AGS 2017 Poster Schedule

THURSDAY, MARCH 2
7:00 AM – 8:00 AM Moderated Poster Session (1-50)
7:00 AM – 5:00 PM Poster viewing (1-50)

FRIDAY, MARCH 3
7:00 AM – 8:00 AM Moderated Poster Session (51-101)
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SATURDAY, MARCH 4
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7:00 AM – 3:30 PM Poster viewing (102-142)

THURSDAY, MARCH 2

Surgery

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### FRIDAY, MARCH 3

#### Structural and Functional Assessment/Epidemiology/Pharmacology

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**SATURDAY, MARCH 4**

**Surgery/Lasers/Tonometry**

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**Poster Abstracts**  
Thursday, March 2 / Posters 1-50  

**Surgery**

I. Clinical Result of Trabeculectomy and Ologen Implant as Compared with CO2 Laser Assisted Sclerectomy (Class) and Ologen Implant in Patients with Open-Angle Glaucoma

JUAN CARLOS IZQUIERDO VILLAVICENCIO1, Maria Corina Ponte-Davila, Fabiola Patricia Quezada, Ana Luisa Gonzalez Mendez, Barbara Rubio Lastra

1 Oftalmo salud

**Purpose/Relevance**
Comparative outcome postoperative on Patient with Refractory Glaucoma submitted to Trabeculectomy Surgery+Ologen and Patients CO2 Laser Assisted Sclerectomy (Class)+Ologen.

**Methods**
This is an Analytic, Retrospective and Cross-sectional study on a case of series of 88 eyes. We compare the results of two surgical techniques, the Phacoemulsification+Trabeculectomy Surgery+Ologen was done in 2013-2014 and Phacoemulsification+ CO2 Laser Assisted Sclerectomy (Class)+Ologen were done in 2015-2016. We included in the study all patients diagnosed with Refractory Open Angle Glaucoma. We measured intraocular Pressure (IOP) at 1 month, 3 months, 6 months and 9 months. We also evaluated best corrected Visual Acuity (BCVA) and decrease of antiglaucoma medication at 1 month and 9 months. We described the postoperative complication during the 9 months. Success rate was defined as the decrease in IOP less than 18 mm Hg without medication at 9 months of surgery.

**Results**
A total of 88 eyes, 49 eyes were included in the trabeculectomy group and 39 eyes in the Class group. Both groups were followed for 9 months. In the trabeculectomy group mean ± SD preoperative IOP was 19.22 ± 9.20 with a decrease to 9 months 13.31 ± 3.48. The mean ± SD preoperative BCVA was 0.26 ± 0.43, the mean ± SD at 9 months was 0.40 ± 0.64. The antiglaucomatous preoperative drug was 2.81 ± 1.20, at 9 months the mean ± SD was 1.47 ± 1.50. The postoperative complications were athalamia 4%, Hemorrhagic Detachment 2%, Choroid Detachment 2% and need another surgery to reduce intraocular pressure (endocyclophotocoagulation or Baerveldt Valvular implant ) was 5% of the 49 eyes. The success rate of this technique was 64.4%. On the other hand, the Class group preoperative IOP mean ± SD was 22.87 ± 9.17, at 9 month was 12.97 ± 2.42. The mean ± SD preoperative BCVA was 0.27 ± 0.32, at 9 month was 0.11 ± 0.17. The mean ± SD preoperative antiglaucomatous drug was 3.51 ± 0.75 and at 9 month reduced to 2.08 ± 0.95. The main early postoperative complication was transient ocular hypertension in 4% of patients; it was treated with acetazolamide orally and was resolved in all cases at 1 postoperative month. During the 9 month postoperative we had to make goniopunture on 18% (7 eyes), needeling on 12% (5 eyes) and iridectomy on 5% (2 eyes). The success rate for the Class group was 94.9%.

**Discussion**
The trabeculectomy is a procedure that over the years demonstrated control of intraocular pressures; however, it is a surgery that presents high complications postoperatively that compromise visual acuity of patients, with a success rate that it has proven to be less time, that techniques most modern, as the CO2 Laser Assisted Sclerectomy (Class), which also allows proper control intraocular pressure, evidenced minor complications postoperative which preserves the visual acuity of patients, having excellent success rates that should be studied over time to see if they are kept.

**Conclusion**
Our study showed that CO2 Laser Assisted Sclerectomy (Class) is a safe technique that allows greater reduction of intraocular IOP, maintains better visual acuity, has lower rates of postoperative complications and higher success rates than conventional trabeculectomy.
References


2 Patch Grafts in Fenestrated Glaucoma Drainage Implant Coverage and Postoperative Intraocular Pressure

HELEN JIANG¹, Tak Yee Tania Tai, Reena Garg, Daniel Elefant
¹ New York Eye and Ear Infirmary

Purpose/Relevance
Various graft materials are used for glaucoma drainage implant (GDI) tube coverage, but data is lacking on the potential contribution of different graft materials toward lowering of intraocular pressure (IOP) post-operatively when used in coverage of non-valved fenestrated tubes.

Methods
A retrospective chart review of GDI surgeries performed at one institution between 2012 and 2015 was conducted. Change in IOP at post-operative day 1 (POD1), post-operative week 1 (POW1), and post-operative month 1 (POM1) from pre-operative IOP were compared between scleral, corneal, and pericardial patch graft groups. Absolute change in IOP at POD1, POW1, and POM1 were also compared.

Results
Seventy-six eyes were identified with placement of a non-valved GDI with tube fenestration and coverage by pericardial patch graft (n=14), scleral patch graft (n=20), or corneal patch graft (n=42). Mean IOP change at POD1 was 12.50 (SD 15.52) in the pericardial group, 6.26 (SD 15.52) in the scleral group, and 7.12 (SD 15.36) in the corneal group (p =0.46). Mean IOP change at POW1 was 14.92 (SD 14.22) in the pericardial group, 11.94 (SD 17.21) in the scleral group, and 10.03 (SD 14.15) in the corneal group (p =0.59). Mean IOP change at POM1 was 12.00 (SD 12.38) in the pericardial group, 14.00 (SD 14.40) in the scleral group, and 11.23 (SD 14.89) in the corneal group (p=0.79). Absolute IOP did not differ significantly between different graft types at POD1, POW1, or POM1.

Discussion
The effect of different patch graft materials on early post-operative IOP has not previously been studied. It is possible different materials may allow for different rates of filtration from non-valved, fenestrated tubes. In this study, no significant difference was noted in mean IOP change at POD1, POW1, or POM1 from pre-op IOP among the different patch graft groups. These findings suggest that the selection of different graft materials in fenestrated tube coverage does not have an impact on early post-operative intraocular pressure.

Conclusion
No significant difference was noted in IOP change at POD1, POW1, or POM1 among different patch graft groups, which may suggest there is no early IOP difference in the selection of different graft materials, though further studies need to be undertaken.
### Reference

3 Efficacy and Safety of Stand-alone Ab Interno Gelatin Microstent Implantation with MMC Versus Stand-alone Trabeculectomy with MMC: Multicenter Retrospective Cohort Design

MATT SCHLENKER1, Husayn Gulamhusein, Alix Somers, Ingeborg Stalmans, Fritz Hengerer, Iqbal Ike Ahmed

1 University of Toronto

Purpose/Relevance
To compare retrospectively the efficacy and safety of standalone ab interno gelatin microstent implantation with MMC versus standalone trabeculectomy with MMC in consecutive eyes from Jan 2011 to July 2015 at 3 centers: Mississauga, Canada, Frankfurt, Germany, and Leuven, Belgium.

Methods
Multi-center interventional cohort study. 373 eyes in 311 patients were identified, 80 eyes excluded due to previous incisional surgery, atypical forms of glaucoma, age extremes, or follow-up less than 1 mo. Primary outcome was time to failure (IOP outside of 6-17 on no medications) on 2 consecutive visits despite in-clinic maneuvers (including needling). Secondary outcomes included upper limit IOP cutoffs of 14 and 21 (with and without medications), complications, and reoperations. Risk factors for failure / possible confounders included age, ethnicity, gender, preoperative visual acuity, glaucoma type, mean deviation, previous glaucoma laser, and diabetes status. Baseline characteristics were compared using Fisher Exact tests and Wilcoxon rank sum tests. A Cox proportional hazards model accounting for correlation between eyes stratified by site and adjusted for baseline characteristics was used to compare the hazard rate of the two interventions.

Results
Baseline characteristics were similar, except fewer females (41% vs. 55%), eyes >0.4logMAR vision (19% vs. 35%), and eyes without prior trabeculoplasty (50% vs. 70%) in the microstent group. Median follow-up/survival was 20.2 mo (IQR 16.5-28.6) for microstent eyes and 23.6 mo (IQR 16.2, 33.2) for trabeculectomy eyes. The crude 12 mo survival was 72.1% and 70.3% for IOP of 6-17 on no medications. The crude hazard rate (HR) for the microstent relative to trabeculectomy was 0.82 (95% CI 0.52-1.30), 0.83 (95% CI 0.49-1.41) adjusted for baseline characteristics, and 0.77 (95% CI 0.56-1.19) using an adjusted parametric model fit to a Weibull distribution. The adjusted HR for IOP of >14 was 0.90 (95% CI 0.55-1.46) and >21 was 0.79 (95% CI 0.47-1.31). The adjusted HR for failure despite medications was 1.00 (95% CI 0.48-2.11), 1.52 (95% CI 0.79-2.90), and 0.82 (95% CI 0.35-1.95) for ≤17, ≤14, and ≤21 upper IOP cutoffs. On a univariate basis covariates associated with increased risk of failure were diabetes (HR 4.8 [2.6-8.8]) and non-Caucasian ethnicity (HR 2.4 [95% CI 1.5-3.9]), and on multivariate diabetes (HR 3.7 [1.9-7.3]). 17% and 10% had complications (p=0.1), though most were transient. 9% and 7% received reoperation (p=0.7).

Discussion
In a large multi-center cohort we were unable to detect a difference in the risk of failure or safety profile between standalone ab interno gelatin microstent implantation with MMC and standalone trabeculectomy with MMC. The most important risk factor for failure was history of diabetes.

Conclusion
A standalone ab interno microstent with MMC and a trabeculectomy with MMC appear to be comparable alternatives for uncontrolled glaucoma in eyes with no prior incisional surgery.
Proportion of Eyes with IOP of 6-17 on No Medications

Reference
4 Outcomes of Resident Versus Attending Performed Glaucoma Tube Surgery in a United States Residency Program

KUNJAL MODI1, Elliot Crane, Loka Thangamathesvara, Albert Khouri
1 Rutgers New Jersey Medical School

Purpose/Relevance

Literature exists analyzing resident-performed trabeculectomy, however data is scarce on resident-performed tube surgery. Our aim was to assess resident performance with tube shunt surgery, compared to faculty performance. The secondary aim was to compare early vs. experienced resident performance.

Methods

Medical records were reviewed for glaucoma tube surgeries at Rutgers University, between 2008-2015. Inclusion criteria were resident as primary surgeon and 1-year post-operative follow up. Data collected included demographic information, vision, IOP, medications, intraoperative time, complications.

“Early” senior (PGY4) resident surgeries (from July-Dec) were compared to “experienced” senior residents surgeries (from Jan-June). Resident cases were compared with case-matched attending surgery (match criteria: glaucoma subtype, tube type, age ±15 years).

Primary outcomes measure was the rate of treatment success, defined as IOP >6 and <21 throughout 1-year follow up. Treatment failure was considered IOP ≥21 or IOP <6 on two consecutive visits, loss of light perception, or need for further glaucoma incisional surgery.

Results

Of 181 total tube cases, 41 resident cases met inclusion; 28 eyes (68.3%) met treatment success, and 13 eyes (31.7%) failed. IOP and medication burden was significantly reduced throughout 1-year follow up.

The attending operative time was less than residents (p<0.01). Success rates for residents and attendings were 76.7% and 90.0% respectively (Table 2, p=0.01). There was no significant difference in IOP or medication burden at any time point up through the 1-year follow up period.

Both early and experienced residents achieved a significant reduction in intraocular pressure throughout follow up (table 1); experienced residents achieved a higher success rate.

Discussion

The resident surgery cohort yielded a tube surgery success rate comparable to national averages. Intraoperative complications were rare and postoperative complications were few, and mostly self-limited.

The early and experienced residents both achieved significant reductions in IOP and medication burden from baseline. The case matched resident cases had similar success rates to attending cases.

Conclusion

This analysis shows residents achieved a high success rate in tube surgery, with comparable IOP measurements throughout follow-up compared to attendings. Tube surgeries did not have different postoperative IOP or medication burden by early or late senior residents nor when compared to attendings.

