diseases was determined based on all available medical record information. The difference in prevalence of autoimmune diseases between POAG and controls was determined based on available medical record information. The difference in prevalence of autoimmune diseases between POAG and controls was assessed with chi-square test and these results were adjusted for covariates including age, body mass index (BMI), gender, ethnicity, and type 2 diabetes using multinomial logistic regression.

Results
62 POAG patients (HVF MD: -11.06±8.00 dB; available and reliable for 78% of patients) and 97 controls were included. POAG patients were older than controls (74.56±7.97 vs 70.92±11.14 years, p=0.027) and comprised of 38% male versus 45% in the control group (p=0.380). Both groups had similar BMI (overall 27.4±4.5, p=0.773) and pre-operative IOP (overall 15.9±4.5 mmHg, p=0.414). The cup to disc ratio was 0.76±0.15 in POAG patients and 0.33±0.13 in controls (p=0.0001). The overall prevalence of autoimmune diseases was 27% in the POAG group and 9% in the controls (p=0.003). The most prevalent autoimmune disease was polymyalgia rheumatica in POAG (4.84%) and psoriasis in controls (3.1%, Table 1). In the fully adjusted multinomial logistic regression analysis, having an autoimmune disease was associated with 4.61-fold increased odds of POAG relative to controls (95% CI: 1.69-12.5, p=0.003), while age and non-white ethnicity also increased odds of POAG (odds ratio = 1.05, 1.54, respectively, p<0.05 for both).

Discussion
POAG patients showed a higher prevalence of autoimmune diseases compared to controls. This information supports current literature that autoimmunity may be involved in the pathogenesis of POAG.1

Conclusion
POAG may be associated with autoimmune disorders.

References

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<th>Controls (n = 97)</th>
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<tr>
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<td>Hashimoto’s thyroiditis</td>
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<tr>
<td>Rheumatoid arthritis</td>
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Table 1. Autoimmune diseases present in patients with POAG and control subjects. Note that the diagnosis of each disease (n) appears higher than the overall prevalence of autoimmune disease stated in the abstract as certain patients had multiple autoimmune diseases.
128 Update on the Association Between 24-Hour Blood Pressure and Optic Disc Hemorrhage in Glaucomatous Eyes

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Purpose/Relevance
We prospectively followed 24-hour blood pressure and daytime mean ocular perfusion pressure (OPP) in glaucomatous eyes with and without optic disc hemorrhage (ODH) to assess the relationship between ODH and hemodynamic instability. This is an update to a presentation given at AGS 2018.

Methods
We identified patients of Bascom Palmer Eye Institute with glaucoma using PSD and GHT on SAP. One eye underwent SAP, examination and disc photography to classify presence of ODH. BP was measured every 60 minutes for 24 hours using an ambulatory recording device (Welch Allyn ABPM 6100). IOP and seated BP were taken at 8 am, 10 am, noon and 4 pm. Analysis utilized SPSS® 24.0 software with chi square test for ordinals and independent t-test for continuous variables.

Results
We included 22 eyes with ODH and 22 without. There were no significant differences in baseline demographics other than age; presence or treatment of systemic hypertension; glaucomatous parameters such as baseline IOP, classification as POAG or NTG, SAP MD, PSD, or average RNFL thickness; mean daytime IOP, MOPP, or MAP; or mean nocturnal MAP. ODH was significantly associated with a nocturnal dip in MAP ≥ 10 mmHg. ODH eyes had a mean nocturnal MAP dip of 13.3 mmHg ± 6.8 versus 7.3 mmHg ± 8.4 in non-ODH eyes (P = 0.006).

Discussion
Risk factors such as ODH suggest avenues for novel therapies, but the pathophysiology of ODH remains unclear. Theories include mechanical shearing forces following neuronal atrophy, or primary vascular or hemodynamic insults causing secondary neuronal atrophy.

The LoGTS showed associations between ODH and low SBP, systemic β-blocker use, and low OPP, supporting a hemodynamic mechanism.¹ Rao et al found no difference in OCTA vessel density between POAG with and without ODH, arguing against a vascular mechanism.²

We found a significant association between ODH and larger dips in nocturnal MAP, similar to findings from Kwon et al.³ We posit that large dips in MAP induce hypoperfusion by exceeding local autoregulation. How hypoperfusion would induce ODH is unclear.

We cannot measure nocturnal IOP without disturbing sleep-wake cycles. OPP may be more sensitive to MAP than to IOP because of the difference in magnitudes; if so, IOP dips would exhibit less correlation to ODH.

Conclusion
Aggressive IOP control fails to halt progression in a subset of cases. The next step to explore treatment by reducing MAP fluctuations would be 24-hour IOP monitoring to differentiate effects of fluctuating IOP vs. MAP on ocular perfusion and ODH.
References


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Figure 1
**I29 Glaucoma-Related Malpractice Litigation: A Review of the Westlaw Database**

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**Purpose/Relevance**

U.S. ophthalmologists have a high risk of malpractice claims during their careers, as 5-10% of ophthalmologists face such a claim annually.1 Gaining understanding of glaucoma-related malpractice litigation may highlight ways to improve patient care, as well as how providers can minimize their risk of litigation. This study aims to analyze the outcomes and characteristics of glaucoma-related malpractice litigation.

**Methods**

The Westlaw legal database (Thomson Reuters, NY, NY) was used to identify cases regarding “medical malpractice” AND “glaucoma” or related terms (i.e., trabeculectomy, tube shunt, narrow angle, iridotomy, cyclophotocoagulation, IOP, angle closure, trabeculoplasty, suprachoroidal shunt). Cases were analyzed for characteristics such as alleged cause of malpractice, outcome, and demographics.

**Results**

The included search terms yielded 498 results, 106 of which met further inclusion criteria upon data extraction. The cases were litigated from 1942 to 2019. 38 (36%) were resolved via jury trial. Of these, verdicts in favor of the plaintiff were issued in 13 cases (34%), with median adjusted damages of $702,986. 66 (62%) of the 106 cases reviewed resulted in verdicts in favor of the defendant. Ophthalmologists were named as defendants in 85% of the cases (with glaucoma specialists representing 7% of the ophthalmologists); optometrists in 20%. 60% of the cases involved non-surgical treatment. The most commonly litigated surgical procedure was cataract surgery (38%), followed by iridotomy (13%), unspecified glaucoma surgery (12%), trabeculectomy (8%), and tube shunt (6%). The most common medical reasons for litigation were failure to diagnose (39%), inappropriate/negligent treatment (33%), and failure to treat (20%). Glaucoma malpractice litigation has increased: cases from 2010-2019 represent 34% of total glaucoma litigation since 1942 (Figure 1).

**Discussion**

Glaucoma malpractice litigation is becoming more prevalent, with medical mismanagement alleged in the majority of cases. Of the surgical procedures, cataract surgery and iridotomies were the most commonly litigated. A minority of cases involved glaucoma specialists. A majority of glaucoma-related cases resulted in favor of the provider.

**Conclusion**

This historical analysis of glaucoma-related malpractice cases might provide perspective and aid physicians seeking to avoid litigation.

**Reference**

Guidelines-Driven IOP Targets and Visual Field Progression

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Purpose/Relevance
To determine if guidelines-driven target IOPs can help minimize glaucomatous visual field (VF) progression.

Methods
7,233 24-2 VF tests of 442 eyes, 281 patients of African (AD) or European (ED) descent, with glaucomatous optic neuropathy and VF loss from a prospective longitudinal study (ADAGES) were analyzed. Patients with fewer than 5 visits and 2 years of follow-up were excluded. Eyes were divided into 3 groups based on their baseline mean deviation (MD): G1 (better than -5.0), G2 (-5.0 to ≥ -10), and G3 (worse than -10 dB). The slopes of MD values (dB) over time (years) were calculated with least squares linear regression. A clinically stable rate of VF change was defined as an MD slope more positive than -0.1 dB/year (an approximation of the age-related decay in sensitivity).1 We investigated the relationship between current target IOP guidelines and rates of progression in these groups, for each descent: G1 <21, G2 <18, and G3 <16 mmHg.2

Results
Among G1, G2, and G3 eyes, the median follow-up IOP values associated with clinically stable VFs were 15.28 (IQR, 13.0 to 18.16), 13.7 (10.8 to 15.7), and 12.1 (10.4 to 14.3) mmHg, respectively (Kruskal-Wallis test: P < 0.001). In G1, G2, and G3 the IOP target guidelines were associated with median MD slopes of -0.19 (-0.37 to -0.01), -0.15 (-0.58 to 0.01), and -0.11 (-0.33 to 0.03) dB/year, respectively (P = 0.040). Of note, AD eyes tended to have higher follow-up IOP across severity stages (G1: 15.1 vs. 14.8, P = 0.065; G2: 14.2 vs. 13.3, P = 0.039; G3: 13.5 vs. 11.6, P < 0.001).

Discussion
Although target IOP should be individualized and continuously readjusted, this is the first report to quantitatively estimate the IOP levels associated with slower rates of functional deterioration at different severity stages based on current target IOP guidelines.

Conclusion
In a sample of patients with manifest glaucoma, despite substantial variability between eyes, adhering to treatment guidelines appears to help slow the rates of VF progression at various stages of disease.

References
Purpose/Relevance
Primary open-angle glaucoma (OAG) is a leading cause of visual impairment and blindness. Current information on costs of managing ocular hypertension (OHT) and OAG, particularly by disease severity, are limited. This study assessed recent data on annual OHT/OAG health care resource utilization (HCRU) and costs by disease severity.

Methods
Using IQVIA’s Adjudicated Health Plan Claims Database, adults with OHT/OAG were identified during the study period, stratified by initial disease severity (defined by ICD-10 codes), and followed for one year. Eye-related HCRU and direct medical costs by disease severity were assessed. Incremental costs of disease progression were estimated using multivariate analyses. Adjusted risk of additional sequelae, including risk of falls/fractures, were estimated. All costs were adjusted to 2018 USD.

Results
177,352 prevalent OHT/OAG patients were identified (57,177 OHT and 120,175 OAG). OAG patients had more eye-related outpatient visits than OHT patients (mean 4.2 vs. 3.0) and greater numbers of visits were seen with increasing OAG severity (mean 3.7, 4.3, and 5.1 for mild, moderate, and severe, respectively). Higher eye-related outpatient costs were associated with increasing disease severity (mean [SD] of $882 [$1916], $1147 [$2493], $1557 [$3004] for mild, moderate, and severe patients, respectively), which were driven by office visit costs and glaucoma surgery-related costs (mean [SD] per surgical recipient of $1693 [$2179], $1736 [$2095], and $2241 [$2491] for mild, moderate, and severe patients, respectively). Additionally, increasing disease severity was associated with increasing glaucoma pharmacy HCRU and costs. In adjusted analyses, a change in disease status was significantly associated with 2-fold higher annual eye-related costs (P < 0.0001).

Controlling for baseline characteristics, notably age, patients with severe glaucoma had significantly higher odds of a fall/fracture compared to OHT patients (OR = 1.34, 95% CI: 1.13, 1.59; P = 0.001).

Discussion
This study provides an updated estimation of the costs associated with increasing glaucoma severity and disease progression, including quantification of sequelae such as falls/fractures. Disease progression and worsening severity were associated with significantly higher HCRU and costs, even after adjusting for baseline characteristics such as age.

Conclusion
Glaucoma disease progression and increasing disease severity incur a heavy economic burden. Therapies that delay disease progression may provide economic benefits.

Reference
132 Cost Analysis of a Tele-ophthalmology Mobile Screening Unit

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Purpose/Relevance

Ophthalmology presents a unique arena for telemedicine because of the significant use of technology in our field. Recent advances in portable devices used for routine and specialty ophthalmologic care allow the ability to diagnose diseases remotely. The Tele-Ophthalmology Mobile Screening Program provides exams to individuals to screen for sight-threatening disease. In this study we analyze expenses and identify strategies for cost-effectiveness.

Methods

Costs were analyzed using a micro-costing approach. We analyzed the total cost per participant compared to office expenses. Costs were divided into staff and non-staff related expenses. Non-staff related items such as wage rates, mobile unit operating costs, and office supplies were allowed to vary by 25% of the total cost in the analysis to account for real-world variation.

Results

In 2017, 340 patients were screened, while 617 were screened in 2018. Follow-up recommendations were given to patients at the end of each screening, and patients were contacted at selected intervals for follow-up. The total number of screening hours completed in 2017 was 139, and 204 hours in 2018. The average time spent per patient was 24 minutes in 2017, 20 minutes in 2018. In the study period, approximately 50% of patients screened were diagnosed with one of the following: cataract, glaucoma, diabetic retinopathy, and/or age-related macular degeneration. The total cost, personnel and equipment, per new sight-threatening diagnosis was $1267.62 in 2017 and $414.15 in 2018. The total cost per participant was $372.83 in 2017, $291.99 in 2018. The average office visit cost was estimated to be $589.96, more than double the per-patient cost of mobile screening in 2018. In 2017, the total cost of the program was $126,761.52, while in 2018, the cost was $180,154.86.

Discussion

The growing and aging population will soon surpass the number of ophthalmologist office visits available. The need to reach more individuals to prevent sight-threatening diseases will drive the market for teleophthalmology. Tele-ophthalmology will maximize efficiency in diagnosis of sight-threatening disease, thus preventing long-term vision loss and diminishment in quality of life.

Conclusion

The average cost of initial diagnosis of can be reduced significantly using tele-ophthalmology programs versus the traditional office-based evaluation.

References

Impact of the Support, Educate, Empower (SEE) Glaucoma Coaching Program on Glaucoma Medication Adherence: A Pilot Study

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1 University of Michigan Kellogg Eye Center

Purpose/Relevance
To assess the preliminary efficacy of the Support, Educate, Empower (SEE) personalized glaucoma coaching program in improving medication adherence among poorly adherent glaucoma patients.

Methods
Glaucoma patients ≥40 years old, taking ≥1 medication, and who self-reported poor adherence were prospectively recruited from the University of Michigan, Kellogg Eye Center. Adherence was monitored electronically (AdhereTech, New York, NY) for a 3-month baseline period. Adherence was calculated as the percentage of doses taken on time of those prescribed. Patients with baseline adherence ≤80% were enrolled in the SEE program and followed for 7 months, during which time adherence was also monitored. The SEE program included (1) automated medication reminders, (2) three in-person counseling sessions with a glaucoma coach who had brief training in motivational interviewing (MI), and (3) five phone calls with the coach for between-session support.1 The coach used a web-based tool to generate an education plan tailored to the patient’s glaucoma diagnosis, test results, and the ophthalmologist’s recommendations (www.glaucomaeyeguide.org). The tool guided an MI-based conversation between coach and patient to identify barriers to adherence and possible solutions. Descriptive statistics were used to summarize baseline patient characteristics, and differences between those who did and did not complete the SEE program were tested with 2-sample t-, chi-square, and Fisher’s exact tests. Adherence was compared before and during the SEE program with paired t-tests.

Results
48 participants were eligible for the study. Eligible participants were 54% male, 46% white, on average 64 years old (standard deviation, SD = 10.8), with a worse eye mean deviation (MD) score of -7.9 dB (SD = 8.8), and were 58.5% adherent to their glaucoma medications (SD = 18.7%, range = 13.3%-80.0%). Those completing the program (n = 39) did not differ significantly from those that dropped out (n = 9) on sex, race, age, MD, or baseline adherence (all P > 0.05). Baseline adherence improved from 59.9% to 81.3% (SD = 17.6%; P < 0.0001) during the SEE program. 95% of participants showed an improvement in adherence (mean relative improvement = 21.4%, SD = 16.5%, range = -3.2% to 74.4%, median = 20.1%). 59.0% of participants had adherence >80% upon completing the SEE program.

Discussion
Participants in the SEE Program had a clinically meaningful, statistically significant improvement in glaucoma medication adherence.

Conclusion
Future work will test the efficacy of the SEE Program on medication adherence compared to a control group.

Reference
Standardized Quantification of Episcleral Venous Flow Using Erythrocyte-Mediated Angiography

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Purpose/Relevance
Quantification of episcleral venous flow may serve as a reliable outcome marker that can guide preoperative planning or intraoperative decision making for minimally invasive glaucoma surgeries (MiGS). Erythrocyte-mediated angiography (EMA) is a novel technology that allows direct visualization of individual erythrocytes within the ocular microvasculature in vivo, specifically in the retina, choroid, optic nerve head, and anterior segment vessels. We describe a standardized process to accurately quantify blood flow in episcleral veins.

Methods
We describe the standardized process of measuring episcleral venous flow using EMA with a Heidelberg scanning laser ophthalmoscope (Heidelberg Engineering, Heidelberg, Germany) at 24.6 frames per second. After obtaining EMA angiograms, the episcleral vein of interest was identified by comparing a deviation plot created through ImageJ, a slit lamp image, and conventional ICG angiograms (Figure 1). A semi-automated MATLAB program was used to identify and track individual erythrocytes. Blood flow velocities were measured from 4 episcleral veins of 4 subjects (2 glaucoma, 2 controls). The velocity was determined using an ophthalmoscope tool of known diameter for scaled measurements.

Results
Mean erythrocyte velocities for glaucoma patients were 5.49 ± 2.05 mm/s and 5.08 ± 1.86 mm/s, while for control patients they were 1.43 ± 0.52 mm/s and 3.87 ± 2.95 mm/s.

Discussion
The results from this small sample of patients show that the individuals with glaucoma have greater episcleral venous flow compared to controls. This may be in part due to the fact that glaucoma patients were on medications at the time of imaging, which may affect episcleral venous flow. EMA allows for direct visualization of ICG-labeled ghost erythrocytes in vivo to observe and precisely quantify ocular blood flow. While our group has previously published data on its use in the posterior segment, there is a gap in the literature for its application in the anterior segment due to its unique challenges. First, due to the absence of optic disc, the EMA videos had to be registered to the light reflected on the conjunctiva. Second, the episcleral vein of interest was identified and confirmed by looking at slit lamp photography and conventional ICG angiography to differentiate it from conjunctival vessels. Lastly, an external tool of known diameter had to be utilized to approximate the scale when calculating velocities. The same procedure was applied to four subjects, and therefore we believe it can be adopted in a larger number of patients and other laboratories, as well.

Conclusion
We describe a standardized procedure for quantifying episcleral venous blood flow. Further studies with a larger sample size and pre and post treatment are warranted.
Figure 1: The episcleral vessel of interest was identified through a deviation plot of EMA videos (A), slit lamp photo (B), and traditional ICG angiography (C).

References
Foveal Avascular Zone (FAZ) in Glaucoma

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Purpose/Relevance
FAZ is the most metabolically active part of the retina and may be affected by age, diabetic retinopathy, and hypertension. However, the role of FAZ progression in glaucoma is not well characterized. The purpose of this study was to see how optical coherence tomography angiography (OCTA) measurements of the FAZ region would change with progression of glaucoma.