References

### Table 1: Comparison of early (July-December) and experienced (January-June) residents performing tube surgery

<table>
<thead>
<tr>
<th></th>
<th>Early Residents (July-Dec)</th>
<th>Experienced Residents (Jan-June)</th>
<th>( p ) value</th>
</tr>
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<tbody>
<tr>
<td><strong>Number (n)</strong></td>
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<tr>
<td><strong>Glaucosa subtype:</strong></td>
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<tr>
<td>Uveitic Glaucoma</td>
<td>7 (41.2%)</td>
<td>8 (33.3%)</td>
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</tr>
<tr>
<td>POAG</td>
<td>4 (23.5%)</td>
<td>10 (41.7%)</td>
<td></td>
</tr>
<tr>
<td>CACG</td>
<td>0 (0%)</td>
<td>5 (20.8%)</td>
<td></td>
</tr>
<tr>
<td>Neovascular glaucoma</td>
<td>3 (17.6%)</td>
<td>1 (4.2%)</td>
<td></td>
</tr>
<tr>
<td>Traumatic glaucoma</td>
<td>2 (11.8%)</td>
<td>0 (0%)</td>
<td></td>
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<tr>
<td>Steroid-induced</td>
<td>1 (5.9%)</td>
<td>0 (0%)</td>
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<tr>
<td><strong>Number with previous glaucoma surgery</strong></td>
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<td>7</td>
<td>0.03</td>
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<tr>
<td><strong>LogMAR VA</strong></td>
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<td>1.18</td>
<td>0.03</td>
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<tr>
<td><strong>Pre-operative IOP (mm Hg)</strong></td>
<td>29.91</td>
<td>31.31</td>
<td>0.57</td>
</tr>
<tr>
<td><strong>Pre-operative # drops</strong></td>
<td>4.18</td>
<td>3.33</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Operative time (min)</strong></td>
<td>55.8</td>
<td>60.6</td>
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<td><strong>Intraoperative complications</strong></td>
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<td>1 (4.2%)</td>
<td>0.22</td>
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<tr>
<td><strong>Intraop intravitreal Lucentis</strong></td>
<td>1</td>
<td>1</td>
<td>0.03</td>
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<td><strong>Treatment success:</strong></td>
<td>9 (52.9%)</td>
<td>19 (79.2%)</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Treatment failures:</strong></td>
<td>8 (47.1%)</td>
<td>5 (20.8%)</td>
<td>0.03</td>
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<tr>
<td><strong>Reasons for failures:</strong></td>
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<td></td>
<td>0.93</td>
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<tr>
<td>Hypertony (IOP&gt;21)</td>
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<td>2</td>
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<td>Loss of light perception</td>
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<tr>
<td>Need for add'l surgery</td>
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<td></td>
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<td><strong>Post-operative complications:</strong></td>
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<td>9/21 (42.9%)</td>
<td>[( \chi^2 ) analysis]</td>
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<td>Infection</td>
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<td><strong>Post-operative IOP:</strong></td>
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<td>6 month</td>
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<td>1.02</td>
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<td>1 year</td>
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<td>Resident performed tube surgeries (30)</td>
<td>Attending performed tube surgeries (30)</td>
<td>p-value</td>
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<td><strong>Mean age</strong></td>
<td>55.9 years</td>
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<td><strong>Pre-operative visual acuity:</strong></td>
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<td>LogMAR</td>
<td>$0.91 \pm 0.68$</td>
<td>$0.68 \pm 0.61$</td>
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<td>Snellen equivalent</td>
<td>20/162</td>
<td>20/96</td>
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<td><strong>Pre-operative IOP control:</strong></td>
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<td>Intraocular pressure (mm Hg)</td>
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<td>28.75 $\pm$ 10.03</td>
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<td>Uveitic Glaucoma</td>
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<td>12 (40.0%)</td>
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<td>POAG</td>
<td>13 (43.3%)</td>
<td>13 (43.3%)</td>
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</tr>
<tr>
<td>CAGG</td>
<td>4 (13.3%)</td>
<td>4 (13.3%)</td>
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<tr>
<td>Traumatic glaucoma</td>
<td>1 (3.3%)</td>
<td>1 (3.3%)</td>
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</tr>
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<td>6 (20.0%)</td>
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<td><strong>Pre-operative cup/disc ratio</strong></td>
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<td><strong>Previous glaucoma laser:</strong></td>
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<tr>
<td>Laser trabecuoplasty</td>
<td>2 (6.7%)</td>
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<tr>
<td>Peripheral iridotomy</td>
<td>11 (36.7%)</td>
<td>7 (23.3%)</td>
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<td>Cyclophotocoagulation</td>
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<tr>
<td><strong>Operative time (min)</strong></td>
<td>55.75 $\pm$ 9.75</td>
<td>48.58 $\pm$ 9.09</td>
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<td><strong>Concurrent intraop procedures</strong></td>
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<tr>
<td><strong>Intraoperative complications</strong></td>
<td>1 (3.3%)</td>
<td>0</td>
<td></td>
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<td><strong>Treatment success:</strong></td>
<td>23 (76.7%)</td>
<td>27 (90.0%)</td>
<td>$[\chi^2$ analysis]</td>
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<tr>
<td><strong>Treatment failures:</strong></td>
<td>7 (23.3%)</td>
<td>3 (10.0%)</td>
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<tr>
<td><strong>Reasons for failures:</strong></td>
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<tr>
<td>Hypertony (IOP $&gt;$ 21)</td>
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<td>2 (66.7%)</td>
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<tr>
<td>Hypotony (IOP $&lt;$ 6)</td>
<td>2 (28.6%)</td>
<td>1 (33.3%)</td>
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<tr>
<td>Loss of light perception</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
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</tr>
<tr>
<td>Need for add'l surgery</td>
<td>1 (14.3%)</td>
<td>0 (0%)</td>
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<tr>
<td><strong>IOP (mm Hg)</strong></td>
<td></td>
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<tr>
<td>Pre-operative</td>
<td>29.58 $\pm$ 7.60</td>
<td>28.75 $\pm$ 10.03</td>
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<td>1 month</td>
<td>21.07 $\pm$ 9.06</td>
<td>21.72 $\pm$ 10.99</td>
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<td>3 month</td>
<td>18.57 $\pm$ 6.75</td>
<td>18.73 $\pm$ 6.04</td>
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<td>6 month</td>
<td>14.72 $\pm$ 4.15</td>
<td>14.54 $\pm$ 5.00</td>
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<td>1 year</td>
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<td>14.68 $\pm$ 3.23</td>
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<tr>
<td>Pre-operative</td>
<td>3.70 $\pm$ 1.37</td>
<td>2.75 $\pm$ 1.17</td>
<td>&lt;0.01</td>
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<td>1 month</td>
<td>1.04 $\pm$ 1.32</td>
<td>0.60 $\pm$ 0.89</td>
<td>0.15</td>
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<td>3 month</td>
<td>2.04 $\pm$ 1.40</td>
<td>1.17 $\pm$ 1.12</td>
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<td>6 month</td>
<td>1.85 $\pm$ 1.26</td>
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<td>1 year</td>
<td>1.90 $\pm$ 1.24</td>
<td>1.43 $\pm$ 1.10</td>
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<tr>
<td><strong>LogMAR visual acuity</strong></td>
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<tr>
<td>Pre-operative</td>
<td>0.91 $\pm$ 0.68</td>
<td>0.68 $\pm$ 0.61</td>
<td>0.15</td>
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<tr>
<td>1 month</td>
<td>0.89 $\pm$ 0.66</td>
<td>0.78 $\pm$ 0.63</td>
<td>0.53</td>
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<tr>
<td>3 month</td>
<td>0.79 $\pm$ 0.70</td>
<td>0.72 $\pm$ 0.67</td>
<td>0.74</td>
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<td>6 month</td>
<td>0.76 $\pm$ 0.85</td>
<td>0.69 $\pm$ 0.59</td>
<td>0.70</td>
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<tr>
<td>1 year</td>
<td>0.81 $\pm$ 0.65</td>
<td>0.62 $\pm$ 0.55</td>
<td>0.24</td>
</tr>
</tbody>
</table>
5 Impact of Glaucoma Intervention in Patients Undergoing Boston Type I Keratoprosthesis

MARK LIN1, Sameh Mosaed, Mason Schmutz
1 University of California, Irvine

Purpose/Relevance
Glaucoma management is challenging in Boston Type 1 Keratoprosthesis (KPro) patients, but also imperative as its incidence and rate of progression are high in this cohort. This study retrospectively examines the impact of surgical glaucoma intervention in patients receiving KPro implantation.

Methods
In this retrospective cohort study, we identified 34 eyes of 22 patients who had undergone KPro performed at University of California, Irvine between 2003 and 2009 with a minimum of 12 months follow up after KPro implantation. Within this cohort, 20 eyes in 19 patients who met the inclusion criteria remained at 1 year. Subjects were divided into two groups: Group 1 included subjects who received surgical glaucoma intervention (including prior and concurrent interventions) within 3 months of KPro implantation; Group 2 included subjects with no surgical glaucoma intervention or intervention later than 3 months following KPro. Best Corrected Visual Acuity (BCVA) following stabilization of refraction post KPro and at 12 months were recorded and converted to logMAR equivalents.

Results
The mean age for group 1 was 57.1 ± 17.7 years, with average follow-up time of 18.0 ± 11.3 months. Group 2 had a mean age of 65.0 ± 16.6 years with average follow-up time of 20.70 ± 8.88 months. In Group 1, mean BCVA within a year of KPro surgery was 20/125 (range 20/40 to Count Fingers; n=11) and mean BCVA at 1 year from KPro surgery was 20/125 (range 20/40 to Count Fingers; n=11). 9 out of 10 patients retained BCVA at 1 yr status post KPro implantation. In Group 2, the mean BCVA within a year of KPro surgery was 20/100 (range 20/25 to 20/400; N=9) and mean BCVA at 1 year from KPro surgery was Count Fingers (range 20/60 to No Light Perception; N=9). 7 out of 9 patients lost significant vision at one year status post KPro implantation. Group 1 retained BCVA better than Group 2 using Fisher’s exact test (p-value = 0.005).

Discussion
While this study does not aim to identify subjects with only glaucomatous vision changes, there appears to be a clear association between better vision retention and early glaucoma surgical intervention.

Conclusion
These findings support the recommendation for concurrent or pre-emptive glaucoma surgical intervention in patients undergoing KPro implantation.

References
6 Minimally Invasive Supraciliary Microstent for IOP Control in Combined POAG-Cataract Surgery: Two-Year COMPASS Trial Results

QUANG NGUYEN, George Reiss, Steven Vold
1 Vold Vision

Purpose/Relevance
To evaluate 2-year safety and efficacy of a supraciliary microstent (CyPass) for reducing IOP in primary open-angle glaucoma (POAG) subjects undergoing cataract surgery.

Methods
Prospective, randomized, comparative, multi-center investigation conducted in the United States. Primary open-angle glaucoma subjects qualified for cataract surgery (N=505) had unmedicated intraocular pressure (IOP) measured prior to randomization to either supraciliary microstenting + phaco (Microstent, n=374) or phaco (Control, n=131) groups (approximately 3:1 ratio). The primary effectiveness endpoint was defined as the proportion of eyes with ≥20% decrease in mean unmedicated diurnal intraocular pressure (DIOP) from baseline to Month 24. The secondary effectiveness endpoints were mean change in unmedicated DIOP between baseline and Month 24, and proportion of eyes with unmedicated DIOP ≥6 mm Hg and ≤18 mm Hg at Month 24. Safety endpoints included incidence of postoperative adverse events (AEs).

Results
Baseline demographics were well balanced between groups. Microstent and Control group respective baseline mean IOPs were 24.4±2.77 and 24.5±2.95 mm Hg. In the Microstent group, 72.5% of patients (compared to 58.0% of patients in the Control group) had ≥20% decrease in unmedicated DIOP from baseline (P=.003). The mean reduction in unmedicated DIOP was 7.0 mm Hg in the Microstent group and 5.3 mm Hg in the Control group (P=.0001). In the Microstent group, 61.2% of patients maintained unmedicated DIOP levels ≥6 mm Hg and ≤18 mm Hg 2 years after surgery, compared to 43.5% in the Control group (P=.0005). Postoperative adverse events were reported in 39.3% of patients in the Microstent group and 35.9% in the Control group.

Discussion
In the largest micro-invasive glaucoma surgical (MIGS) device study to date, with a 2-year follow-up for over 500 mild to moderate glaucoma patients undergoing cataract surgery, supraciliary microstenting in conjunction with cataract surgery demonstrated superior IOP-lowering outcomes versus cataract surgery alone.

Conclusion
This first supraciliary microstenting randomized controlled trial demonstrated adequate safety and significant, as well as sustained, IOP-reduction in patients with mild to moderate POAG undergoing cataract surgery.

Reference
Purpose/Relevance
Trabeculectomy with Mitomycin-C (trab/MMC) is often done to lower intraocular pressure (IOP). Bleb leaks may occur at any time and can be managed medically or surgically. A biodegradable subconjunctival collagen matrix (Ologen) prevents scarring after surgery mainly by mechanically separating the conjunctiva and episclera. It has been shown to be non-inferior to MMC in lowering IOP when used in primary trabeculectomy surgery.

Methods
Case series of 5 eyes of 4 patients with advanced glaucoma. Each eye had bleb revision surgery for late leaks by a single surgeon. A 12x1mm collagen implant was placed over the sclerostomy site. No anti-metabolites were used.

Results
Patient 1: 64-year-old male with bilateral trab/MMC and thin cystic blebs. Both eyes developed a leak 2 years later with mean IOP 10 mmHg in the right and 11.5 mmHg in the left eye. After revision the right eye was stable for 3 years, at which time it developed a new leak which was treated conservatively and has not had another leak in 44 months. The left eye is stable after surgery with no leak for 80 months, but required a prostaglandin for IOP. Patient 2: 76-year-old female with left eye express shunt. A leak was noted 4 years later that persisted despite medical management. Mean IOP was 10 before and 13.5 after revision. The eye is stable with no leak at 96 months. Patient 3: 66-year-old female with bilateral trab/MMC. The right eye developed a leak 9 years later that recurred after initial conservative treatment. After revision the eye is stable with no leak at 39 months with mean IOP 8.5. Patient 4: 81-year-old female with bilateral trab/MMC and bleb dysesthesia. The right eye developed a leak 6 years later and was revised the next week. Mean IOP was 10 before and 12.5 after surgery. It developed cystoid macular edema which resolved with drops and is stable with no leak at 21 months.

Discussion
After bleb revision with the collagen implant 4/5 eyes are without a leak for a mean follow up of 59 months. 1/5 eyes had a new leak that was managed conservatively. 1/5 eyes required a single drop for IOP. There was no major complication nor additional surgery required for bleb leak or progression of glaucoma.

Conclusion
Bleb leaks can occur any time after trabeculectomy and may require surgery. The collagen implant is a promising option as it can be used without anti-metabolites. A multicenter prospective trial is needed to evaluate its safety and efficacy in bleb revision surgery.

References
A Novel Dual Blade Device for Goniotomy: Six-Month Follow-up

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¹ NYU Langone Ophthalmology Associates

Purpose/Relevance
The aim of this study is to assess the clinical experience with the Kahook Dual Blade (New World Medical, Inc, Rancho Cucamonga, CA) for performing goniotomy in adult glaucomatous eyes. The novel design of the device allows for excision of trabecular meshwork (TM) tissue.¹

Methods
This was a multicenter cohort study. Glaucoma patients >18 yrs of age undergoing goniotomy with the KDB under gonioscopic visualization were included. Patients with previous glaucoma surgery were not excluded. Surgeons were surveyed about their intraoperative experience. Data were collected on glaucoma type and severity, concurrent surgeries, preoperative glaucoma medications and intraocular pressure (IOP) and intraoperative complications. In follow up visits (Day 1, Week 1, Month 1, Month 3 and Month 6), patient IOP, glaucoma medications and complications were recorded.