Methods
This IRB-approved retrospective study used 1431 eligible eyes from 736 consecutive patients, categorized as 411 healthy controls, 472 ocular hypertension, 185 mild glaucoma, 274 moderate glaucoma, and 89 severe glaucoma eyes. Eligibility was defined as follows: >18 years old with primary open-angle glaucoma, no retinal or vascular pathology, non-glaucoma visual field defects, vision better than 20/200. Data collected included: race, gender, family history, hypertension, diabetes, myopia, and OCTA FAZ parameters. The effect of disease severity as well as the impact of co-morbidities on FAZ parameters was evaluated. Data analysis used one-way ANOVA, unpaired t-tests, and chi square analysis.

Results
Patient demographics are in Table 1. Compared to the controls (Table 2), the values for mild, moderate, and severe as follows: FAZ area progressed from 0.269 µm² to 0.338 µm² to 0.405 µm² (P < 0.05), FAZ perimeter increased from 2.103 µm to 2.357 µm to 2.719 µm (P < 0.05), but flow area density decreased from 45.94 µm to 44.44 µm to 43.81 µm as glaucoma severity increased (P < 0.05). Additionally, hypertensive patients displayed higher FAZ perimeter (2.140 µm, 2.514 µm) than non-hypertensive patients (2.041 µm, 2.158 µm) in mild and moderate glaucoma (P < 0.05), but not in severe glaucoma. No differences were found in the FAZ region between diabetic and non-diabetic patients (P > 0.05).

Discussion
Collectively, the data suggest that FAZ measurements indeed follow the progression of glaucoma, in terms of FAZ area, perimeter, and flow density, suggesting vascular compromise. Hypertensive patients with glaucoma display higher FAZ perimeter and lower flow length density than those without hypertension, probably because of underlying microangiopathy. Interestingly, diabetic patients display no significant differences.

Conclusion
This study shows that FAZ morphology changes as glaucoma progresses. While concurrent hypertension in patients with glaucoma adversely affects FAZ parameters, these OCTA changes are unique from the changes seen in glaucoma, increasing OCTA efficacy as a glaucoma diagnostic tool.
References


136 Barriers to Glaucoma Follow-up Care in a West African Population

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Purpose/Relevance
Glaucoma is highly prevalent in West Africa, and previous studies have shown that subjects of African descent are at significantly greater risk of going blind from glaucoma.1-3 Attending routine follow-up appointments is important so that patients can be monitored and receive timely therapeutic interventions to prevent glaucoma progression and visual impairment. The purpose of this study was to measure potential barriers to glaucoma follow-up among Africans in Ghana.

Methods
Cross-sectional study of 66 adult patients who were recruited at the Tema Christian Eye Center, Tema, Ghana. All participants were required to have an established glaucoma diagnosis (e.g., primary open angle or closed angle glaucoma, normal tension glaucoma, or pigmentary glaucoma) with follow-up at that clinic for more than 12 months. An oral questionnaire pertaining to demographic information and barriers to follow-up for glaucoma care was administered to all participating patients. The primary outcome measure was the prevalence of significant barriers.

Results
The vast majority of the patients had advanced glaucoma (77.3%) in at least one eye as determined by visual field testing, while only 18.2% and 4.5% had moderate or mild disease severity, respectively. The most prevalent barriers to follow-up care included outpatient fees (45.5%), transportation costs (27.3%), surgical fees (16.7%), and inability to leave work responsibilities (15.2%). Additionally, a large number of patients denied any perceived barriers to obtaining follow-up care (28.8%).

Discussion
Financial concerns due to transportation costs, outpatient fees, and surgical fees were common barriers to follow-up for glaucoma patients in Ghana. Strategies to improve adherence to follow-up recommendations should address ways to supplement clinic and surgical fees and consider developing programs that provide affordable transportation for this high-risk population.

Conclusion
The barriers identified in our study may result in missed or delayed ophthalmology appointments, increased health expenditures, and poor visual outcomes. Further studies are needed to evaluate strategies for patients at increased risk of disease progression.

References
Purpose/Relevance
To introduce a new head-mounted device perimeter (HMDP) with eye tracking capabilities and its correlation with a standard automated perimeter (SAP).

Methods
In this prospective interventional study, 25 (50 eyes) healthy subjects and 27 (53 eyes) individuals with a controlled glaucoma had visual field test with both HMDP (VisuALL NormalT protocol, Olleyes, Inc., Summit, NJ) and Humphrey (HFA 24-2 protocol, Carl Zeiss Meditec, Dublin, CA) perimeters. The correlation between the perimeters was calculated using Spearman correlation coefficient (r). The HMDP is lightweight, portable, and comfortable, and there is no need for an eye patch. The test is run through its application on a cellphone, tablet, or laptop (Figure 1). The HMD has two tracking systems with an accuracy of less than 1 degree.

Results
Similar number of healthy individuals were included per decade of life for reference purposes (age ranged from 30 to 79 years old), and the glaucoma group mean age was 66 years old (23-86). Sixty percent of the healthy group and 51% of the glaucoma group were female. The global mean sensitivity of the HMDP and the SAP correlated in healthy (r = 0.54, P < 0.001) and glaucoma (r = 0.77, P < 0.001) groups. The mean sensitivity of the quadrants also correlated in both the healthy [superonasal (SN) r = 0.47, P = 0.003; inferonasal (IN) r = 0.33, P = 0.04; superotemporal (ST) r = 0.39, P = 0.01; inferotemporal (IT) r = 0.58, P < 0.001] and glaucoma groups (SN r = 0.65, P < 0.001; IN r = 0.76, P < 0.001; ST r = 0.62, P < 0.001; IT r = 0.67, P < 0.001).

Discussion
In this study, the assessed parameters of HMDP and SAP had a good correlation. The HMDP promises several advantages. The patient can be tested in virtually any position, the head can be freely moved during the test, the HMDs efficiently control the testing environment luminance and the HMD-based perimetry does not require a dedicated room or technician support and could be performed outside the doctor’s office.

Conclusion
The perimetric results of the HMDP and the SAP were comparable. The HMDP has the potential to be an effective and versatile clinical perimetry device.

References
Purpose/Relevance

In glaucoma care, patient compliance with follow-up is integral to optimizing management outcome, and travel time to/from a glaucoma specialist’s office is a major factor in compliance. However, there are no systematic analyses of statewide travel time as a marker of glaucoma care access. In this study, we performed a service coverage analysis of American Glaucoma Society (AGS) members’ office addresses and analyzed the travel time of Florida residents aged >65 years.

Methods

We used the AGS national provider registry to geocode all service providers into a geographic information system (GIS). We calculated four service areas representing 15, 30, 60, and 120-minute driving times to the nearest AGS provider, accounting for Wednesday 12 PM mean traffic patterns, to visualize geographic service coverage. We then analyzed the Census’ 2016 American Community Survey data for all Florida census blocks by calculating the percent of Florida’s older adult population (65+), and other select demographic characteristics, residing within each service area.

Results

There are 3,797,625 Florida residents aged over 65 years, of which 1,153,320 (30.4%) live within 15 minutes of driving time from an AGS provider’s office, 2,586,825 (68.1%) within 30 minutes, 3,358,983 (88.4%) within 60 minutes, and 3,491,815 (91.9%) within 120 minutes. There are 305,810 (8.9%) Florida residents aged >65 years that are more than 120 minutes away from the nearest AGS provider. The regions with the lowest access include rural areas around Lake Okeechobee and throughout the Florida panhandle (excluding Tallahassee).

Discussion

While more than 90% of Florida residents aged >65 years are within 120 minutes of driving time of an AGS member provider’s office, only 68.1% are within 30 minutes, which constitutes travel burden for the remaining demographic population at risk for glaucoma. GIS and geo-demographic profiles of glaucoma patients may provide insight into care access barriers. Future studies are needed to elucidate the role of public transportation infrastructures in glaucoma care access.

Conclusion

Approximately one-third of Florida residents aged >65 years do not have access to a glaucoma specialist with drive time under 30 minutes.


**139 Ability to Predict Visual Field Damage Using Patient-Reported Symptoms**

**YESHA SHAH¹, Aleksandra Mihailovic, Michael Cheng, Pradeep Ramulu**

¹ Johns Hopkins University SOM

**Purpose/Relevance**
Currently, characterization of glaucoma severity is accomplished through testing, i.e., optic nerve findings, OCT, or visual field (VF) assessment.¹ In practice, a useful adjunct to these tests is discussion of patient symptoms, though the ability of symptom-related questions to predict severity is unknown. Here, we evaluate which questions best capture glaucoma severity and determine, using VF damage as the gold standard, to what extent symptoms can capture disease severity.

**Methods**
Patients in two groups (diagnosed glaucoma with VF mean deviation [MD] worse than -5 dB in both eyes and suspected glaucoma with VF MD better than -4 dB in both eyes) graded the presence and severity of 30 visual symptoms. Univariate and multiple linear regression models evaluated the amount of variance (adjusted R²) in VF MD explained by patient-reported symptoms or, for comparison purposes, OCT total retinal nerve fiber layer (RNFL) thickness. Multiple models controlled for age, sex, race, and education.

**Results**
A total of 177 patients were recruited (81 with glaucoma and 96 with suspected glaucoma). Mean age was 65 years and 58% were female. Among glaucoma patients, the most commonly reported symptoms were having better vision in one eye (n = 72), blurry vision (n = 62), and glare (n = 54). In univariate analysis, severity of two symptoms, better vision in one eye and peripheral loss, explained 33% and 34% of variance in VF damage, respectively, while the frequency of the following five symptoms: objects looking different sizes with each eye, missing patches, cloudy vision, weekly vision variance, and glare explained 33%, 32%, 26%, 19%, and 6% of the variance in VF damage, respectively. A multiple linear regression model including the above seven symptoms explained 52% of the variance in VF damage, while a multiple linear regression model including total RNFL thickness explained only 37% of the variance in VF damage.