Results
Ease of use: In 98% of cases surgeons strongly agreed or agreed that the use of the KDB was straightforward and entry into the canal with the KDB was uncomplicated.
In 99% of cases surgeons strongly agreed or agreed that advancement of the KDB along the canal was smooth.

Efficacy: As seen in Tables 1 and 2, the mean IOP significantly reduced from baseline by 5.8 mm Hg for all eyes and by 4.7 mm Hg for the phaco+KDB cohort. The medications also significantly reduced by 0.8 for all eyes and by 0.7 for the phaco+KDB cohort.

Adverse Events: Intraoperative blood reflux was observed in 39% of cases, with 9%, 3% and 0.8% of cases having retained blood at day 1, week 1, and at an additional visit between week 1 and month 1, respectively. Eight patients had IOP spikes, with 6 at week 1, 1 at month 1, and 1 between the two time intervals. Four of the IOP spikes were associated with retained viscoelastic or retained blood. Two patients required additional glaucoma surgery for uncontrolled IOP. All other complications were rare and considered minor.

Discussion
Overall, surgeons were satisfied with the usability and safety of the KDB. The KDB allows for minimally invasive excision and removal of TM as a standalone procedure or combined with cataract extraction. The use of KDB significantly lowers IOP and medications 6 months post surgery.

Conclusion
The KDB ophthalmic knife demonstrates an excellent safety and efficacy profile at 6 months.

Reference
Two-Year Outcomes of Phacoemulsification with Trabecular Micro-Bypass Stent Implantation in a Predominantly Hispanic Population with Cataract and POAG

MARK GALLARDO¹, Richard Supnet
¹ University of Texas HSC San Antonio

Purpose/Relevance
To review preoperative surgical goals and 2-year postoperative experience after combined cataract surgery and trabecular stent implantation in eyes with primary open-angle glaucoma (POAG) and cataract.

Methods
This study evaluates 2-year outcomes following cataract surgery and trabecular micro-bypass stent implantation in 148 consecutive eyes of 133 subjects from a single surgeon’s practice. Preoperatively, all eyes were placed into one of three groups based on their objective(s) for surgery: eyes in Group 1 had controlled intraocular pressure (IOP) on glaucoma medications (meds) and goal of medication reduction; eyes in Group 2 had uncontrolled IOP on meds and goal of IOP reduction; and eyes in Group 3 had uncontrolled IOP on ≥ 3 meds and goal of IOP reduction in order to avoid a traditional glaucoma filtering surgery. All eyes underwent uneventful implantation of 1 trabecular micro-bypass stent during cataract surgery. Eighty-nine eyes thus far have been followed through 2 years, and follow-up is ongoing. Baseline medical/surgical history and preoperative/postoperative IOP, medications, visual field, cup to disc (CD) ratio, and complications/interventions were reviewed.

Results
In this predominantly Hispanic (71%) patient cohort, 57% of eyes had moderate or severe glaucoma; mean preoperative IOP was 16.5 ± 4.0 mmHg; and 74% of eyes were taking 2-4 meds preoperatively. Two years after surgery, mean IOP decreased to 12.7 ± 1.9 mmHg and medication use was eliminated in 56% of eyes. At 2 years postoperative, the surgical goal had been achieved in 90% of eyes, and IOP was ≤ 13 mmHg in 92% of eyes; 4 eyes required filtering surgery. Safety parameters were favorable.

Discussion
This mainly Hispanic patient cohort with primarily moderate or severe POAG experienced IOP reduction to ≤ 13 mmHg and decreased medication burden through 2 years postoperative after cataract surgery with trabecular micro-bypass stent implantation, with a high safety profile.

Conclusion
These study data suggest that trabecular stent implantation during cataract surgery can provide IOP and medication reduction safely in Hispanic eyes with a relatively more advanced stage of disease.

References
Purpose/Relevance
It has been well established that the presence of a GDD increases the risk of DSAEK graft failure, with rates ranging from 18-75% at 24 months. Few studies have been conducted assessing the surgical outcomes for patients with more than one GDD. Although results from Schoenberg et al indicate that multiple tubes increase the risk of graft failure, they are not statistically significant. This study examines the long term follow up data in patients who have undergone the DSAEK procedure with multiple preexisting anterior chamber GDDs, and intends to evaluate the timeframe of graft survival and refloat rates in patients with one vs multiple GDDs.

Methods
A retrospective chart review was conducted of all patients who underwent DSAEK by a single surgeon (R.S.A.) between 2013 and 2015. Criteria for inclusion were pseudophakia and the presence of one or more tube shunts in the anterior chamber of the operative eye within the timeframe of the study, with at least 1 year of follow up containing data on graft survival, VA, IOP, number of glaucoma drops, and anterior segment findings. These were recorded for this study at pre-surgery, 1 day, 1 week, 1 month, 3 months, 6 months, 12 months, 15 months, and 18-24 months post-surgery. Eyes with history of retinal detachment or multiple intravitreal injections were excluded. Graft failure was defined as the occurrence of irreversible corneal edema; any patient who needed a repeat corneal graft surgery had by definition a failed graft.

Results
Of the 22 eyes (10 multiple GDDs, 12 single GDD) in the study, the failure rate for multiple GDDs was 40% versus the 25% for single, with the average time to graft failure occurring 7 months earlier for multiple GDDs (17 months and 24 months, respectively). Refloat rates for patients with multiple tubes was 34% higher than those with single (50% and 16%, respectively).

Discussion
These results yielded a statistically insignificant p value of .32 for failure rates and .08 for refloat time. This indicates that failure rates may be unaffected by the number of tubes, and refloat rates may be higher with multiple GDDs.

Conclusion
Though more challenging than PKP, DSAEK surgery is a viable solution for corneal decompensation in the setting of previous GDD implantation, even in eyes with multiple GDDs. Although visual outcomes were worse and failure rates were higher in eyes with multiple GDDs, the lack of statistically significant results support the viability of this procedure. Larger, prospective studies are necessary to further evaluate these phenomena and conclusions.
References


Autologous Buccal Mucosa Grafting for Exposed Glaucoma Drainage Devices

**ADAM BREUNIG**, Steven Brown
1 Chicago Glaucoma Consultants

**Purpose/Relevance**
Glaucoma drainage devices (GDD) are important tools in the surgical management of glaucoma. Exposure of the device through the conjunctiva is a complication that glaucoma specialists must be prepared to manage. Repair of eroded GDD using buccal mucosa grafts has been described previously.1,2 This study describes our mid- and longer-term outcomes of buccal mucosa grafts in the repair of GDD tube erosions.

**Methods**
Retrospective case series

**Results**
Eight out of 9 (89%) buccal mucosa grafts remain intact and cover the previously exposed tube after a mean follow-up of 18 months. One patient had previous exposure with reinforcement using donor sclera 7 years prior to autologous buccal mucosa grafting for re-exposure. One graft had melted by 1 month follow-up and demonstrated delayed epithelialization; in this case the tube did remain covered by the donor cornea placed below the graft at the time of surgery. Average preoperative logMAR VA was 0.93, and average postop logMAR VA was 0.97 (p=0.7). Mean preoperative IOP was 17 mmHg, and mean postoperative IOP was 15 mmHg (p=.57).

**Discussion**
Our results demonstrate favorable outcomes for autologous buccal mucosa grafting in the repair of exposed GDD tubes. The failed graft occurred in a patient receiving concomitant anti-vascular endothelial growth factor (VEGF) treatment for refractory cystoid macular edema, and we believe this may have hindered the vascularization process needed for graft success. Longer follow-up with more patients would help solidify the conclusions of the study.

**Conclusion**
In patients with exposure of a GDD, autologous buccal mucosa grafts can be a useful long-term solution.

**References**
12 Trabeculectomy Success Rate After Glaucoma Drainage Device Surgery

**REZA ALIZADEH**, Handan Akil, James Tan, Joseph Caprioli, Simon Law

1 Doheny Eye Institute, UCLA

**Criteria used for definition of success after trabeculectomy with Mitomycin C after failed glaucoma drainage device surgery**

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Definition</th>
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<tbody>
<tr>
<td><strong>Criterion A</strong></td>
<td>Final IOP ≤ 18 mmHg and one of the following: 20% ≤ reduction of IOP or a reduction of 2 medications with final IOP ≤ baseline if baseline IOP ≤ 18 mmHg</td>
</tr>
<tr>
<td><strong>Criterion B</strong></td>
<td>Final IOP ≤ 15 mmHg and one of the following: 25% ≤ reduction of IOP or a reduction of 2 medications with final IOP ≤ baseline if baseline IOP ≤ 15 mmHg</td>
</tr>
<tr>
<td><strong>Criterion C</strong></td>
<td>Final IOP ≤ 12 mmHg and one of the following: 30% ≤ reduction of IOP or a reduction of 2 medications with final IOP ≤ baseline if baseline IOP ≤ 12 mmHg</td>
</tr>
</tbody>
</table>

**Purpose/Relevance**
Trabeculectomy is not typically considered as a treatment option when glaucoma drainage device (GDD) surgery fails. We evaluated the success rate of trabeculectomy in glaucoma refractory to GDD surgery.

**Methods**
In this retrospective study, all patients from Stein and Doheny Eye Institutes who had trabeculectomy with MMC after failed GDD were included. Demographic data, diagnosis, systemic conditions, surgery information, IOP, vision and number of medication in each visit are recorded. Criteria used to define success are shown in the Table.

20 patients (eleven males and nine females) were included. Half of the patients were Caucasian. Diagnoses were: primary open-angle glaucoma (10), uveitic glaucoma (4), chronic angle closure glaucoma (2) and iridocorneal endothelial syndrome (1). Median follow up was 3.7 years. Time between GDD surgery and trabeculectomy ranged from two weeks to six years. Median follow up was 22.1 months. Mean (± SD) MMC usage was 6.2 ± 5.4 (mg•min/ml). Apart from hypotony maculopathy in one patient, no serious complications occurred.

Mean IOP was reduced from 19.3 ± 4.2 (baseline, post GDD) to 9.8 ± 2.2 mmHg at 1y; 8.8 ± 3.2 at 3y; and 8.4 ± 1.5 at 5y (all p<0.001). Average number of medications after GDD and before trabeculectomy was 2.9 ± 0.5; this reduced to 0.4 ± 0.2 at 1y; 0.8 ± 0.3 at 3y; and 1.1 ± 0.4 at 5y follow ups (all p<0.001).

Kaplan-Meier survival curves for different success criteria over five years of follow up are shown in the Figure.

**Discussion**
Options for treatment of glaucoma refractory to GDD surgery include implanting a second GDD or endoscopic cyclophotocoagulation (ECP). The results of trabeculectomy with MMC after GDD are comparable to these surgical options. On the other hand, results for trabeculectomy after GDD surgery are better compared to repeat trabeculectomy after initial trabeculectomy, as perhaps conjunctival scarring is more localized after GDD placement.
Conclusion
Trabeculectomy is a reasonable option for surgical treatment of glaucoma refractory to prior single glaucoma drainage device implantation.

References
**Purpose/Relevance**

Intraocular Pressure (IOP) reduction after combined phacoemulsification and trabecular micro-bypass with the iStent (Glaukos, Laguna Hills, CA) has a relatively wide range of results. Phacoemulsification alone (phaco) has been demonstrated to lower the IOP by at least 1.5-2 mmHg in both healthy and Primary Open-Angle Glaucoma patients, particularly in short follow-up times like one year. Cases of combined phacoemulsification with a single first-generation micro-bypass stent (PS) with lower baseline IOP tend to have smaller IOP reductions, so it is very important to consider baseline IOPs when making comparisons. Our primary goal was to compare IOP reduction following PS vs phaco by matching patients based on age and baseline IOP.

**Methods**

This was a retrospective chart review including all patients who had PS at our institution with 12 months of follow-up. The control group consisted of mild glaucoma patients who received phaco by one of the same two surgeons during the same time period. Patients were matched based on age (±3 years) and baseline IOP (± 2 mmHg). A student’s t-test was used to compare continuous data.

**Results**

The average age of both groups was 77 ± 7 years, with 17 cases in each group. The mean baseline IOP for PS was 15.8 ± 2.9 mmHg on 2.1 ± 1.3 medications. The mean baseline IOP for phaco was 16.3 ± 2.2 mmHg on 0.9 ± 0.4 medications. One year after surgery, the IOP after PS averaged 13.7±2.1 mmHg (13% decrease from preoperative IOP, p<0.05) on 1.5 fewer medications, while the phaco group averaged 15.6±2.2 mmHg (4% decrease from preoperative IOP, p=0.5) with no significant change in medications. While 30% of PS achieved an IOP ≤12 mmHg, this occurred in only 5% of phacos, p<0.05. Preoperatively only 15% of PS and 17% of phacos were medication-free (p=0.4), and this increased to 60% for PS vs. 16% for phacos at one year (p<0.01).

**Discussion**

The PS group sustained a mean 13% IOP decrease from baseline versus a 4% IOP decrease with phaco after 1 year. The absolute difference of 1.9 mmHg was not statistically significant. Although the mean IOP’s were similar, the frequency of achieving low IOP’s was higher with PS despite being on fewer medications.

**Conclusion**

This small case-matched series showed that although the mean IOP at one year was similar between cases of phaco and PS, the PS group on average used 1.5 fewer medications, with more cases achieving lower IOPs.

**References**

Tables: Percentage of Patients Reaching Intraocular Pressure (IOP) Cutoffs Before and After Surgery

<table>
<thead>
<tr>
<th>Preoperative</th>
<th>Stent+Phaco (%)</th>
<th>Phaco (%)</th>
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<tbody>
<tr>
<td>IOP&lt;21</td>
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<tr>
<td>IOP&lt;18</td>
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<table>
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<tr>
<th>Postoperative</th>
<th>Stent+Phaco (%)</th>
<th>Phaco (%)</th>
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<td>IOP&lt;21</td>
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<td>100</td>
</tr>
<tr>
<td>IOP&lt;18</td>
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<tr>
<td>IOP&lt;15</td>
<td>80</td>
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</tr>
<tr>
<td>IOP&lt;12</td>
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</table>
14 Intraocular Pressure Outcomes Following Phacoemulsification Combined with Trabeculectomy Ab Interno Versus Phacoemulsification Alone

NICOLE GOLBARI1, Kevin Kaplowitz, Edward Yung, Azin Abazari, Robert Honkanen
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Purpose/Relevance
Minimally invasive glaucoma surgeries (MIGS) such as combined phacoemulsification with trabeculectomy ab-interno with the trabectome (Neomedix, Tustin, CA) present an opportunity to lower the Intraocular Pressure (IOP) with a side effect profile very similar to phacoemulsification alone. Low baseline IOP is a proven risk factor for IOP failure with trabectome.1,2 Our primary goal was to compare the IOP reduction following phacoemulsification (phaco) versus phacoemulsification combined with trabectome (PT) after matching patients based on age and baseline IOP.

Methods
This was a retrospective chart review including all patients who had PT at our institution in a two-year period. The control group consisted of mild glaucoma patients who received phacoemulsification by one of the same two surgeons during the same time period. Patients were matched based only on age (±3 years) and baseline IOP (± 2 mmHg).

Results
There were 20 patients in each group. The average age of PT was 77 ± 8 years old vs 76 ± 8 for phaco, p=0.6 The mean baseline IOP for PT was 16.3 ± 3.8 mmHg on 2.3 ± 1.2 medications. The mean baseline IOP for phaco was 16.7 ± 3.2 mmHg on 1 ± 0.6 medications. One year after surgery, the IOP after PT averaged 15.1 ± 7.2 mmHg (8% decrease from preoperative IOP, p=0.5) on 1.3 fewer medications (p=0.001) while the phaco group averaged 14.5 ± 2.2 mmHg (13% decrease from preoperative IOP, p=0.02) with no significant change in medications. While 50% of PT achieved an IOP ≤12 mmHg, this occurred in only 17% of phacos, p<0.05.

Discussion
The use of trabectome with phacoemulsification sustained a similar mean IOP decrease to phacoemulsification alone after 1 year (8% vs 13% reduction, p=0.86). Although the mean IOP’s were similar, the frequency of achieving low IOP’s was higher with PT even while being on fewer mean medications.

Conclusion
This small case-matched series showed that although mean IOP at one year was similar between cases of phaco and PT, the PT group on average used 1.3 fewer medications with more cases achieving lower IOPs.

References
15 Safety and Efficacy of Trabeculectomy with 20µG Versus 15µG Mitomycin C Injection

SZE WONG1, Albert Khouri
1 Rutgers University

Purpose/Relevance
Trabeculectomy is conventionally performed with subconjunctival mitomycin-C (MMC) soaked sponges to prevent fibrosis; however, the use of injected MMC has become popular, and offers more diffuse and predictable dose delivery. It is not known what dose of MMC is best. This study compares injecting 20µg vs 15µg of MMC.

Methods
We did a retrospective chart review on trabeculectomies with MMC injection performed by one surgeon. During surgery, a snip conjunctival peritomy was performed, followed by subtenon MMC injection (0.4 mg/mL diluted 50:50 with lidocaine 2%; 0.1mL=20µg, 0.075mL=15µg). The incision was compressed with cellulose spear to prevent egress. Data on intraocular pressure (IOP), medication use, and complications were collected.

Results
50 eyes (30 had 20µg MMC, 20 had 15µg) with 6-month follow-up were reviewed. At baseline, there was no statistical difference in age, number of glaucoma medications, and IOP between groups. Table 1 lists IOP and number of glaucoma medications at various time points; there was no statistical difference between groups. In the 15-µg and 20-µg groups, the proportion of eyes with persistent hypotony (no intervention required) were 5% and 10%, respectively (P=0.47); the proportion of eyes with <20% IOP reduction on medications were 10% and 17%, respectively (P=0.51); the proportion of eyes with bleb leaks were 0% and 20% (all ≤1 month postop and self-limited), respectively (P=0.03). More postoperative interventions were done in the 15-µg vs 20-µg group (5-fluorouracil injections 30% vs 17% and laser suture lysis 45% vs 30%, respectively). No corneal decompensation occurred.

Discussion
Injecting 15µg of MMC lowered IOP just as effectively as 20µg, with fewer cases of bleb leak. However, more postoperative interventions to lower IOP were needed.

Conclusion
Trabeculectomy with 15-µg MMC injection is safe and adequate for IOP control. A prospective study with longer follow-up is needed to elucidate whether MMC dose should be adjusted based on age and race.

References

Table 1. Intraocular Pressure and Number of Glaucoma Medications After Trabeculectomy with Injected Mitomycin C Doses of 15 µg vs. 20 µg

<table>
<thead>
<tr>
<th>IOP±SD</th>
<th>Baseline</th>
<th>POD1</th>
<th>POW1</th>
<th>POM1</th>
<th>POM3</th>
<th>POM6</th>
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<tbody>
<tr>
<td>15 µg</td>
<td>23.0±8.1</td>
<td>17.6±10.4</td>
<td>15.0±7.1</td>
<td>11.5±5.1</td>
<td>11.7±4.5</td>
<td>11.9±4.0</td>
</tr>
<tr>
<td>20 µg</td>
<td>22.0±7.6</td>
<td>14.5±7.1</td>
<td>12.4±6.0</td>
<td>11.1±5.4</td>
<td>12.1±5.8</td>
<td>11.1±4.6</td>
</tr>
<tr>
<td>No. of Glaucoma Medications±SD</td>
<td>3.1±1.1</td>
<td>0.0</td>
<td>0.2±0.7</td>
<td>0.1±0.3</td>
<td>0.5±0.9</td>
<td>0.6±1.2</td>
</tr>
<tr>
<td>20 µg</td>
<td>3.0±1.2</td>
<td>0.2±0.7</td>
<td>0.2±0.5</td>
<td>0.2±0.6</td>
<td>0.2±0.8</td>
<td>0.3±0.5</td>
</tr>
</tbody>
</table>

IOP = intraocular pressure; POD1 = postoperative day 1, POW1 = postoperative week 1, SD=st dev, POM1 = postoperative month 1, POM3 = postoperative month 3, POM6 = postoperative month 6
16 Initial Trabeculectomy with Mitomycin C in Subjects of African Descent: Intermediate-Term Outcomes and Risk Factors for Failure

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1 Stein Eye Institute, UCLA

Purpose/Relevance
To compare intermediate outcomes after initial trabeculectomy with Mitomycin-C (MMC) in subjects of African descent (AD) to those of European descent (ED) and assess risk factors for failure.

Methods
One hundred thirty-five eyes from 104 AD glaucoma patients were matched to 135 eyes from 118 ED patients by surgeon, age (±5 years), lens status, and follow-up time (±1 year). Three sets of criteria (A through C) defined success as final IOP ≤18, ≤15 and ≤12 mmHg along with ≥20%, ≥25%, and ≥30% reduction of IOP or reduction of ≥2 medications, respectively. Primary outcome measures were qualified success rates (with or without medication) based on the above criteria. Secondary outcome measures were postoperative complications and further glaucoma surgery. Kaplan-Meier survival curves were compared and Cox’s proportional hazard models were used to identify prognostic factors for failure.

Results
Success rates at 5 years for criteria A, B and C were 61%, 43% and 25% in AD eyes and 67%, 60%, and 40% in ED eyes (p=0.273, =0.013 and =0.029, respectively). On multivariate Cox’s regression analyses, African ancestry was associated with higher failure rate with criteria B and C (p=0.003 and 0.002). The incidence of bleb leaks was higher in the AD group (p=0.002). AD patients required more additional glaucoma surgeries than ED patients (p=0.02).

Discussion
Patients of African descent experience higher failure rates and have a higher incidence of bleb leaks after initial trabeculectomy with MMC compared to subjects of European descent.

Conclusion
These findings need to be carefully taken into account when surgical treatment of glaucoma is contemplated in AD patients. A low target pressure is harder to achieve with trabeculectomy in AD patients; however, given the higher incidence of trabeculectomy, increased use of MMC may not be warranted.
References


17 Intraocular Pressure in the Fellow Eye of Patients with Primary and Secondary Glaucoma After Ahmed Valve Implantation

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Purpose/Relevance
To determine the intraocular pressure (IOP) changes in the fellow eye of patients with primary and secondary glaucoma during the early post-operative phase after Ahmed glaucoma valve surgery.

Methods
Sixty-five patients with glaucoma undergoing Ahmed valve surgery at University of California, San Francisco between May 2013 and August 2014 were prospectively followed. Data were collected at pre-operative visits and at 1-2, 4, 6, 8 and 12 weeks post-operatively. Changes of IOP from pre-operative baseline were calculated using Wilcoxon signed rank test and longitudinal analysis with linear mixed effects regression. Subgroup analysis was performed on the basis of glaucoma subtype.

Results
Post-operatively, patients with secondary glaucoma, including uveitic, post-steroid-injection, and post-corneal transplant glaucoma, had a pronounced increase in fellow eye IOP from baseline compared to patients with steroid-naïve primary glaucoma at 1-2 weeks (4.5±5.8 mmHg vs. 0.2±3.2 mmHg; P = 8.0×10-3). The peak of difference was at 1-2 weeks, and remained elevated up to week 6 (1.5±5.0 mmHg, P = 5.6×10-3). In contrast to the increase in fellow eye IOP, no significant changes in visual acuity or the number of glaucoma medications used were observed for the fellow eye during the follow-up period.

Discussion
There is an IOP elevation in the fellow eye during the immediate post-operative period after AGV implantation in patients with the diagnosis of secondary glaucoma, possibly due to their higher sensitivity to steroids. While patients with primary glaucoma have no significant IOP changes after AGV surgery.

Conclusion
This study highlights the importance of IOP monitoring in both eyes following AGV implantation. The potential risk of postoperative IOP elevation in the fellow eye, especially in patients with previous exposure to steroid, should be included in both patient education and the decision making process when contemplating surgery in high-risk patients.

References
18 Comparison of Ahmed and Baerveldt Tube Shunts in Treating Refractory Neovascular Glaucoma

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Purpose/Relevance
To compare rates of no light perception (NLP), failure, and complications between Ahmed (AGI) and Baerveldt (BGI) tube shunts in neovascular glaucoma (NVG).

Methods
Patients with NVG who had primary AGI or BGI from January 1, 1996, to February 1, 2015, were reviewed. Eyes were excluded if they had a prior tube shunt or cyclodestruction, NLP vision, or less than 6 months follow-up. If both eyes met inclusion criteria, the first eye receiving study intervention was selected. Postoperatively, we recorded IOP, number of IOP lowering medications, vision, and complications up to 5 year follow up or progression to NLP. The primary outcome was incidence and time to NLP. The secondary outcomes were complication events as well as incidence and time to implant failure (NLP, persistent hypotony, additional IOP lowering intervention, need for oral CAI). Kaplan-Meier survival analysis compared the cumulative rates of NLP and implant failure. Poisson regression analysis compared complication rates per eye-month.

Results
115 eyes (71 AGI, 44 BGI) were included. The mean follow-up time was 25.6 months for AGI and 22.6 months for BGI (p=0.31). There were no differences in age, gender, baseline vision, IOP, and IOP lowering medications. Race distribution was different between groups (p=0.026). Hispanics were more likely implanted with AGI (77%), while other races were distributed equally. At 1 year, the cumulative rate for NLP was 18% (12) in AGI and 8% (3) in BGI (p=0.18). During the study period, 22 AGI eyes (31%) went to NLP with a mean of 34.4 months survival time and 13 BGI eyes (30%) with 44.3 months survival time (p=0.66, Figure 1). For implant failure, the cumulative failure rate was 34% (23) in AGI and 24% (10) in BGI at 1 year (p=0.46). During the study period, 33 AGI eyes (47%) failed with a mean of 28.7 months survival time and 21 BGI eyes (48%) failed with 32.8 months survival time (p=0.80, Figure 2). There were 52 complication events (0.029/eye-month) observed in AGI group and 47 events (0.079/eye-month) in BGI (p=0.013).

Discussion
Almost 30% of all eyes progressed to NLP, and nearly 50% of all implants failed during the study period. The rates of progression to NLP and implant failure were similar between 2 groups. However, complications per eye-month in the BGI group was about 3 times more than the AGI group.

Conclusion
In NVG patients, the rate of progression to NLP and overall failure rates were similar in AGI and BGI groups, with up to a third of patients going to NLP in both groups.
Reference

Long-term Outcomes of Post-trabeculectomy Refractory Glaucoma Treated with 2 Trabecular Micro-Bypass Stents, 1 Suprachoroidal Stent, and a Postoperative Prostaglandin

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Purpose/Relevance
There are limited options in the treatment of refractory glaucoma. The purpose of this study was to determine the long-term success of micro-invasive glaucoma surgery (MIGS) with two trabecular micro-bypass stents, a suprachoroidal stent, and postoperative travoprost in these cases.

Methods
This prospective, single-arm study enrolled subjects with OAG refractory to a previous trabeculectomy and currently taking 1 to 3 ocular hypotensive medications. Preoperative medication intraocular pressure (IOP) was required to be 18-45 mmHg and IOP after medication washout was required to be 21-45 mmHg. Eyes were implanted with 2 trabecular bypass stents and a suprachoroidal stent; on postoperative Day 1, travoprost was prescribed. Evaluation through 5 years is ongoing, and includes IOP, BCVA, slit lamp and optic nerve evaluation, medications, and adverse events (AEs). Unmedicated IOP also is measured annually following 1-month medication washouts.