**Discussion**
Patient-reported symptoms explained a significant amount of variance in VF damage, outperforming RNFL thickness, a commonly used glaucoma tool.

**Conclusion**
In glaucoma, patient communication with specific terms may be useful in staging disease and can complement clinical testing. Communication may be particularly useful in judging disease severity in patients where traditional testing is difficult to obtain.

**Reference**
140 Comparison of Peripapillary and Macular Blood Flow in Patients with Pseudoexfoliation Syndrome, Primary Open Angle Glaucoma, and Healthy Controls

WESAM SHALABY', Carina Sanvicente, Daniel Lee, L Jay Katz
1 Wills Eye Hospital

Purpose/Relevance
To assess and quantify retinal and optic nerve vascular changes in patients diagnosed with pseudoexfoliation syndrome, with or without glaucoma, compared to age- and severity-matched primary open angle glaucoma (POAG) patients and age-matched healthy controls using optical coherence tomography (OCT) angiography.

Methods
OCT angiography (OCTA) scans with a Zeiss Cirrus HD-OCT AngioPlex 5000 (Zeiss Meditec, Inc., Germany) were acquired using the following protocols: 3x3 mm OCTA Optic Disc Scan and 6x6 mm OCTA Macula Scan. The peripapillary retina and macula scans were evaluated for perfusion density (P): the percent area that contains perfused microvasculature. Flux Index (FI), the normalized mean of flow signal intensity of microvasculature, was also measured.

Results
71 eyes of 44 patients were scanned, 19 eyes with pseudoexfoliation glaucoma (PEX+), 18 eyes with pseudoexfoliation syndrome without glaucoma (PEX-), 13 eyes with POAG, and 21 normal control eyes. The average Peripapillary peripapillary perfusion density and flux index were evaluated for perfusion density (P): the percent area that contains perfused microvasculature. Flux Index (FI), the normalized mean of flow signal intensity of microvasculature, was also measured.

Table 1. Peripapillary and Macular Perfusion Density in the Four Study Groups

<table>
<thead>
<tr>
<th>N</th>
<th>Peripapillary Perfusion Density (P)</th>
<th>Macular Perfusion Density</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>PEX+  (n = 19)</td>
<td>190.393 (0.046)</td>
<td>0.415 (0.038)</td>
</tr>
<tr>
<td>PEX-  (n = 18)</td>
<td>180.409 (0.0498)</td>
<td>0.439 (0.022)</td>
</tr>
<tr>
<td>POAG (n = 13)</td>
<td>130.394 (0.051)</td>
<td>0.391 (0.032)</td>
</tr>
<tr>
<td>Normal(n = 21)</td>
<td>210.436 (0.033)</td>
<td>0.431 (0.027)</td>
</tr>
</tbody>
</table>

Discussion
Pseudoexfoliation syndrome is the most common clinical precursor to secondary open angle glaucoma. Vascular abnormalities may be associated with the increased risk of glaucoma found in patients with pseudoexfoliation. Many pathophysiological mechanisms have been proposed for these vascular abnormalities, including deposition of PEX material in blood vessels, either in the endothelium or smooth muscle. Aside from the classic associations with glaucoma and other anterior segment findings, pseudoexfoliation syndrome has been correlated with iris perfusion defects and micro neovascularization. One study found an association of pseudoexfoliation syndrome with retinal vein occlusion (independently to IOP), especially with the ischemic central retinal vein occlusion, strongly supporting the syndrome’s relationship to relevant systemic and ocular vascular abnormalities. Although compared to normal controls, PEX+ patients showed very statistically significant impaired peripapillary blood flow, there was still no statistically significant difference between PEX+ and POAG in our sample. This study was limited by sample size, and enrollment is ongoing.

Conclusion
Vascular dysfunction in macular and peripapillary blood flow might play a role in the pathogenesis in the pseudoexfoliation glaucoma. Further studies and larger sample size are warranted to investigate the consistency of our results.

Table 2. Comparison between PEX+ vs. POAG, and PEX- vs. Normal and PEX+ vs. Normal

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Groups</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peripapillary (P)</td>
<td>PEX+POAG</td>
<td>0.9514</td>
</tr>
<tr>
<td>Peripapillary (FI)</td>
<td>PEX+POAG</td>
<td>0.2838</td>
</tr>
<tr>
<td>Macula</td>
<td>PEX+POAG</td>
<td>0.07</td>
</tr>
<tr>
<td>Macular Vessel Density</td>
<td>PEX+POAG</td>
<td>0.0467</td>
</tr>
<tr>
<td>Macular Perfusion Density</td>
<td>PEX+POAG</td>
<td>0.0713</td>
</tr>
<tr>
<td>PEX-Normal</td>
<td>Peripapillary</td>
<td>0.051</td>
</tr>
<tr>
<td>Peripapillary (FI)</td>
<td>PEX-Normal</td>
<td>0.4035</td>
</tr>
<tr>
<td>Macula</td>
<td>PEX-Normal</td>
<td>0.3249</td>
</tr>
</tbody>
</table>
Table 1. Peripapillary and macular perfusion density in the four study groups

<table>
<thead>
<tr>
<th></th>
<th>N</th>
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<th>Macular Perfusion Density</th>
</tr>
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<tbody>
<tr>
<td>PEX+</td>
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</tr>
<tr>
<td>PEX-</td>
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<td>0.439 (0.022)</td>
</tr>
<tr>
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<td>13</td>
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<td>0.391 (0.032)</td>
</tr>
<tr>
<td>Normal</td>
<td>21</td>
<td>0.436 (0.033)</td>
<td>0.431 (0.027)</td>
</tr>
</tbody>
</table>

Table 2. Comparison between PEX+ vs POAG and PEX- vs Normal

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Groups</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PEX+</td>
<td>POAG</td>
</tr>
<tr>
<td>Peripapillary</td>
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</tr>
<tr>
<td>Macula</td>
<td>0.415 (0.038)</td>
<td>0.391 (0.032)</td>
</tr>
<tr>
<td>PEX-</td>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td>Peripapillary</td>
<td>0.409 (0.0498)</td>
<td>0.436 (0.033)</td>
</tr>
<tr>
<td>Macula</td>
<td>0.439 (0.022)</td>
<td>0.431 (0.027)</td>
</tr>
</tbody>
</table>

References

Purpose/Relevance
To assess abnormalities in the optic nerve head (ONH) and peripapillary microvasculature in eyes with primary open angle glaucomatous (POAG) and paracentral visual field (VF) loss.

Methods
In a cross-sectional study, swept-source optical coherence tomography angiography (OCTA) images were obtained from 14 POAG patients with paracentral VF loss (PaVFL), 12 POAG patients with peripheral VF loss (PpVFL) and 22 controls. POAG groups were matched by VF mean deviation (MD). Microvasculature within the superficial and deep ONH, were quantified, in addition to the superficial peripapillary microvasculature, defined as a 0.70-mm annulus around the Bruch’s membrane opening (BMO). The boundary of the ONH was delineated based on BMO and large vessels were removed to measure vessel density (VD) and the integrated OCTA by ratio analysis signal (IOS) suggestive of flow. Superior and inferior hemispheres were defined by a line dividing the interartery angle measured from the center of the ONH, and the affected hemisphere corresponded to the hemifield of more severe VF loss.

Results
The groups had similar demographics, visual acuity and intraocular pressure on the day of imaging (Table 1). POAG groups had similar MD (-2.9±2.3 dB overall) and average retinal nerve fiber layer (RNFL) thickness (73.5±14.0 µm overall). Compared to controls, PaVFL group had significantly reduced VD and IOS in the deep ONH, peripapillary region and the affected peripapillary hemisphere (P≤0.02), while PpVFL group had significantly lower VD in the deep ONH, lower VD and IOS of the affected deep ONH hemisphere and peripapillary IOS (P=0.04 for all). Among the POAG groups, VD was significantly reduced in the affected peripapillary hemisphere in PaVFL compared to PpVFL (P=0.009), while the peripapillary RNFL thickness was similar (P=0.44). This difference between PaVFL and PpVFL remained significant in the affected peripapillary VD (β=-0.03; 95% confidence interval, -0.05 to -0.01; P=0.002), after adjusting for hemispheric peripapillary RNFL thickness (P=0.94), MD (P=0.23), age (P=0.08) and gender (P=0.02).

Discussion
In the eyes with glaucomatous paracentral VF loss, decreased superficial peripapillary microvasculature density was found in the affected hemisphere when compared to controls and eyes with peripheral loss, although the study was limited by sample size.