Results
Eighty total subjects were enrolled into the study, with preoperative mean IOP (SD) of 22.0 (3.1) mmHg on 1.2 (0.4) medications, and 26.4 (2.4) mmHg after washout.1 At all study timepoints through 36 months postoperative, mean medicated IOP remained at or below 13.7 mmHg at all visits, with 4 eyes requiring a second medication. Post-washout IOP remained \( \leq 17.1 \) mmHg at annual medication washouts (Months 13, 25, 37). In 1 subject, the suprachoroidal stent was unable to be placed due to inadequate intraoperative visualization (as documented previously)1; however, there were no other intraoperative complications in the remaining subjects. Eight subjects experienced reduction in best corrected visual acuity (BCVA) postoperatively: 7 due to advancing cataract and 1 due to fluctuating vision from limited visual field. Data through 4 years will be presented.

Discussion
This study treated subjects with post-trabeculectomy refractory glaucoma with MIGS using two trabecular micro-bypass stents, a suprachoroidal stent, and postoperative travoprost. The results indicate long-term IOP reduction with favorable safety in these subjects.

Conclusion
MIGS surgery with two trabecular stents, one suprachoroidal stent, and postoperative travoprost may be a viable treatment option for subjects with glaucoma refractory to prior trabeculectomy.

Reference
20 Outcomes Through 2 Years Following MIGS with 2 Second-Generation Trabecular Bypass Stents in Eyes with Open-Angle Glaucoma Taking 1 Medication

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Purpose/Relevance
To evaluate long-term outcomes of micro-invasive glaucoma surgery (MIGS) with 2 second-generation trabecular micro-bypass stents in a sole procedure in subjects with open-angle glaucoma (OAG) on 1 preoperative ocular hypotensive medication.

Methods
This 5-year, prospective, nonrandomized study enrolled subjects with OAG taking 1 ocular hypotensive medication and with preoperative IOP of 18-30 mmHg on medication and 22-38 mmHg post-washout. Eligible subjects were implanted with 2 second-generation trabecular micro-bypass stents in a sole procedure. If elevated IOP and/or optic nerve changes occurred postoperatively, hypotensive medication was prescribed. Postoperative efficacy and safety evaluations included IOP, medications, slit-lamp findings, gonioscopy findings, fundus/optic nerve evaluation, best-corrected visual acuity (BCVA), and adverse events.

Results
This study enrolled 57 subjects, all of whom have completed their 18-month visit and 7 of whom have completed their 24-month visit. Preoperatively, mean medicated IOP (SD) was 19.5 (1.5) mmHg, and mean post-washout IOP was 24.4 (1.3) mmHg. Postoperatively, mean IOP remained at or below 15.3 mmHg at all visits through 24 months, with 1 subject requiring medication (due to change in optic nerve appearance; IOP was 17.7 mmHg). One subject experienced BCVA reduction due to advancing cataract at Month 24, but otherwise postoperative safety was excellent.

Discussion
The standalone implantation of two second-generation trabecular micro-bypass stents provided long-term IOP and medication reduction in eyes with OAG on 1 preoperative glaucoma medication. The limited adverse events support the long-term safety of this approach.

Conclusion
These study findings demonstrate safe and long-lasting IOP control in eyes with OAG following implantation with two second-generation trabecular micro-bypass stents.

Reference
Efficacy of 2 Targeted Versus Non-targeted Trabecular Micro-Bypass Stents: A Preliminary Investigation

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Purpose/Relevance
In an effort to improve intraocular pressure (IOP) reduction outcomes of trabecular micro-bypass stents, some operators are now employing a targeted placement technique where the device is implanted near large, pulsatile episcleral vessels draining Schlemm’s canal. The purpose of this study was to compare the efficacy of targeted vs. non-targeted implantation of two trabecular micro-bypass stents.

Methods
Single-center, retrospective, investigational cohort study. 102 eyes, 72 patients with ≥2 months follow-up that had micro-bypass stent implantation at Trillium Health Partners (Mississauga, Canada) from Jan. 2010 to Jul. 2016. 72 eyes targeted implantation, 40 non-targeted. Primary outcome: IOP≤21mmHg and on fewer IOP-lowering medications on last follow up vs. baseline. Secondary outcomes: 1) IOP≤18, no medications, and 2) ≥20% IOP reduction, no medication increase. Baseline characteristics were compared with Fisher Exact tests and Wilcoxon rank sum tests. Mixed effects model adjusted for baseline characteristics and accounting for correlation between eyes was used to compare interventions.

Results
Baseline characteristics were similar between groups with these exceptions: targeted group had higher median IOP (16.0 vs. 15.0mmHg, p=0.03), and more IOP-reducing medications (3.2 vs 2.6, p=0.01). Median follow up was 13.2 months in targeted group and 13.9 months in non-targeted (p=0.24). 70.2% (53.0-83.1) of targeted eyes achieved the primary outcome and 35.1% (18.6-60.0) of non-targeted (adjusted OR 4.4 [95% CI 1.4-13.7]). There was insufficient evidence to conclude a difference in the percentage of patients achieving the secondary outcomes between groups.

Discussion
Targeted micro-bypass stent implantation has the theoretical impact of improved IOP control by directing aqueous outflow toward segments of the trabecular meshwork that are more likely draining toward episcleral vessels with improved flow. In this retrospective analysis, targeted stent implantation was associated with improved odds of IOP≤21mmHg on fewer medications. Future studies should be randomized, prospective, and assess washed out IOP in a masked fashion.

Conclusion
Targeted micro-bypass implantation was more likely than non-targeted to achieve IOP≤21mmHg on less medication; no difference was identified for other success criteria. While regression adjusted for baseline characteristics, unmeasured confounders cannot be accounted for.

Reference
22 Injected Versus Sponge-Applied Mitomycin-C (MMC) During Modified Trabeculectomy in New Zealand White Rabbit Model

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Purpose/Relevance
Mitomycin-C (MMC) is utilized during glaucoma filtration surgery (GFS) to enhance bleb survival. Recently, surgeons have elected to perform an intra-Tenon injection of MMC at a given concentration and dose over the sponge-applied method, which delivers an unknown quantity of MMC. The purpose of this study was to compare the intraocular pressure (IOP) and bleb morphology of an intra-Tenon injection of MMC versus the sponge-applied method during modified trabeculectomy in the New Zealand White rabbit model.

Methods
10 New Zealand white rabbits (aged 3-4 months) underwent modified GFS in both eyes. The right eye received 1 of 2 treatments: pre-operative intra-Tenon injection of MMC (0.1mg/ml x 0.2ml = 20 micrograms injected, 5 rabbits) or intra-operative application of MMC using a cellulose sponge (0.4 mg/ml for 4 minutes, 5 rabbits). The left eye did not receive MMC. Post-operative IOP was recorded weekly for 4 weeks. All rabbits were euthanized after the 4-week post-operative period. Both eyes were enucleated and sent for histological analysis with attention to goblet cell count, neovascularization, and collagen content and alignment at the bleb site.

Results
All rabbits completed the post-operative period. One rabbit in the injection group developed hypotony without a flat chamber. The mean IOP measurement in the injection group was 6.1 mmHg (average pre-op IOP was 6.8 mmHg) compared to 9.4 mmHg (average pre-op IOP was 7.8 mmHg) in the sponge-applied group (p<0.05). Data presented in mean ± standard deviation format. The goblet cell counts in the injection and sponge-applied groups were 3.7 cells ± 0.49 and 0.5 cells ± 0.55, respectively (p<0.05). The vascularity counts for the injection and sponge-applied groups were 8.0 vessels ± 2.0 and 5.67 vessels ± 2.74, respectively (p<0.05). Collagen content and alignment (Figures 1 and 2) in the injection and sponge-applied groups was 42.5 percent threshold staining ± 5.57 and 58 percent threshold staining ± 2.51, respectively (p<0.05).

Discussion
The lower IOP in the injection group represents the broader application of MMC resulting in low-lying diffuse blebs.1 Collagen content and alignment was reduced in the injection group resulting in decreased scar formation. A greater number of goblet cells were preserved in the injection group, which may benefit ocular surface disease patients. The increase in vascularity in the injection group raises concerns for long-term bleb survival. However, this may represent lower bleb-related complications such as delayed leaks and endophthalmitis associated with avascular blebs.2,3

Figure 1. Picrosirius Red staining demonstrating collagen arrangement and density in injected MMC rabbit eye. Note the less densely packed fibers and thin, short, and loose fibrils as yellow-green.

Figure 2. Picrosirius Red staining demonstrating collagen arrangement and density in sponge applied MMC rabbit eye. Note the densely packed and long fibers of type 1 collagen as bright red-orange.
Conclusion

An injection of MMC demonstrated lower post-operative IOP, increased number of goblet cells, and less scar formation at the bleb site despite increased vascularity. An intra-Tenon injection can be an effective method of delivering MMC when compared to the sponge-applied method.

References


23 Stand-alone Ab Interno Gelatin Stent with MMC Versus Stand-alone Trabeculectomy with MMC: Postoperative Patient Experience and Healthcare Utilization

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Purpose/Relevance
In evaluating new surgical approaches for uncontrolled glaucoma on maximum tolerated therapy, we not only need to evaluate the efficacy and safety, but also the patient experience and the effect on healthcare utilization. This information is critical in determining a new approach’s merit from the patient’s perspective and to feed into decision analysis and cost effectiveness models for policy makers.

Methods
Multi-center retrospective interventional cohort study. 373 eyes in 311 patients were identified from Jan 2011 to July 2015 in 3 centers. 80 eyes were excluded due to previous incisional surgery, atypical forms of glaucoma, age extremes, or follow-up less than 1 mo. Assessed outcomes include: 1) number of in-clinic maneuvers, 2) proportion of eyes receiving and time to needling, 3) number of post-operative visits at 1 month and 3 months, 4) proportion of patients with >2 lines of vision loss at last follow-up, 5) time to visual recovery, 6) proportion of patients with ≥0.5D of surgically induced astigmatism. Time to failure was assessed with a Cox proportional hazards model, and continuous/categorical outcomes were assessed with a mixed effects linear model adjusted for baseline characteristics accounting for correlation between eyes.

Results
The microstent eyes had 1.0 maneuvers per eye (148 total) and the trabeculectomy eyes had 1.6 (219 total). There were 92 needlings in 67 eyes (40%) and 70 needlings in 42 (31%) (adjusted HR 1.4 [0.9-2.3]). In microstent eyes, there were 7 lasers to the iris/microstent area, 3 iris sweeps, and 3 microstent repositions in 2 eyes. In trabeculectomy eyes, there were 101 laser suture lysates in 68 eyes (50%) and 23 bleb/conjunctiva/ flap revisions in 10 patients, and 1 iris sweep. Trabeculectomy eyes had an adjusted average 1.4 (0.8-2.0) extra visits in the 1st month and 1.8 (0.8-2.8) in the first 3 months. 13% and 25% of eyes lost > 2 lines of vision at last follow-up (adjusted OR 0.4 [0.2-0.8]), and the adjusted rate of visual recovery to baseline was 1.4 (0.95-2.0) higher for microstent eyes. 37% and 63% had an increase of ≥0.5D of corneal astigmatism (adjusted OR 0.3 [0.2-0.6]).

Discussion
In a large multi-center cohort ab interno gelatin microstent eyes had fewer in-clinic maneuvers (though some evidence for more needlings), fewer postoperative visits, less vision loss, and experienced less surgically induced astigmatism than trabeculectomy eyes.

Conclusion
Overall the post-operative course appears to be less intensive and visually debilitating for an ab interno microstent with MMC compared to a trabeculectomy with MMC, though there may be increased needlings.
Reference

24 Outcomes of Microcatheter-Assisted Trabeculotomy Following Failed Angle Surgeries in Congenital Glaucoma

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Purpose/Relevance
Outcomes of Microcatheter-assisted Trabeculotomy Following Failed Angle Surgeries in Congenital Glaucoma.

Methods
Retrospective chart review of 42 eyes of 35 patients who underwent microcatheter-assisted trabeculotomy for congenital glaucoma by a single surgeon between January 2014 to January 2015 with a median follow-up period of 12 months. Group 1, 23 eyes of 18 patients, had no previous angle surgery. Group 2, 19 eyes of 17 patients, had no more than 2 previous failed angle surgeries. Success was defined as an intraocular pressure (IOP)<21 mm Hg with at least a 30% reduction from preoperative IOP with (qualified success) or without (complete success) the use of anti-glaucoma medication.

Results
Mean IOP decreased from 32.5±7.4mmHg in group 1 and 35.1±7.2mmHg in group 2 preoperatively to 15.1±3.4mmHg (P<0.001) and 13.5±3.4mmHg (P<0.001) postoperatively at 12 months, respectively. Median number of medications decreased from 3 (range:0-4) in group 1 and 3 (range:0-4) in group 2 preoperatively to 0 (range:0-4) (P=0.003) and 0 (range:0-0) (P=0.003) postoperatively at 12 months, respectively. There was no statistically significant difference between group 1 and group 2 in terms of IOP change and medication use at any postoperative time points (P>0.05). The mean percentage decrease in IOP was 44.0±21.7% in group 1 and 39.4±40.2% in group 2, P=0.310. Qualified success was achieved in 87.0% in Group 1 and 78.9% in Group 2, respectively (P=0.499). Complete success was achieved in 73.9% in Group 1 and 63.2% in Group 2, respectively (P=0.465). Complications were minimal.

Discussion
Our studies are limited by the small sample size and relatively short followup duration. In addition, there are pre-op parameter differences between group 1 and 2: patients in group 2 were older at time of surgeries, group 1 had infantile onset eyes associated with other anomalies while group 2 had none and group 2 had more PCGs with birth-onset.

Conclusion
Microcatheter-assisted trabeculotomy achieved significant pressure lowering effects, with a reduction in medication use in congenital glaucoma. Its success rate and surgical outcome are not significantly different between eyes with and without previous failed angle surgeries. Microcatheter-assisted trabeculotomy represents a reasonable choice of initial and repeat surgical treatment for congenital glaucoma.

References
25 Increased Rate of Postoperative Blepharoptosis Following Glaucoma Drainage Device or Trabeculectomy Surgery Compared to Cataract Extraction

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Purpose/Relevance
Blepharoptosis (or ptosis) is a complication following cataract surgery and trabeculectomy, occurring as frequently as 4 – 21%¹ and 10%,² ³ respectively, while its incidence after tube shunt placement is not known. In this study we sought to determine the rate of post-operative ptosis in patients who underwent cataract extraction, trabeculectomy, or tube shunt placement by a single surgeon.

Methods
Patients with glaucoma who underwent anterior segment surgery including Ahmed or Baerveldt tube shunt placement, trabeculectomy, and/or cataract surgery by phacoemulsification were prospectively and consecutively enrolled by a single surgeon at Mayo Clinic, Rochester, MN. Palpebral fissures were measured pre-operatively and one month post-operatively. Ptosis was defined as a decrease in palpebral fissure of ≥ 2 mm when compared pre and post operatively.¹ ² A student’s t-test was used for statistical analysis.

Results
48 patients were prospectively and consecutively enrolled who underwent tube shunt placement, trabeculectomy, and/or cataract extraction and completed one month follow-up. Twenty patients underwent trabeculectomy surgery (5 of these were combined trabeculectomy and cataract extraction), 16 patients who underwent tube shunt placement (one underwent combined tube shunt placement and cataract extraction), and 12 patients who underwent cataract extraction by phacoemulsification alone. Patients undergoing cataract extraction had change in palpebral fissures of 0 ± 0.9 mm and a rate of ptosis of 8%. Patients undergoing trabeculectomy had a decrease in palpebral fissure length of 1 ± 1.3 mm and a rate of ptosis of 25% (p=0.3 vs. cataract extraction alone). Patients undergoing tube shunt placement had a decrease in palpebral fissure length of 1 ± 1.2 mm (p=0.07 vs cataract extraction alone) and a rate of ptosis of 25%.

Discussion
In our prospective single surgeon study, patients undergoing glaucoma surgery including trabeculectomy and tube shunt placement had a higher incidence of post-operative ptosis than patients who underwent cataract extraction alone. In our study, one out of every four patients who underwent glaucoma surgery developed post-operative ptosis. This is significant for patients as ptosis may further limit their already restricted visual field. We hypothesize that the greater incidence of ptosis with glaucoma surgery is secondary to greater conjunctival dissection, manipulation of the extraocular muscles, and duration of surgery compared to cataract extraction by phacoemulsification.

Conclusion
Glaucoma surgeons may elect to discuss the high risk of post-operative ptosis in the pre-operative setting for patients undergoing trabeculectomy and tube shunt placement.

References
26  The Outcomes of Gonioscopy-Assisted Transluminal Trabeculotomy (GATT) in Open-Angle Glaucoma

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Purpose/Relevance
To evaluate the outcomes of Gonioscopy-Assisted Transluminal Trabeculotomy (GATT) in open angle glaucoma.

Methods
Patients diagnosed with primary or secondary open angle glaucoma were enrolled. The number of medications, intraocular pressure, best corrected visual acuity, and surgical complications were recorded at baseline and at follow up visits. Surgical failure was defined as an IOP > 21 mmHg or < 5mmHg, an IOP reduction from baseline of less than 20%, reoperation needed, or loss of light perception on 2 consecutive visits 3 months after the procedure.

Results
Seventy-six patients (age range of 16-85) underwent GATT at Wills Eye Hospital. Of these patients, 55.2% were men, 64.5% were Caucasian, and 28.9% were African American. Patients were followed for 8.1±6.6 months. At 3 months follow up, Intraocular pressure (IOP) decreased by 26.4% (SD, 41%), with an average decrease in glaucoma medication of 1.1 (SD, 1.2). At 6 months, IOP decreased by 36.2% (SD, 24.8%) with an average of 1.4 fewer medications (SD, 1.3). Decrease in IOP was significantly greater in Caucasians than in African Americans (p=0.02). Mean preoperative best-corrected visual acuity was 0.20 log MAR, which changed to 0.23 log MAR at last follow up (p=0.15). The most common complication was transient hyphema, seen in 20% of patients. Inflammation needing treatment and hypotony each occurred at a rate of 5.3%. Failure rate at 6 months follow up was 19.0%. Postoperative IOP spikes >30 mm Hg was present in 23.6% and was significantly related to surgery failure (p<0.001). African Americans and patients with pseudoexfoliation glaucoma had a higher rate of surgery failure but it was not statistically significant. Age, gender, preoperative pressure, and number of glaucoma medications were not significantly related to surgery failure.

Discussion
The preliminary results for GATT as a minimally invasive, conjunctival-preserving glaucoma surgery are promising, showing it to be a safe option for patients who are unresponsive or intolerant to glaucoma medications.

Conclusion
GATT is a safe and minimally invasive surgical procedure that fills the gap between medication/laser and trabeculectomy.

Reference
Purpose/Relevance

To determine performance and safety outcomes of 1, 2, or 3 stents implanted in eyes with open-angle glaucoma (OAG) not controlled on ocular hypotensive medication.

Methods

This prospective, randomized study enrolled subjects with OAG and preoperative IOP of 18-30 mmHg on topical ocular hypotensive medication and 22-38 mmHg after medication washout. Subjects were randomized to undergo standalone surgery with 1, 2, or 3 trabecular micro-bypass stents. The protocol specified postoperative use of ocular hypotensive medications for elevated IOP and/or optic nerve changes. We assessed IOP, medications, slit-lamp findings, gonioscopy findings, fundus/optic nerve evaluation, BCVA, and adverse events.

Results

As reported previously, the preoperative mean medicated IOP was 19.8 ±1.3 mmHg (mean ±SD) in the 1-stent group (n=38), 20.1 ±1.6 mmHg in the 2-stent group (n=41), and 20.4 ±1.8 mmHg in the 3-stent group (n=40). Through 42 months postoperative, mean medicated IOP was 15.7 mmHg or lower at all visits in the 1-stent group, 15.7 mmHg or lower at all visits in the 2-stent group, and 14.3 mmHg or lower at all visits in the 3-stent group. At 42 months, medication had been added in 8 eyes (of 16) in the 1-stent group, 0 eyes (of 19) in the 2-stent group, and 0 eyes (of 17) in the 3-stent group. There were no intraoperative complications and no serious adverse events throughout the follow-up period.

Discussion

Standalone MIGS implantation of 1, 2, and 3 trabecular micro-bypass stents demonstrated a clear titration effect in eyes with OAG. The low incidence of complications and adverse events demonstrates the long-term safety of this approach.

Conclusion

One, two, or three micro-bypass stents can be implanted safely to achieve customized IOP control in eyes with OAG on ocular hypotensive medication.

References

28 Gonioscopy-Assisted Transluminal Trabeculotomy (GATT) in the Treatment of Angle Recession-Related Glaucoma

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Purpose/Relevance
Angle recession related glaucoma occurs commonly following blunt ocular trauma. Traditional glaucoma surgery like the trabeculectomy or tube shunt, bypassing the trabecular meshwork and collector channel system is the more common approach to treatment of elevated IOP in this group of patients. The purpose of the study is to determine the effectiveness of an angle based procedure, specifically the GATT, in reducing intraocular pressure in patients with angle recession related glaucoma.

Methods
A retrospective review of charts of patients with angle recession who had the gonioscopy assisted transluminal trabeculotomy (GATT) for control of intraocular pressure (IOP) between January 2012 and October 2016 was performed. Patient demographics including race, age, sex as well as pre and post operative intraocular pressure (IOP) and number of medications was collected and analysed. Follow up on patients ranged from 3 months to 4 years. Patients with a history of active uveitis were excluded from the study. Failure was defined as the need for additional glaucoma surgery for pressure control.

Results
A total of 13 eyes of patients that had a GATT procedure between January 2012 and October 2016 was reviewed. There was one female and twelve males, with 53.8% caucasian, 38.4% african american and 7.6% hispanic. The age range was between 23 and 69 years (Mean 49.8yrs). The average preoperative IOP was 31mmHg (Range 14-50mmHg) and with the mean number of medications used preoperatively being 3. Mean intraocular pressures at 1 month, 3 months and 6 months were 18mmHg (1.07 meds), 14.2mmHg (0.6 meds) and 12.12mmHg (0.42 meds) respectively. Of the 6 patients with one year follow up, 2 patients required additional surgery at one year. Mean IOP at one year for all the 6 patients was 20.2mm Hg (1.6 meds).

Discussion
GATT procedure was succesful in reducing intraocular pressure as well as mean number of medication in patients with angle recession glaucoma. There was a significant reduction in IOP from baseline at last preoperative visit compared to post operative visit at 1, 3, 6 and 12 months respectively. IOP reduction was sustained for up to 4 years in patients with long term follow-up.

Conclusion
Gonioscopy assisted transluminal trabeculotomy is a viable option for reduction of intraocular pressure elevation in patients with angle recession glaucoma. Careful consideration of timing of surgery as well as the patient’s race are important factors that may affect success. Longer term follow-up would be required to determine long term success of the procedure in this patient subgroup.

References
2. Outcomes of Gonioscopy-assisted Transluminal Trabeculotomy (GATT) in Eyes With Prior Incisional Glaucoma Surgery. Grover, Davinder S. MD, MPH, Godfrey, David G. MD; Smith, Oluwatosin MD; Shi, Wei MS; Feuer, William J. MS; Fellman, Ronald L. MD. Published Ahead-of-Print.
Purpose/Relevance
To evaluate the efficacy and safety of supraciliary micro-stent implantation in conjunction with cataract surgery, including changes in intraocular pressure (IOP) and rate of adverse events (AEs) at 3-year follow-up.

Methods
Multi-center, open-label registry. Of 470 subjects, 245 had combined procedure with cataract surgery. These subjects were further divided into those with uncontrolled baseline (BL) IOP (≥21 mm Hg; Cohort 1) or controlled BL IOP (<21 mm Hg, Cohort 2). Investigators performed standard cataract surgery followed by implantation of a supraciliary micro-stent (CyPass Micro-Stent, Alcon, Inc., Fort Worth, TX) into the supraciliary space through the phaco incision.

Results
In Cohort 1 (n=93), mean IOP decreased from 25.3±5.2 mm Hg at BL to 17.2±3.8 mm Hg at 36 months (M). IOP reduction for Cohort 1 was 34%, 30%, and 28% at M12, M24, and M36, respectively. In Cohort 2 (N=152), mean IOP was 16.4±2.7 at BL and 16.5±3.3 at M36. Four AEs occurred in >3% of subjects, including CyPass obstruction (9.0%), retinal complication (4.1%), best-corrected visual acuity loss ≥2 lines (3.7%), and anterior chamber inflammation (3.3%). No major AEs such as choroidal hemorrhage occurred in the 36-month follow-up period.

Discussion
The supraciliary micro-stent reduced IOP in eyes with BL IOP ≥21 mm Hg and sustained control of IOP in eyes with BL IOP <21 mm Hg at 3 years postoperatively. The 3-year safety profile of the supraciliary micro-stent gives long-term evidence of its compatibility with cataract surgery, and the potential to employ this therapy earlier in the glaucoma treatment paradigm as compared with conventional surgery.

Conclusion
The supraciliary micro-stent reduced IOP in eyes with uncontrolled IOP at BL and maintained IOP in eyes with controlled IOP at BL. The supraciliary micro-stent implantation is a minimally invasive intervention for the treatment of open-angle glaucoma that spares the conjunctiva, sclera, and trabecular meshwork, and can be performed in conjunction with cataract surgery.

References
Effect of Ologen Collagen Matrix (OCM) on Prevention of the Hypertensive Phase Following Ahmed Valve Implantation (AGV-FP7)

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Purpose/Relevance
OCM has been shown to modulate post-operative wound scarring. We hypothesized that OCM would decrease encapsulation around the plate, reducing intraocular pressure (IOP) spikes during the post-operative hypertensive phase. We examined the effect of the OCM on IOP in the early post-operative period and at 1 year.

Methods
A prospective, randomized, controlled study was performed on eyes with refractory glaucoma requiring an AGV-FP7. Eyes with IOP >20 mmHg on maximally tolerated glaucoma medications were included. In study eyes, a round 12 mm x 1 mm OCM implant was placed flush over the AGV-FP7 plate immediately before conjunctival closure. Student’s t-test was used for statistical analysis.

Results
Of 18 patients enrolled, 11 were randomized to receive OCM. Mean preoperative IOP was 31.4±9.8 mmHg and 39.1±9.8 mmHg in the study and control group (p=0.12). At post-operative months 1, 2, and 3, the IOP was lower in the Ologen-treated eyes compared to controls (p <0.05 at months 1 and 2; p = 0.06 at month 3, Table I). One study eye developed transient hypotony for 2 months. At 1 year, mean IOP was comparable between both groups (17.5±3.5 mmHg and 18.8±6.2 mmHg for control [range 15-20 mmHg] and study eyes [range 9-26 mmHg], p=0.8) on a similar number of medications.

Discussion
Wound healing mediates the hypertensive phase following AGV-FP7 surgery. OCM, a biodegradable extracellular matrix, acts as a scaffold to assist in guiding fibroblasts in scar formation. Data from this ongoing study show that eyes with OCM placed over the AGV-FP7 plate demonstrated a statistically significant lowering of IOP during the early postoperative period compared to controls.

Conclusion
Intraoperative implantation of Ologen collagen matrix over an AGV-FP7 can prevent a post-operative hypertensive phase with no long-term adverse effects.

References
31 Prognostic Factors for Lowering IOP in POAG Patients After Combined Supraciliary Microstenting-Phaco Cataract Surgery: COMPASS RCT

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Purpose/Relevance
To evaluate prognostic factors for reducing intraocular pressure (IOP) by supraciliary microstenting (CyPass) in primary open-angle glaucoma (POAG) patients having cataract surgery.

Methods
Primary open-angle glaucoma subjects qualified for cataract surgery (N=505) had unmedicated IOP measurements prior to randomization to supraciliary microstenting + phaco (Microstent, n=374) or phaco (Control, n=131) groups (3:1 ratio). The primary effectiveness endpoint was defined as the proportion of eyes with ≥20% decrease in mean unmedicated diurnal intraocular pressure (DIOP) from baseline (BL) to Month 24. Subgroup analyses were performed to examine the effect of age, gender, race, baseline IOP group, and number of ocular hypotensive medications used at screening on the primary endpoint. Safety endpoints included rate of postoperative adverse events (AEs).