Conclusion
Paracentral VF loss in POAG is associated with pathology in the peripapillary microvasculature compared to eyes with POAG and peripheral loss.
### Table: Comparison between control subjects, primary open angle glaucoma eyes with paracentral visual field loss and eyes with peripheral visual field loss

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
<th>(P)-value</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control (N=27)</td>
<td>POAG with paracentral VF loss (N=14)</td>
<td>POAG with peripheral VF loss (N=11)</td>
<td>POAG with parac. VF loss vs. Control</td>
<td>POAG with periph. VF loss vs. Control</td>
</tr>
<tr>
<td>Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender, Male (%)</td>
<td>15(55.6%)</td>
<td>5(35.7%)</td>
<td>5(45.5%)</td>
<td>0.98</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Age (years)</td>
<td>65.2±10.3</td>
<td>61.9±8.3</td>
<td>67.7±6.3</td>
<td>0.80</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Ethnicity, Caucasian (%)</td>
<td>23(85.2%)</td>
<td>12(85.7%)</td>
<td>9(81.8%)</td>
<td>&gt;0.99</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Systemic disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus (%)</td>
<td>5(18.5%)</td>
<td>0(0%)</td>
<td>1(9.1%)</td>
<td>0.44</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Systemic hypertension (%)</td>
<td>12(44.4%)</td>
<td>5(35.7%)</td>
<td>5(45.5%)</td>
<td>&gt;0.99</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Hypertensive medication usage (%)</td>
<td>11(40.7%)</td>
<td>5(35.7%)</td>
<td>6(24.5%)</td>
<td>&gt;0.99</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Ophthalmologic findings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual acuity (logMAR)</td>
<td>0.04±0.07</td>
<td>0.08±0.13</td>
<td>0.05±0.09</td>
<td>0.98</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>IOP at the imaging visit (mmHg)</td>
<td>15.0±2.9</td>
<td>13.6±2.5</td>
<td>14.1±3.4</td>
<td>0.43</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Humphrey visual field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MD (dB)</td>
<td>N/A</td>
<td>-3.4±2.3</td>
<td>-2.4±2.2</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>PSD (dB)</td>
<td>N/A</td>
<td>6.1±3.8</td>
<td>2.9±0.8</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Glaucoma medications (% of eyes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prostaglandin analogues</td>
<td>0</td>
<td>11(78.6%)</td>
<td>8(72.7%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Topical Beta blockers</td>
<td>0</td>
<td>11(78.6%)</td>
<td>5(45.5%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Carbonic anhydrase inhibitors</td>
<td>0</td>
<td>8(57.1%)</td>
<td>5(45.5%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Alphagoonals</td>
<td>0</td>
<td>3(21.4%)</td>
<td>4(36.4%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Structural parameters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average RNFL ((\mu)m)</td>
<td>97.9±9.0</td>
<td>70.9±14.5</td>
<td>76.8±13.2</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Affected hemispheric peripapillary RNFL ((\mu)m)</td>
<td>99.2±8.6</td>
<td>67.8±16.8</td>
<td>77.5±14.9</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>OCT Angiography findings (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ONH VD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superficial vasculature (ILM to BM)</td>
<td>41.2±3.3</td>
<td>39.7±3.8</td>
<td>42.5±2.8</td>
<td>0.68</td>
<td>0.66</td>
</tr>
<tr>
<td>Deep vasculature (BM to 390 (\mu)m below)</td>
<td>42.9±5.0</td>
<td>38.2±4.1</td>
<td>38.2±4.8</td>
<td>0.01</td>
<td>0.04</td>
</tr>
<tr>
<td>ONH IOS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superficial vasculature (ILM to BM)</td>
<td>38.8±5.0</td>
<td>37.0±5.0</td>
<td>41.1±4.8</td>
<td>&gt;0.99</td>
<td>0.25</td>
</tr>
<tr>
<td>Deep vasculature (BM to 390 (\mu)m below)</td>
<td>43.1±6.6</td>
<td>36.1±5.6</td>
<td>38.1±6.6</td>
<td>0.004</td>
<td>0.15</td>
</tr>
<tr>
<td>Affected hemispheric ONH VD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superficial vasculature (ILM to BM)</td>
<td>40.9±3.6</td>
<td>39.0±3.6</td>
<td>42.1±2.6</td>
<td>0.36</td>
<td>0.75</td>
</tr>
<tr>
<td>Deep vasculature (BM to 390 (\mu)m below)</td>
<td>42.0±5.8</td>
<td>38.8±5.8</td>
<td>37.8±3.8</td>
<td>0.31</td>
<td>0.04</td>
</tr>
<tr>
<td>Affected hemispheric ONH IOS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>Superficial vasculature (ILM to BM)</td>
<td>38.0±4.6</td>
<td>37.2±5.1</td>
<td>42.1±4.4</td>
<td>&gt;0.99</td>
<td>0.05</td>
</tr>
<tr>
<td>Deep vasculature (BM to 390 (\mu)m below)</td>
<td>43.3±7.5</td>
<td>35.7±4.8</td>
<td>37.4±5.4</td>
<td>0.001</td>
<td>0.04</td>
</tr>
<tr>
<td>Peripapillary VD (ILM to RNFL)</td>
<td>41.0±4.8</td>
<td>36.5±2.7</td>
<td>40.5±5.9</td>
<td>0.001</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>Peripapillary IOS (ILM to RNFL)</td>
<td>46.6±5.0</td>
<td>42.7±4.4</td>
<td>43.3±5.6</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Affected hemispheric peripapillary VD</td>
<td>39.4±2.4</td>
<td>34.9±2.4</td>
<td>38.1±2.3</td>
<td>&lt;0.001</td>
<td>0.44</td>
</tr>
<tr>
<td>Affected hemispheric peripapillary IOS</td>
<td>46.6±3.4</td>
<td>40.2±4.2</td>
<td>43.9±3.3</td>
<td>&lt;0.001</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Data are expressed as mean ± standard deviation.

Comparison between the three groups was performed using one-way analysis of variance (ANOVA) with Bonferroni correction for multiple comparisons. Bold and italics font indicates statistically significant difference (\(P<0.05\)).

Abbreviations: POAG, primary open angle glaucoma; VF, visual field; logMAR, logarithm of the minimum angle of resolution; IOP, intraocular pressure; N/A, not available; MD, mean deviation; PSD, pattern standard deviation; RNFL, retinal nerve fiber layer; OCT, optical coherence tomography; ONH, optic nerve head; IOS, integrated OCT angiography by ratio analysis signal; ILM, internal limiting membrane; BM, Bruch’s membrane.

**Reference**

142 Reference Standard Optic Disc Images Associated with Threshold Glaucomatous Visual Field Loss Determined by Archetypal Analysis

BRIAN SONG1, Emily Seo, Tobias Elze, Louis Pasquale
1 Kaiser Permanente - Ontario Medical Center

Purpose/Relevance
To determine reference standard optic disc images, stratified by disc size, associated with threshold superior peripheral, superior paracentral, inferior peripheral, and inferior paracentral visual field (VF) loss.

Methods
Archetype analysis, a computational method to decompose VFs into 16 vision loss patterns/archetypes (AT) with corresponding weighting coefficients to allow for classification and quantification of regional VF loss, was performed on a data set of 13,231 reliable Humphrey VFs from 2006-2012. VFs with weighting coefficients of >50% for early glaucomatous superior peripheral (AT 3), superior paracentral (AT 14), inferior peripheral (AT 5), and inferior paracentral (AT 16) subtypes were included. Color optic disc photographs within 6 months of VFs were identified and stratified based on Cirrus optical coherence tomography of the retinal nerve fiber layer (OCT-RNFL) measurements of disc area (small <1.5 mm², medium 1.5-2.0 mm², large >2.0 mm²). Gradable optic disc images associated with the greatest mean deviation meeting early-stage Hodapp-Parrish-Anderson criteria on reproducible VFs were selected. Structural OCT parameters (disc area, rim area, vertical cup-disc ratio [VCDR], average RNFL thickness) were compared based on disc size and VF defect type (peripheral versus paracentral).

Results
Sixty-eight optic disc images from 68 patients were included. Mean OCT-derived structural parameters for all images are shown (see table). Statistically significant differences in disc area (P < 0.001) and VCDR (P = 0.001) were seen when stratified by optic disc size. Paracentral VF loss was associated with significantly reduced rim areas (P = 0.005) and increased VCDR (P = 0.002). There were significantly greater superior VF defects compared to inferior VF defects (P < 0.001). Mean deviation on VF was -3.47 ± 1.51 dB for all selected optic discs.

Discussion
VCDR associated with threshold VF loss increases with disc size. Using computational archetype analysis to categorize VF loss patterns, data from a tertiary care glaucoma clinic can be used to identify optic disc and OCT structural features associated with early VF loss. As in retinopathy of prematurity and diabetic retinopathy, in which reference images are used to standardize definitions of referable disease, standard optic disc images identified using these methods may be helpful to predict VF loss in telemedicine settings or patients unable to reliably perform VFs.

Conclusion
Further refinement of such methods using additional datasets may be helpful in developing automated tools to distinguish glaucoma suspect and glaucomatous optic discs.
References


The Use of Health Information Technology by U.S. Patients with Glaucoma

BRIAN STAGG1, Rachel Hess, Kensaku Kawamoto, Paula Anne Newman-Casey, Joshua Ehrlich, Divakar Gupta
1 University of Utah Moran Eye Center

Purpose/Relevance
Patient-oriented health information technologies (e.g., scheduling appointments or filling prescriptions online) are an integral part of modern healthcare delivery. These technologies can improve patient access, understanding, and adherence and may be particularly helpful in a chronic disease like glaucoma.1-5 It is not known what proportion of U.S. patients with glaucoma use health information technologies.

Methods
The National Health Interview Study (NHIS) is a nationally representative annual study of U.S. individuals. Survey years 2016-2017 included questions about glaucoma and the use of five health information technologies (looking up health information online, filling prescriptions online, scheduling appointments online, communicating with health provider by email, and using online chat groups to learn about health topics) during the past 12 months. We calculated the proportion of individuals over the age of 18 who used health information technologies and used bivariable logistic regression accounting for complex survey design to determine if a diagnosis of glaucoma was associated with use of health information technologies. We repeated the logistic regression and adjusted for sociodemographics and whether or not the participant lived with a spouse/partner, worked for pay, or had another comorbid medical condition (self-reported hypertension, high cholesterol, heart disease, stroke, lung disease, cancer, or diabetes).

Results
Overall, 59,770 participants were included in the study, and 1,996 of these had glaucoma (weighted %: 2.6). The weighted proportion of participants with and without glaucoma who used each of the five health information technologies is listed in Table 1. Participants with glaucoma were less likely to look up health information online ($P < 0.001$) and schedule appointments online ($P < 0.001$). However, after adjusting for sociodemographics and the presence of another comorbid medical condition, patients with glaucoma were more likely to look up health information online ($P < 0.001$), communicate with a health provider by email ($P = 0.05$), and use online chat groups to learn about health topics ($P = 0.05$) compared to those without glaucoma.