Results
Microstent and Control group respective BL mean unmedicated IOPs were 24.4±2.77 and 24.5±2.95 mm Hg. In the Microstent group, 72.5% of patients (compared to 58.0% of patients in the Control group) had ≥20% decrease in unmedicated DIOP from baseline (P=.003). None of the BL variables examined reached statistical significance (Gail-Simon test, p > 0.15) indicating that age, gender, race, baseline IOP group, and number of hypotensive medications used at screening did not affect the primary effectiveness endpoint. In the Microstent group, the mean number of ocular hypotensive medications was 1.4 (standard deviation [SD] 0.9) at BL and 0.2 (SD 0.6) at the 24-month visit. In the Control group, the mean number of ocular hypotensive medications was 1.3 (SD 1.0) at BL and 0.6 (SD 0.8) at the 24-month visit. Postoperative AEs were reported in 39.3% of patients in the Microstent group and in 35.9% of the Control group.

Discussion
Subgroup analyses were performed to assess the impact of BL unmedicated DIOP, the number of glaucoma medications at screening, gender, race, or age on effectiveness. No interactions were found to be significant for any subgroup.

Conclusion
Supraciliary microstenting at the time of cataract surgery reduced IOP in multiple subgroups vs controls.

Reference
32 Multiple iStent Implantation Following Glaucoma Filtering Procedure(s) in Patients with Refractory Glaucoma

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¹ University of Alberta

Purpose/Relevance
To describe the effect of implantation of multiple iStents on intraocular pressure (IOP) in patients with refractory glaucoma after trabeculectomy procedures and/or glaucoma shunts.

Methods
A retrospective case series of patients with refractory glaucoma undergoing iStent implantation was performed and data was retrieved from electronic health records in Edmonton, Alberta, and Toronto, Ontario. Eleven patients, 6 males and 5 females, met the inclusion and exclusion criteria with a minimum one-year follow-up. Collected data included patient demographics, pre- and post-operative IOP, number of pre- and post-operative topical medications, and complications.

Results
Of the 11 study patients, 7 had primary open-angle glaucoma, 2 had pseudoexfoliative glaucoma, 1 had mixed-mechanism glaucoma and 1 had pigmentary glaucoma. The average age was 72.5 years (standard deviation (SD) = 8.75 years). The average pre-operative IOP was 18.55mmHg (SD = 6.11mmHg) with an average of 3.00 ocular hypertensive drops (SD = 1.21 drops). There was a reduction in post-op IOP to 14.6mmHg (SD = 4.64mmHg; \( p=0.0541 \)) at one year and a corresponding decrease in ocular hypertensive drops with 1.91 ocular hypertensive drops (SD = 1.31 drops; \( p=0.0279 \)) at one year. Four patients had post-operative IOP reductions greater than 6mmHg at one year while another four patients showed minimal IOP reduction, defined by a 2mmHg decrease or less, at one year.

Discussion
Current indications for minimally-invasive glaucoma surgery (MIGS) include initial surgery for glaucoma of mild to moderate severity.¹ The potential role for MIGS in cases of refractory glaucoma was investigated, and a reduction in post-operative IOP at one year was identified along with a statistically significant reduction in the number of topical medications in patients undergoing iStent implantation following prior trabeculectomy and/or glaucoma shunt surgery. A case study by Roelofs et al.² showed similar results. The post-operative IOP reduction failed to reach statistical significance, likely as a result of an underpowered study with a small sample size. Future validation in a larger study is required to further elucidate this finding.

Conclusion
Although success rates may not be as high as in primary surgery, implantation of multiple micro-bypass stents following trabeculectomy procedures or shunt tubes, combined with medication, could be considered as an alternate method to decreased IOP in some refractory glaucoma patients, when other surgical techniques may be contraindicated.

References
33 Retrospective Review of Ciliary Sulcus Versus Anterior Chamber Glaucoma Tube Shunt Implantation

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1 University of Pittsburgh

Purpose/Relevance
To evaluate outcomes of ciliary sulcus (CS) versus anterior chamber (AC) placement of glaucoma drainage implant (GDI).

Methods
This study is a nonrandomized, retrospective case series evaluating the outcomes of glaucoma drainage implantation in ciliary sulcus versus anterior chamber in a university setting between 2010 and 2014. Either an Ahmed or Baerveldt was implanted at the discretion of the surgeon, as a standalone procedure or combined with phacoemulsification and lens implantation. Patients included in the study were 18 years of age or older with primary or secondary open-angle glaucoma, closed angle glaucoma or neovascular glaucoma with a minimum of 6 months follow-up. Data on postoperative intraocular pressure (IOP), number of hypotensive medications, and surgical complications were recorded.

Results
Of the implanted devices, 72 (37%) were placed in the AC and 119 (63%) in the CS. Baseline IOP for the AC group was 25.7 ± 12.1 mmHg with significant (p<0.05) postoperative reduction in IOP at post-operative day 1, week 1, months 1, 3, 6, 9, and 12 (18.0, 16.0, 17.6, 15.8, 15.1, 15.4, 14.3 mmHg respectively). Baseline IOP for the CS group was 25.6 ± 10.9 mmHg with significant postoperative reduction in IOP at post-operative week 1, months 1, 3, 6, 9, and 12 (18.3, 18.4, 15.3, 14.2, 15.0, 14.5 mmHg respectively). There was no significant difference in IOP reduction from baseline between the two groups at any of the time points over the first 12 months after surgery, except post-operative day 1. On average, the AC group was on 3.2 ± 1.0 hypotensive medications at baseline, while the CS group was on 2.7 ± 1.3. Post-operatively, the number of medications decreased in both groups at each time point, with 2.4 ± 1.4 and 1.7 ± 1.5 medications in the AC and CS groups respectively at 12 months follow-up. The most common early (<1 month) surgical complications were hypotony (IOP<5 mmHg), followed closely in the AC group by choroidal effusions and IOP spike >30 mmHg in the CS group. The most common late surgical complications were hypotony and inflammation for both groups.

Discussion
IOP control achieved after tube placement in the ciliary sulcus is comparable to that in the anterior chamber without additional significant surgical complications.

Conclusion
Insertion of glaucoma drainage implants in the ciliary sulcus is a safe and effective method for IOP control. Further randomized control studies would be warranted to determine the optimal tube shunt placement.

References
Multicenter, Single-Arm, Open-Label Study of the Intraocular Pressure-Lowering Effect and Complications of an Ab Interno Implanted Gelatin Stent in Refractory Glaucoma: Twelve-Month Results

DAVINDER GROVER1, William Flynn, Kent Bashford, Richard Lewis, Yi-Jing Duh, Barbara Niksch

1 Glaucoma Associates of Texas

Purpose/Relevance
To establish the 12-month intraocular pressure (IOP)-lowering effect and assess complications of a minimally invasive subconjunctival gelatin stent (XEN®45, Allergan plc) in refractory glaucoma.

Methods
Patients aged ≥45 years with refractory glaucoma (prior failed filtering or cilioablative procedures, or having a condition where experience indicates a filtering procedure would provide unsatisfactory results [eg, neovascular, congenital or infantile glaucomas], or uncontrolled IOP on maximum-tolerated medical therapy), IOP ≥20 and ≤35 mmHg, Shaffer angle grade ≥3, and visual field mean deviation ≤-3 dB were eligible. Patients underwent implantation of one 6 mm gel stent via an ab interno method. Performance outcomes: subjects (%) achieving ≥20% IOP reduction from baseline treated with the same or fewer hypotensives, and mean IOP decrease from baseline at 12 months. Procedure-related complications and ocular adverse events (AEs) were assessed.

Results
Of 65 subjects implanted (intent-to-treat population), 83% completed 12 months. At baseline, 85% of subjects had failed prior glaucoma procedures, 85% were using ≥3 hypotensives, and mean medicated IOP (standard deviation [SD]) was 25.1 (3.7) mmHg. At month 12, 76% of subjects achieved ≥20% IOP reduction from baseline on the same or fewer medications; mean IOP reduction (standard error) was 6.4 (1.1) mmHg (95% CI: 4.2, 8.7). Observed data yielded similar results (n=61). Mean medication use (SD) decreased from 3.5 (1.0) at baseline (N=65) to 1.7 (1.5) at month 12 (n=52). At 12 months, 13.8% of subjects required secondary surgery (failures). There were no intraoperative complications. Ocular AEs (Table 1) were mostly mild to moderate resolving without sequelae. Of 16 hypotony cases, 13 occurred on day 1 and resolved by day 27; none required surgical intervention. Of 21 subjects who required needling, 17 experienced no complications.

Discussion
Although 85% of subjects had a history of failure with a prior glaucoma procedure, the gel stent lowered IOP and reduced medication use. Thus, minimally invasive glaucoma surgeries, specifically the ab interno placement of the gel stent, offer an alternative for lowering IOP.1

Conclusion
The study showed the gel stent to be beneficial in refractory glaucomas as it lowers IOP and decreases topical hypotensive dependence without raising new/unexpected safety concerns.

Reference

Table 1. Ocular AEs reported by ≥2 subjects at ≤12 months (excluding post-explantation reports)

<table>
<thead>
<tr>
<th>Events, n (%)</th>
<th>Subjects (N=65)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypotony (IOP &lt;6 mmHg)</td>
<td>16 (24.6)*</td>
</tr>
<tr>
<td>IOP increase ≥10 mmHg from baseline</td>
<td>14 (21.5)</td>
</tr>
<tr>
<td>BCVA loss of ≥2 lines from baseline</td>
<td></td>
</tr>
<tr>
<td>≤30 days</td>
<td>10 (15.4)</td>
</tr>
<tr>
<td>&gt;30 days</td>
<td>7 (10.8)</td>
</tr>
<tr>
<td>At 12 months (persistent)</td>
<td>4 (6.2)</td>
</tr>
<tr>
<td>Wound leak / dehiscence</td>
<td>6 (9.2)</td>
</tr>
<tr>
<td>Anterior chamber tap</td>
<td>6 (9.2)</td>
</tr>
<tr>
<td>Explant with secondary glaucoma procedure</td>
<td>6 (9.2)</td>
</tr>
<tr>
<td>Wound repair</td>
<td>5 (7.7)</td>
</tr>
<tr>
<td>Hyphema (≥2 mm in height –layered- at any time)</td>
<td>3 (4.6)</td>
</tr>
<tr>
<td>YAG capsulotomy</td>
<td>3 (4.6)</td>
</tr>
<tr>
<td>Choroidal effusion (extending posterior to equator, without blood)</td>
<td>2 (3.1)</td>
</tr>
<tr>
<td>Anterior chamber cells</td>
<td>2 (3.1)</td>
</tr>
</tbody>
</table>

*None associated with choroidal effusions, suprachoroidal hemorrhage, or maculopathy.
Purpose/Relevance
To evaluate clinical and safety parameters through 25 months following treatment with 2 second-generation trabecular micro-bypass stents and a postoperative topical prostaglandin in subjects with open-angle glaucoma (OAG) on 2 preoperative medications.

Methods
This prospective study by the Micro-Invasive Glaucoma Surgery (MIGS) Study Group enrolled 53 subjects with OAG that were treated with 2 ocular hypotensive medications and had preoperative intraocular pressure (IOP) of 18-30 mmHg on medication and 22-38 mmHg after medication washout. Qualified subjects underwent standalone implantation of 2 second-generation trabecular bypass stents, then started topical travoprost on postoperative Day 1. Additional glaucoma medication was started in cases of disease progression and/or elevated IOP. Follow-up is continuing, including documentation of IOP, medications, BCVA, adverse events, and findings from slit-lamp, gonioscopy, and fundus/optic nerve examinations.

Results
Of the 53 subjects enrolled in the study, all have completed 18 months of follow-up and 27 have completed the 25-month post-washout visit. As reported previously,\(^1\) preoperative medicated IOP was 19.7 ±1.5 mmHg (mean ±SD) and post-washout IOP was 24.9 ±1.1 mmHg. Postoperatively, mean medicated IOP remained at or below 13.0 mmHg at all visits through 24 months, and mean unmedicated IOP at 25 months (after 1-month medication washout) was 16.2 mmHg. One subject to date has been placed on a second medication for changes in optic nerve appearance (IOP was 18 mmHg). Favorable safety was observed, including stable best corrected visual acuity (BCVA), cup-to-disc ratio, and visual field mean deviation, and minimal to no adverse events.

Discussion
In this cohort of eyes with OAG on 2 preoperative glaucoma medications, implantation of 2 second-generation trabecular stents combined with a postoperative topical prostaglandin produced clinically meaningful IOP and medication reduction and favorable safety through 25 months.

Conclusion
These study data suggest that MIGS with second-generation trabecular micro-bypass stents and postoperative prostaglandin produces safe and long-lasting IOP and medication reduction in eyes with OAG on 2 medications.

Reference
1. Greenwood M, Berdahl J. Trabecular Bypass Second Generation Stents and One Postoperative Prostaglandin to Treat Patients with Open Angle Glaucoma Not Controlled on Two Preoperative Medications. Poster presented at 2016 Annual Meeting of the American Glaucoma Society, May March 3-6, 2016; Fort Lauderdale, FL.
36 Surgical Management of Traumatic Glaucoma After Open Globe Injury

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Purpose/Relevance
To report outcomes of glaucoma surgery in eyes with traumatic secondary glaucoma after open globe injury (OGI).

Methods
Single-center retrospective chart review. We identified all patients with open globe injuries treated at Massachusetts Eye and Ear between 1/1/1999 and 12/31/2014 who developed traumatic glaucoma requiring surgical intervention (glaucoma drainage implant, GDI, or trans-scleral cyclophotocoagulation, CPC). Patients with a history of glaucoma surgery prior to OGI or with post-operative follow-up periods <1 year were excluded. Primary outcome measure was success at 1 year, defined as a 20% intraocular pressure (IOP) reduction and IOP 21 mmHg or less. Statistical analysis was performed using SPSS v. 23 (IBM Corp., Armonk NY).