Discussion
Fewer individuals with glaucoma use some health information technologies compared to those without glaucoma, though this relationship changes when adjusting for sociodemographics and the presence of another comorbid medical condition.

Conclusion
Individuals with glaucoma in the U.S. use some health information technologies at rates lower than the general population.

Table 1:
The unadjusted weighted proportion of participants with and without glaucoma who used each of the five health information technologies.

<table>
<thead>
<tr>
<th>Health Information Technology</th>
<th>Those with glaucoma (n= 1,996) % (95% CI)</th>
<th>Those without glaucoma (n= 57,687) % (95% CI)</th>
<th>$P$ Value$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Looked up health information online</td>
<td>44.9% (42.0-47.8)</td>
<td>53.5% (52.6-54.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Filled prescriptions online</td>
<td>10.7% (9.0-12.4)</td>
<td>10.0% (9.5-10.4)</td>
<td>0.38</td>
</tr>
<tr>
<td>Scheduled appointments online</td>
<td>9.5% (7.7-11.3)</td>
<td>13.2% (12.6-14.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Communicated with health provider by email</td>
<td>13.6% (11.1-16.0)</td>
<td>13.8% (13.1-14.6)</td>
<td>0.82</td>
</tr>
<tr>
<td>Used online chat groups to learn about health topics</td>
<td>4.1% (2.9-5.3)</td>
<td>4.1% (3.9-4.3)</td>
<td>0.91</td>
</tr>
</tbody>
</table>

$^1$ CI = confidence interval
$^2$ $P$ value calculated using bivariable logistic regression accounting for complex survey design.
References


**144 Pattern Electroretinogram as a Novel Biomarker of Retinal Ganglion Cell Function: Correlation to Foveal Avascular Zone in Preperimetric Glaucoma**

**ANDREW TIRSI**, Joby Tsai, Danielle Kacaj, Benny Wong, Lukas Schwartz, Victoria Rohring, Peter Derr, Alberto Garcia-Gonzalez, Sung Chul Park, Stephen Obstbaum, Celso Tello

**Purpose/Relevance**
To investigate whether the area of the foveal avascular zone (FAZ) as assessed by Optical Coherence Tomography Angiography (OCTA) were altered in Preperimetric glaucoma participants (PrG) and whether these abnormalities were associated with retinal ganglion cells (RGC) dysfunction, assessed by pattern electroretinogram (PERG)

**Methods**
OCTA and PERG were performed on 23 patients (36 eyes) with means age of 59.62± 14.05 years and 69.36 % females. Magnitude (Mag), MagnitudeD (MagD), MagD/Mag ratio and FAZ area were used in the partial correlation and regression analyses. A hierarchical multiple regression analyses was run to determine if the addition of FAZ measurements (2nd step) to glaucoma risk factors (GRF) (1st step) such as age, sex, intraocular pressure (IOP), central corneal thickness (CCT), spherical error (SE), and family history of glaucoma, improved the prediction of PERG parameters

**Results**
FAZ measurements were performed using ImageJ software. The intraclass correlation coefficient was 0.99 indicating a high degree of reliability between 2 raters. After controlling for known GRF, partial correlation analysis revealed significant negative correlations between PERG parameters (Mag and MagD) and FAZ (r > - 0.53, p < 0.013). In the prediction of Mag, after controlling for GRF (1st step), FAZ (2nd step) explained 23.1% of variance [F (1, 19) = 8.77, p=0.008, adjusted R²=0.315]. Similarly, in the prediction of MagD, after controlling for GRF (1st step), FAZ (2nd step) explained 21.7% of variance [F (1, 19) = 7.50, p=0.013, adjusted R²=0.248]. FAZ did not significantly contribute to the variance in MagD/Mag ratio. GRF entered in step 1 did not statistically predict variance in PERG parameters

**Discussion**
Recent studies have demonstrated the presence of RGC dysfunction in OHT and in early glaucoma, using PERG testing, but no studies had demonstrated the direct effects of IOP elevations or disruption of blood flow in the macula on the RGC function. We demonstrated that PrG patients present with RGC dysfunction detected by PERG and that vascular macular abnormalities could be the culprit contributing to the RGC dysfunction, beyond the RGC such as IOP

**Conclusion**
In this study, we report the significant association between RGC dysfunction and enlarged FAZ area, suggesting that early on, macular blood disruption had an additional and independent effect on RGC dysfunction, beyond the effects of RFG

**References**
Diagnostic Capability of PERG and Three Circumpapillary SD-OCT Diameter RNFL Thickness Scans in Pre-Perimetric Glaucoma

JOBY TSAI¹, Andrew Tirsi, Danielle Kacaj, Benny Wong, Lukas Schwartz, Victoria Rohring, Peter Derr, Alberto Garcia-Gonzalez, Sung Chul Park, Stephen Obstbaum, Celso Tello

¹ Zucker School of Medicine at Hofstra/Northwell

Purpose/Relevance
Recent studies have demonstrated that pattern electroretinogram (PERG) has the ability to detect early retinal ganglion cell (RGC) dysfunction years before glaucomatous structural changes are detected on OCT scans.¹ Today most OCT machines use 3.4mm circumpapillary scan diameters as the standard measurement for glaucoma diagnosis; however, few studies have assessed the diagnostic capability of different scan diameters.²⁻⁷ Here we compare the diagnostic capability of PERG and RNFLT measurements in three different circle diameters in pre-perimetric glaucoma (PrG) patients.

Methods
Forty-nine eyes (26 patients) were enrolled in the study at Manhattan Eye, Ear, and Throat Hospital (MEETH), and tested with Humphrey Visual Field Test (24-2), Diopsys NOVA PERG device, and Spectralis SD-OCT. 36 eyes were classified as normal controls and 13 as PrG. Correlation analysis was used among Magnitude (Mag), MagnitudeD (MagD), MagnitudeD/Magnitude Ratio (MagD/Mag Ratio) from the PERG tests and SD-OCT RNFLT in three concentric circle scans of 3.5, 4.1, and 4.7mm. The Area Under the Curve (AUC) was calculated to test the potential of each of the nine RNFLT sectors of each of the three circle diameter scans and each of the three PERG parameters to discriminate between normal and PrG eyes. A hierarchical linear stepwise regression was used to assess the contribution of MagD to the RNFL global thickness (gRNFLT) variance. Age, sex, intraocular pressure (IOP), central corneal thickness (CCT), and spherical error (SE) were entered in Step 1 and Mag D was entered in Step 2.

Results
T-Test analysis revealed significant differences between healthy controls and PrG in the following variables: age, sex, central corneal thickness (CCT), all PERG parameters, and gRNFLT in all three circle scan diameters. All PERG parameters were significantly correlated to all RNFLT sectors (r>0.291, p<0.041) except temporal and nasal sectors in all three circle scans. Spearman Rho was highest in the 3.5mm circle scan analysis and lowest in the 4.7mm circle scan. AUC analysis demonstrated that gRNFLT for 3.5mm circle diameter had the highest diagnostic capability (AUC=0.877), followed by gRNFLT for 4.1 mm (AUC=0.852), and then gRNFLT for 4.7 mm scan diameter (AUC=0.821). Among the PERG parameters, MagD showed the best diagnostic capability (AUC=0.81). The regression analysis revealed that MagD contributed 14.9%, 14.7%, and 10.4% to gRNFLT variance in 3.5, 4.1, and 4.7mm diameter scans respectively.

Discussion
gRNFLT 3.5mm, gRNFLT 4.1mm circle scan diameters, and MagD had the highest diagnostic capability to discriminate between normal controls and PrG patients. We concluded either circle diameters 3.5mm or 4.1mm thicknesses should be used with PERG measurements for early glaucoma detection.

Conclusion
Currently RNFLT measurements taken from OCT only have the capability of detecting structural changes in retinal thinning. By incorporating the use of PERG, which is able to detect functional changes years earlier before structural RNFLT changes, in conjunction with OCT, physicians will be better able to detect and treat glaucomatous changes earlier.

Figure 1
References


Glaucoma Caregivers

NITA TUNGA1, Ashika Angirekula, Roma Pradhan, Chuhan Wang, Pranati Ahuja, Ghadeer Homimat, Matthew Petroll, Karanjit Kooner

1 University of Texas Southwestern Medical School

Purpose/Relevance
Glaucoma is a progressive disease that may cause varying degrees of visual disability in patients. However, there is scant information on the burden placed on friends and family who help patients with their eye care. The purpose of this study was to evaluate the relationship between glaucoma severity and dependency on others for glaucoma care.

Methods
In this IRB-approved prospective study, consecutive patients diagnosed with primary open angle glaucoma (POAG), ocular hypertension (OHT), and those with no glaucoma were interviewed regarding those involved in their eye care. Data collected included gender, race, age, intraocular pressure (IOP), vision, central corneal thickness (CCT), stage of glaucoma damage, number of meds, hypertension (HTN), diabetes (DM), family history of glaucoma, and caregivers’ gender and relation to the patient. Patients who had intraocular or other surgeries in the past 3 months were excluded. Fisher’s exact test, regression analyses, and one-way ANOVA tests were used for statistical analyses.

Results
Demographics of the 110 patients are included in Table 1. 12 non-glaucoma patients were included in Group A, while Group B had 98 patients with glaucoma. Dependency on others increased in Group B versus Group A (52% vs. 17%, P = 0.03), with severity of glaucoma (P = 0.048), DM (P = 0.02), worsening vision (P < 0.01), and increasing glaucoma meds (P = 0.01). In Group B, Asians were the most dependent on others (80%), while in Group A, Blacks were the most dependent on others (33%, Table 2). More men were dependent than women in each severity level, except severe glaucoma (Table 3).

Discussion
Four parameters were responsible for increasing patient dependency on others: severity, number of glaucoma meds, DM, and vision. As patients’ disease or vision worsens, it is harder for them to perform activities of daily living, potentially explaining the correlation with increased dependency on others. Interestingly, DM as a comorbidity seemed to increase a patient’s dependency, possibly because of its multisystem involvement. Gender, race, age, HTN, CCT, and IOP were not found to be significant.

Conclusion
This study concludes that patients’ glaucoma severity, diabetes status, poor vision, and increasing glaucoma medication load determine the likelihood of caregiver assistance.
Table 1. Patient Demographics.

<table>
<thead>
<tr>
<th>Variables (n, %)</th>
<th>Group A N=12</th>
<th>Group B N=98</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (female)</td>
<td>9 (75)</td>
<td>12 (35)</td>
</tr>
<tr>
<td>Age</td>
<td>70 ± 6.67</td>
<td>70 ± 8.62</td>
</tr>
<tr>
<td>Asian</td>
<td>2 (16.6)</td>
<td>2 (5.9)</td>
</tr>
<tr>
<td>Black</td>
<td>3 (25.0)</td>
<td>25 (73.5)</td>
</tr>
<tr>
<td>White</td>
<td>5 (41.6)</td>
<td>5 (14.7)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>2 (16.6)</td>
<td>2 (5.9)</td>
</tr>
<tr>
<td>HTN</td>
<td>8 (66.6)</td>
<td>21 (61.8)</td>
</tr>
<tr>
<td>DM</td>
<td>2 (16.6)</td>
<td>12 (35.3)</td>
</tr>
<tr>
<td>Number of glaucoma meds</td>
<td>1.08</td>
<td>3.97</td>
</tr>
<tr>
<td>Number of systemic meds</td>
<td>12.17</td>
<td>11.79</td>
</tr>
<tr>
<td>Family history</td>
<td>0 (0)</td>
<td>22 (64.7)</td>
</tr>
<tr>
<td>CCT</td>
<td>532.88</td>
<td>534.19</td>
</tr>
<tr>
<td>Vision (LogMAR)</td>
<td>0.067</td>
<td>0.168</td>
</tr>
<tr>
<td>IOP</td>
<td>13.54</td>
<td>15.31</td>
</tr>
<tr>
<td>Pts requiring caregivers (dependency)</td>
<td>2 (16.6)</td>
<td>22 (64.7)</td>
</tr>
</tbody>
</table>

Table 2. Dependency Based on Race.

<table>
<thead>
<tr>
<th>Variables (n, %)</th>
<th>Control</th>
<th>OHT</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asians</td>
<td>0 (0)</td>
<td>2 (100)</td>
<td>3 (100)</td>
<td>2 (100)</td>
<td>1 (50)</td>
<td>0.56</td>
</tr>
<tr>
<td>Blacks</td>
<td>1 (33)</td>
<td>2 (25)</td>
<td>5 (62.5)</td>
<td>5 (55.5)</td>
<td>15 (60)</td>
<td>0.12</td>
</tr>
<tr>
<td>Whites</td>
<td>1 (20)</td>
<td>5 (62.5)</td>
<td>1 (16.7)</td>
<td>4 (40)</td>
<td>3 (60)</td>
<td>0.48</td>
</tr>
<tr>
<td>Hispanics</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1 (33.3)</td>
<td>2 (100)</td>
<td>0.07</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Dependency Based on Gender.

<table>
<thead>
<tr>
<th>Variables (n, %)</th>
<th>Control</th>
<th>OHT</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>1 (11.1)</td>
<td>6 (46.2)</td>
<td>6 (37.5)</td>
<td>3 (33.3)</td>
<td>9 (75)</td>
<td>0.12</td>
</tr>
<tr>
<td>Men</td>
<td>1 (33.3)</td>
<td>3 (50)</td>
<td>3 (60)</td>
<td>11 (73.3)</td>
<td>10 (45.5)</td>
<td>0.39</td>
</tr>
</tbody>
</table>

References

Acknowledgements: Supported in part by an unrestricted grant from the Research to Prevent Blindness, New York, NY; Visual Sciences Core Grant EY020799 and the University of Texas Southwestern Medical Student Research Program, Dallas, TX.
Comparison of Optical Coherence Tomography Parameters at the Optic Disc and Macula Between Eyes with Acute Primary Angle Closure and Their Fellow Eyes

RUTHRA UMAPATHI1, Monisha Nongpiur, Chang Liu, David Friedman, Aung Tin
1 University of Southern California

Purpose/Relevance
To compare the optical coherence tomography (OCT) parameters between affected and fellow eyes in subjects with acute primary angle closure (APAC).

Methods
We evaluated 31 subjects with unilateral APAC and no evidence of PACG in affected or fellow eye. The optic nerve head and macular were imaged with OCT (Cirrus HD OCT, Carl Zeiss Meditec, Inc). The parameters measured are peripapillary retinal nerve fiber layer (RNFL) thickness, macular RNFL thickness, retinal inner limiting membrane-retinal pigment epithelium (ILM-RPE) thickness, and ganglion cell complex (GCC) thickness. The comparison of OCT parameters between affected and fellow eyes was performed using a linear mixed model adjusted for duration after APAC attack.

Results
30 subjects (23 females, 76.7%) of mean age 64.2±7.7 years were analyzed after excluding one subject with poor quality images. There were no significant differences in vertical cup-to-disc ratio (0.49±0.02 vs 0.47±0.02, p=0.16) and visual field mean deviation (-3.47±0.93dB vs -2.18±0.42dB, p=0.16) between affected and fellow eyes. Affected eyes had significantly thinner average, superior, and inferior peripapillary RNFL thickness (p<0.001 for all). At the macular, there was a significant reduction in the minimum and inferior temporal RNFL thickness (p=0.02 & p=0.03) and outer inferior ILM-RPE thickness (p=0.008) of affected eyes as compared to fellow eyes. No differences were noted in the GCC. In a sub-analysis comparing only APAC eyes with pink disc (N=22) to their fellow eyes, similar results were obtained with significant differences noted in the average (p=0.002), superior (p<0.001), and inferior (p=0.002) peripapillary RNFL thicknesses, and the ILM-RPE thickness at the outer inferior macular region (P=0.003).

Discussion
A previous study using OCT shows a reduction in the peripapillary and outer macular RNFL thickness in APAC eyes compared with controls, along with a reduction in visual field1. Our findings suggest that APAC results in significant thinning at the peripapillary and macular RNFL as well as the ILM-RPE layer even in the absence of disc pallor or visual field defect.

Conclusion
Further research should assess the damage to the peripapillary and macular RNFL and ILM-RPE layer as a result of an APAC attack even in the absence of disc pallor or visual field defect.

References
Patient Interest and Willingness to Pay for Teleophthalmology Remote Consultations

MICHAEL WAISBOURD1, Adam Kurnick, Yehuda Mivasair, Eric Shiu, Eldar Rosenfeld, Rony Rachmiel, Shimon Kurtz
1 Tel Aviv Medical Center

Purpose/Relevance
The benefits of telemedicine include improved access to care, patient monitoring, efficiency, resource savings, and follow-up.1-3 This study aimed to assess level of patient interest and willingness to pay for teleophthalmology.

Methods
Patients attending the Ophthalmology Clinic at Tel-Aviv Medical Center were surveyed to assess their interest in receiving remote consultations (teleophthalmology). Comparisons between those interested in teleophthalmology to those not interested were conducted. Logistic regression was used to identify the effect of price on interest in teleophthalmology.

Results
Of 215 enrolled patients, two thirds (66.5%) were interested in teleophthalmology consultations instead of in-person clinic visits. Patients interested in using telemedicine were significantly younger than uninterested patients, with a mean ± SD age of 48.8 ± 22.7 years vs. 62.4 ± 18.3 years, respectively (P < 0.05). Gender, country of origin, educational level, and burden on an accompanying individual were not significantly associated with interest in telemedicine. Of those interested, 42.3% reported that they had to miss work to attend an in-person clinic visit, whereas 26.4% of those not interested would miss work (P < 0.05).

Discussion
Most patients were interested in using teleophthalmology services instead of attending clinic visits, especially if they were younger and their visits were associated with loss of work. Other associated factors included familiarity with electronics, video conferencing, and internet use. The vast majority of interested patients also expressed willingness to pay for such services.

Conclusion
Most patients showed interest in teleophthalmology and many were willing to pay for remote consultations. Targeting factors related to interest in telemedicine may increase patient use of teleophthalmology and enhance communication. Remote consultations could potentially improve access to eye care and increase patient satisfaction.

References
I49 Improving Compliance and Physician-Patient Dialogue in Glaucoma

CHUHAN WANG¹, Ashika Angirekula, Roma Pradhan, Nita Tunga, Pranati Ahuja, Matthew Petroll, Ghadeer Al-Humimat, Karanjit Kooner
¹ UT Southwestern

Purpose/Relevance
Research suggests forgetfulness and poor glaucoma knowledge to be top obstacles to medication compliance. However, discrepancies in fears/concerns regarding glaucoma between patients and physicians, and the relationship of these fears/concerns with obstacles to compliance remain unknown. The purpose of this study was (a) to increase patient compliance through enhancing their knowledge of glaucoma care and (b) advocating better patient-physician communication by determining gaps in fears/concerns of glaucoma.

Methods
In this IRB-approved prospective study, 100 consecutive eligible glaucoma patients were interviewed about glaucoma knowledge, medication usage, and fears/concerns. They were counseled and given handouts regarding glaucoma education, management, and medications. Follow-up interviews were conducted after 3 weeks. 16 glaucoma specialists were also surveyed regarding their awareness of patients’ glaucoma knowledge, compliance, and fears. McNemar’s chi-square test and Fisher’s exact test were used for statistical analysis.

Results
68 out of 100 patients were reached via the post-survey. Among these patients, our intervention increased number of patients with glaucoma knowledge from 41 to 49 (41% to 72%, \( P < 0.05 \)) (Figure 1A) and the number of compliant patients from 50 to 63 (74% to 93%, \( P < 0.05 \)) (Figure 1B). The main survey response differences between patients and physicians were (Figure 1C): (1) becoming blind: 48% to 81% (\( P < 0.05 \)), (2) becoming dependent on others: 22% to 6.3% (\( P > 0.05 \)), (3) cost of medication: 16% to 31% (\( P > 0.05 \)), (4) unable to use medications by themselves: 7% to 25% (\( P < 0.05 \)), (5) not understanding physicians’ instructions: 2% to 13% (\( P > 0.05 \)), (6) not being able to work: 5% to 6% (\( P > 0.05 \)), and (7) denying all glaucoma related fears: 41% to 0% (\( P < 0.05 \)).

Discussion
Our intervention significantly improved glaucoma compliance and knowledge in the patients. Moreover, our surveys revealed three significant differences in fears/concerns between patients and physicians: (1) becoming blind, (2) unable to use medications by themselves, and (3) denying all glaucoma-related fears. Physicians may enhance compliance by working to improve on these areas of weakness.

Conclusion
Our study supports the idea that enhancing patients’ knowledge of glaucoma and providing glaucoma resources can improve compliance. In addition, physicians should regularly emphasize that glaucoma is a blinding disease requiring lifelong treatment and also increase patients’ chances of becoming dependent on others.
**Reference**


---

**Figure 1**

### 1A. Glaucoma Knowledge (n=68): McNemar Chi Sq (Two-Tailed)

<table>
<thead>
<tr>
<th>Pretest</th>
<th>Understand</th>
<th>Not Understand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand</td>
<td>39</td>
<td>2</td>
</tr>
<tr>
<td>Not Understand</td>
<td>10</td>
<td>17</td>
</tr>
</tbody>
</table>

*p value* 0.043 Significant Yes

### 1B. Medication Compliance (n=68): McNemar Chi Sq (Two-Tailed)

<table>
<thead>
<tr>
<th>Pretest</th>
<th>Compliant</th>
<th>Non-Compliant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliant</td>
<td>49</td>
<td>1</td>
</tr>
<tr>
<td>Non-Compliant</td>
<td>14</td>
<td>4</td>
</tr>
</tbody>
</table>

*p value* 0.002 Significant Yes

### 1C. Fears and Concerns in Glaucoma between Patients and Physicians: Fisher’s Exact Test (Two-Tailed)

<table>
<thead>
<tr>
<th></th>
<th>Unable to Use Medication by Themselves</th>
<th>Unable to work</th>
<th>Becoming Blind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Medication</td>
<td><em>p = 0.16</em></td>
<td><em>p = 0.045</em></td>
<td></td>
</tr>
<tr>
<td>Not Understanding instructions</td>
<td><em>p = 0.091</em></td>
<td><em>p = 1</em></td>
<td></td>
</tr>
<tr>
<td>Being Dependent on Others</td>
<td><em>p = 0.19</em></td>
<td></td>
<td><em>p = 0.016</em></td>
</tr>
<tr>
<td>Denying All Glaucoma Related Fears</td>
<td><em>p = 0.0006</em></td>
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</tr>
</tbody>
</table>
Clinical Validation of a Deep Learning Classifier for Detecting Gonioscopic Angle Closure on Anterior Segment OCT Images

BENJAMIN XU1, Michael Chiang, Justin Dredge, Anmol Pardeshi, Abe Song, Rohit Varma
1 University of Southern California

Purpose/Relevance
Gonioscopy, the clinical standard for detecting angle closure, is subjective and dependent on examiner expertise. We previously developed a deep convolutional neural network (CNN) classifier using population-based epidemiologic data that analyzes anterior segment OCT (AS-OCT) images to detect gonioscopic angle closure.1 In this study, we investigate its performance and generalizability in a tertiary-care glaucoma clinic.

Methods
Consecutive new glaucoma patients presenting to the University of Southern California (USC) Roski Eye Institute for routine glaucoma evaluations were recruited. Each subject received gonioscopy followed by AS-OCT under standardized dark ambient lighting. Gonioscopy was performed independently by a glaucoma specialist (BYX) and general ophthalmologist (JD) masked to the subject's clinical status. Tilting of the lens during gonioscopy was permitted, but indentation was not. Angle closure was defined as inability to visualize the pigmented trabecular meshwork. AS-OCT imaging was performed using a Tomey CASIA SS-1000. The CNN model was used to predict angle status (open or closed) using one AS-OCT image per quadrant located at 0, 90, 180, or 270 degrees. Mean area under the receiver operator curve (AUC) metrics were calculated to assess classifier performance using the glaucoma specialist’s gonioscopy as ground truth. Agreement between the CNN and each examiner as well as inter-examiner agreement were calculated using kappa statistics.

Results
104 images from 28 eyes of 20 subjects (mean age 62.5 years, range 42 to 87) were analyzed. 22 images (21.1%) corresponded to quadrants with angle closure on gonioscopy. The AUC of the CNN model for making the classification of open or closed angle was 0.861. There was excellent agreement between the glaucoma specialist and CNN model (k = 0.798). The CNN model had high sensitivity (100.0%) and fair specificity (74.4%) for detecting gonioscopic angle closure. The majority of false positives (90.5%) had angle narrowing (modified Shaffer grade of 2) on gonioscopy by the glaucoma specialist. The general ophthalmologist demonstrated excellent agreement with the glaucoma specialist (k = 0.827) and good agreement with the CNN model (k = 0.664).

Discussion
Our CNN model approximates inter-opthalmologist agreement in detecting gonioscopic angle closure. The model is highly sensitive, which is ideal for a screening method. Its lower specificity could be related to dynamic aspects of gonioscopy (tilting and indentation) that are difficult to model with static images.

Conclusion
A deep learning algorithm for automated analysis of AS-OCT images is highly effective at detecting gonioscopic angle closure in a real-world clinical setting. This method could be used to screen for patients who would benefit from gonioscopy by a glaucoma specialist.

Reference
Predicting Risk of Rapid Visual Field Progression Based on the Initial Visual Field Test Using Machine Learning

JITHIN YOHANNAN¹, Scott Shuldiner, Pradeep Ramulu, C. Gustavo De Moraes, Tobias Elze, Louis Pasquale, Jonathan Meyers, Sarah Wellik, Michael Boland

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Purpose/Relevance

Machine learning algorithms (MLA) trained on visual fields (VF) can diagnose glaucoma¹ or detect progression². Additionally, recent work has shown that an initial VF can be used to predict a patient's performance on subsequent VFs³. However, it is unknown if we can predict the rate of glaucoma progression based on an initial test in order to identify patients at highest risk of glaucoma worsening. Therefore, in this study we assess whether MLA can accurately predict eyes that will undergo rapid visual field progression (RVFP) based on an initial VF test.

Methods

211,465 VFs (30,831 initial VFs) from 14,217 patients who completed ≥5 reliable VFs at academic glaucoma centers were included. RVFP was defined as eyes with MD slope < -1 dB/year. 80% of data was used for a training and validation set and 20% was used as a test set. Global indices from the initial VF and age were used to train MLA designed to predict the likelihood of RVFP. Additionally, the neural network model was trained with point-wise threshold data in addition to global indices and age. MLA test set performance was assessed using the area under the receiver operating curve (AUROC). Performance of models trained on initial VF data alone was compared to performance of models trained on data from the first two VFs.

Results

1968 eyes (8%) underwent RVFP. The support vector machine model (AUROC 0.72 [95% CI 0.70-0.75], optimal specificity/sensitivity: 0.70/0.57) most accurately predicted RVFP when trained on initial visual field data followed by artificial neural network, random forest, logistic regression and naïve Bayes, AUROC (0.72, 0.70, 0.69, 0.68 respectively). Models trained on data from the first two VFs performed no better than models performed on the initial VF alone (all 95% CIs of AUROC curves overlapped). Based on the odds ratio from logistic regression and variable importance plots from the random forest model, older age (OR: 1.03, p<0.01), lower mean deviation (MD) (OR 1.02, p=0.02) and higher pattern standard deviation (PSD) (OR: 1.06, p<0.01) were the variables in the initial VF most strongly associated with RVFP.

Discussion

MLA can be used to predict eyes at risk for RVFP based on an initial VF test. Adding data from a second VF does not improve MLA performance. Older age, lower MD and higher PSD are associated with a higher risk of RVFP.

Conclusion

Initial VF data can be used to predict risk of RVFP with fair accuracy. Further work will incorporate baseline clinical and OCT data to improve model performance.
Receiver operating curves that demonstrate the ability of various machine learning models to classify rapid and non-rapid progressors based on the results of the first or first two visual field. The colors represent the following machine learning methods; Green- support vector machine; Blue- artificial neural network; Purple- random forest; Orange - logistic regression; Red - naive Bayes. The solid lines represent models trained on data from the first VF alone and the dashed line represents models trained on data from the first and second VF. The area under the curve and 95% CI are shown on the bottom right (the top number of each color is a model trained on first VF data alone while the bottom number is a model trained on data from the first two VFs).

Figure 1

References