Results
Among 26 patients identified, 17 patients (17 eyes) met inclusion criteria. Thirteen (76.5%) were male. Median age at OGI presentation was 40 years (range, 2-75). Median follow-up interval was 5.0 years (range, 1.2-11). OGI mechanism was blunt trauma in 8 (47.1%) cases, confined to Zone I in 8 (47.1%) cases. Hyphema was present in all cases. Median interval between OGI and glaucoma surgery was 1.1 years (range, 1 month to 8.9 years); 16 patients (94.1%) underwent retina surgery between OGI and glaucoma surgery with a median number of 2 interval incisional surgeries (range, 0-4). Median pre-operative visual acuity was count fingers (range, 20/30 to LP). Average pre-operative IOP was 30.1 mmHg (SD 7.8, range 20-46) with an average of 4.3 ocular antihypertensive agents (SD 0.8, range 3.0-6.0). Eleven patients (64.7%) underwent Ahmed valve implantation; 4 (23.5%) received Baerveldt devices; 2 (1.2%) underwent CPC. At 1-year follow-up, the success rate of patients who received GDI was 100%, with a mean IOP decrease from 29.6 mmHg to 14.1 mmHg (P <0.0001) and a mean decrease in topical antihypertensive agents from 4.3 to 1.5 (P < 0.0001). Neither patient who received CPC met criteria for success at 1 year; repeated treatments were required to achieve a success rate of 50% at most recent follow-up.

Discussion
Traumatic glaucoma following OGI is primarily due to impaired aqueous outflow. GDI was the most commonly used intervention for traumatic glaucoma and was associated with a high success rate. CPC was reserved for cases with extensive conjunctival or intraocular scarring in patients who carried a worse overall visual prognosis.

Conclusion
GDI may be considered a first line surgical therapy for most patients with traumatic glaucoma following OGI. Long-term follow-up is advisable among patients with history of OGI, in whom traumatic glaucoma may develop years after the injury.

References
37  Stand-alone Implantation of 2 Trabecular Micro-Bypass Stents in Eyes with OAF on Preoperative Medication: Outcomes Through 42 Months

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¹ Dean McGee Eye Institute

Purpose/Relevance
Five-year study to assess outcomes of micro-invasive glaucoma surgery (MIGS) with standalone implantation of two trabecular micro-bypass stents in patients with open-angle glaucoma (OAG).

Methods
Prospective nonrandomized study enrolling subjects with OAG on 1 preoperative ocular hypotensive medication and with preoperative intraocular pressure (IOP) of 18-30 mmHg on medication and 22-38 mmHg after medication washout. Eligible subjects underwent implantation of 2 trabecular micro-bypass stents. Postoperatively, glaucoma medication was prescribed for elevated IOP and/or glaucomatous changes in optic nerve appearance. Postoperative data included IOP and medication burden, as well as best-corrected visual acuity (BCVA), adverse events, and findings from slit-lamp, gonioscopy, and fundus/optic nerve examinations.

Results
Of 39 qualified subjects enrolled in this study, 29 subjects have completed 42 months of follow-up. Preoperative medicated IOP was 20.6 ±2.0 mmHg, and post-washout IOP was 24.1 ±1.4 mmHg.¹ Through 42 months postoperative, mean IOP was 15.2 mmHg or lower at all visits; at the 42-month visit, mean IOP was 14.8 mmHg. A small hyphema was reported in 1 subject at Week 1 (this was reported previously);¹ otherwise a high safety profile was observed through 42 months.

Discussion
A clinically meaningful decrease in IOP was achieved through 42 months after MIGS with 2 trabecular micro-bypass stents in subjects with OAG taking 1 preoperative ocular hypotensive medication. A high safety profile was observed.

Conclusion
These study findings demonstrate safe and long-lasting IOP control in phakic and pseudophakic eyes with OAG following implantation with 2 trabecular micro-bypass stents.

Reference
Five-Year Outcomes in the Phacotrabeculectomy Versus Trabeculectomy (PVT) Study

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Purpose/Relevance
To compare the long-term efficacy, safety and visual recovery of combined two-site phacoemulsification and trabeculectomy surgery versus trabeculectomy surgery alone.

Methods
Retrospective cohort study of 140 eyes of 140 patients who underwent trabeculectomy with mitomycin C (0.3 mg/ml for 2 minutes) with or without phacoemulsification between 2009-2014. 74 patients were in the Phacotrabeculectomy group and 66 patients were in the trabeculectomy group, with mean follow-up duration of 34.3±18.5 months. Failure criteria 1 was defined by IOP of ≤ 5 mmHg on two consecutive visits, and failure criteria 2 is defined by IOP of ≥ 21 mmHg on two consecutive visits with or without medication.

Results
The mean IOP prior to surgery was 17.7±4.6 mm Hg in the phacotrabeculectomy group versus 22.8±9.4 mm Hg in the trabeculectomy group (P=0.0001). The number of glaucoma medications prior to surgery was 3.47±0.07 in the phacotrabeculectomy group and 3.66 ±0.07 in the trabeculectomy group (P=0.0776). The mean IOP at 1 year, 2 years, 3 years, 4 years, 5 years was 12.6±4.1, 12.9±4.6, 12.0±4.2, 14.3±4.3 and 13.3±2.3 in the phacotrabeculectomy group and 11.9±4.7, 12.3±4.6, 12.7±4.9, 12.0±5.8, and 12.4±5.5 in the trabeculectomy group, respectively (P=0.906, repeated measures ANOVA). The mean number of postoperative medications on the last visit was 1.68±0.172 in the phacotrabeculectomy group and 1.65±0.187 in the trabeculectomy group (P=0.8956). Kaplan-Meier survive curve was not significantly different between the two groups during follow-up (p=0.333, p=0.392 for failure criterion 1 and 2, respectively) (Figures 1-2). Cox proportional hazards models adjusting for confounders (pre-op IOP, disease severity, lens status, and number of post-op interventions) remained non-significant when comparing the groups (P=0.189 and 0.450, respectively). Recovery time of vision after surgery in the phacotrabeculectomy group was faster than the trabeculectomy group (2.17±0.8 months sooner on average, P=0.011).

Discussion
Phacotrabeculectomy had a similar success rate compared to trabeculectomy surgery alone during a 5-year follow-up period in the PVT Study. Similar post-op IOP and use of supplemental medical therapy at 5 years were found in both procedures. However, phacotrabeculectomy had earlier visual recovery when compared with trabeculectomy.

Conclusion
Phacotrabeculectomy and trabeculectomy are equally effective in lowering IOP. However, phacotrabeculectomy has a quicker vision recovery.
References


Phaco Combined with Primary Ahmed Glaucoma Valve Versus Primary Trabeculectomy

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1 Asociación para Evitar la Ceguera

Purpose/Relevance

Compare the results of combined glaucoma surgery: phaco and primary trabeculectomy versus phaco and primary Ahmed Glaucoma Valve.

Methods

Retrospective and comparative study of patients which underwent combined cataract and glaucoma surgery. Group 1: phaco and primary trabeculectomy (conventional 2 ports technique with a fornix based approach). Group 2: phaco and primary Ahmed Glaucoma Valve (FP7 silicone plate model with a patchless technique, performing a scleral tunnel for tube insertion with a 23 gauge needle). We selected files of patients that had at least one year follow up, and surgery performed by staff surgeons of the Glaucoma department of the Asociacion para Evitar la Ceguera en Mexico. We excluded from our analysis patients with inflammatory or neovascular glaucoma, previous glaucoma surgery and those whose surgeries were performed by fellows or residents.

Results

We analyzed a total of 110 eyes from 110 patients, 38 (34%) for the trabeculectomy group, and 72 (65%) for the Ahmed Glaucoma Valve group; mean age 69.9 years; diagnosis: 38% POAG, 38% PCAG, 15% PEX, other 9%. Visual acuity improved in both groups without significant differences between both groups. Reduction of postoperative intraocular pressure was significant in both groups. In the trabeculectomy group, preoperative IOP was 16.68 mmHg and final IOP was 13.94 mmHg (p <0.0001) at a three year follow up. In the Ahmed Glaucoma Valve group, preoperative IOP was 18.64 mmHg and final IOP was 13.35 mmHg (p <0.0001) at a three year follow up; with no significant differences between both groups (p 0.42). The number of anti glaucoma medications decreased postoperatively in both groups: in trabeculectomy group from 3.07 average medications before surgery to 1.72 average medications at three year follow-up (p <0.0001) and in the Ahmed Glaucoma Valve group from 3.33 average medications before surgery to 2.0 average medications at three year follow up (p <0.0001), with no significant differences between groups (p 0.43). Reoperations were needed in 21 patients from the trabeculectomy group (55%) and in 15 patients from the Ahmed Glaucoma Valve group (19.2%). Both groups had similar rate of complications—7.8% for the trabeculectomy group and 6.9% for the Ahmed Glaucoma Valve group—and these were more related to the cataract surgery than to the filtering surgery. Survival rate was higher in the Ahmed Glaucoma Valve group but with no significant difference from the trabeculectomy group.

Discussion

Data analysis from this study demonstrates that both techniques have similar success rates, improving visual acuity, reducing intraocular pressure, similar rates of complications, and less anti glaucoma medications needed. Nevertheless we outline that even that there were no statistical significative differences between survival rates for both groups, we did see clinically and a tendency for a higher survival rate in the Ahmed Glaucoma Valve group. Reoperations were needed more frequently in the trabeculectomy group more than doubling the need for reoperations in the Ahmed Glaucoma Valve group.

Conclusion

In this study we can state that both combined surgeries are effective for treating patients with cataract and glaucoma, obtaining a similar reduction of intraocular pressure between groups, a decrease in the number of anti glaucoma drugs needed and with a low complications rate. The Ahmed Glaucoma Valve group demonstrated a clinically higher survival rate that was not statistically significant from the trabeculectomy group. Reoperations percentage was the most important difference between groups, being much more frequent in the trabeculectomy group than in the Ahmed Glaucoma Valve group. This fact should be considered when choosing surgical techniques in patients in need of combined glaucoma and cataract surgery. The conclusions of this study are limited to the number of patients analyzed and to the fact that it is a retrospective study. A higher number of patients should be evaluated preferably in a prospective study to better support these findings.

References

40  Ab Interno Canaloplasty (ABiC) for Mild-to-Moderate Primary Open-Angle Glaucoma: Twelve-Month Follow-up

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¹ University of Texas HSC San Antonio

Purpose/Relevance
To evaluate the safety and efficacy of ab interno canaloplasty (ABiC), a novel minimally-invasive glaucoma treatment, over a 12-month period.

Methods
This non-randomized single-center study investigated 64 eyes experiencing mild-to-moderate primary open-angle (POAG) glaucoma, that underwent ABiC surgery to reduce intraocular pressure (IOP) and glaucoma medication dependence. Patients were followed up over a 12-month period (with 38 eyes available for the 12-month follow-up). Primary endpoints included mean IOP and median number of glaucoma medications, while secondary endpoints included intraoperative and postoperative complications and secondary interventions.

Results
At the 12-month follow-up, there was a significant reduction in IOP from baseline, from 18.4 ± 6.2 mm Hg to 14.1 ± 2.6 mm Hg (p=0.0007). Additionally, the median number of medications reduced from 3 (range 0-4) at baseline to 0.5 (range 0-3) at 12 months (p<0.001). Eyes that underwent standalone ABiC achieved a mean IOP reduction from 20.5 ± 7.5 mm Hg at baseline to 15.1 ± 3.3 mm Hg at 12 months, and a median reduction in medications from 3 (range 1-4) to 1 (range 0-3).

Discussion
In this study, the ABiC procedure successfully reduced IOP and medication dependency in patients with mild-to-moderate POAG, maintaining general stability across the postoperative visits. The procedure also proved safe, with no serious adverse events.

Conclusion
ABiC is a safe and effective procedure that can be utilized to successfully manage mild-to-moderate POAG, and can also be used in adjunct to cataract surgery. Further study is required to investigate longer-term stability.

Reference
41 Twelve-Month Follow-up of Ab Interno Canaloplasty as a Stand-alone Treatment and in Adjunct to Cataract Surgery for the Treatment of Primary Open-Angle Glaucoma

MAHMOUD KHAIMI
Dean McGee Eye Institute

Purpose/Relevance
To compare the efficacy and safety of ab-interno canaloplasty (ABiC) in reducing intraocular pressure (IOP) and glaucoma medication dependence in patients undergoing a standalone procedure and patients undergoing a combined procedure of cataract surgery and ABiC.

ABiC is based on the same dilation principles of Canaloplasty but via an ab-interno approach. Ab-externo Canaloplasty employs placement of a 9-0 or 10-0 Prolene tensioning suture. ABiC does not require a tensioning suture. A review of three-year data by Lewis et al found that 360° viscodilation alone, i.e., ab-externo Canaloplasty without a suture, successfully lowered IOP.¹

Methods
This non-randomized, single-center study included adult patients experiencing mild-to-moderate primary open-angle glaucoma (POAG). Patients underwent either a standalone ABiC procedure or a combined procedure of phacoemulsification and ABiC (phaco-ABiC), and were analyzed within the respective subsets. All eyes were analyzed for mean IOP and median number of glaucoma medications over a 12-month period. Intra- and post-operative complications were also assessed.

Results
There was a significant reduction in mean IOP in all eyes (n=86) from 19.0 ± 5.5 mm Hg at baseline to 15.3 ± 3.7 mm Hg at 12 months (p<0.001), with significant reduction achieved from 1 day (p<0.001). The median number of medications showed significant reduction across all visits from 2 (range 0-4) at baseline to 0 (range 0-2) at 12 months (p<0.001). In the standalone ABiC subset (n=29), mean IOP reduced significantly across visits, from 21.0 ± 5.8 mm Hg at baseline to 15.9 ± 3.4 mm Hg at 12 months (p<0.001). Median medications also reduced significantly across visits from 2 (range 1-4) at baseline to 1 (range 0-2) at 12 months. Significant reduction was achieved as early as 1 day postoperatively, but slowly increased from 1 month onwards. In the phaco-ABiC subset (n=57), mean IOP reduced from 17.9 ± 5.2 mm Hg at baseline to 15.0 ± 3.8 mm Hg at 12 months, stabilizing from 1 month onwards (p=0.002). The median number of medications reduced from 2 (range 0-4) to 0 (range 0-2) across visits when compared to baseline. No serious adverse events were reported intra- or postoperatively.

Discussion
Statistically significant reduction in IOP and number of medications was achieved across both subsets as early as 1 day postoperatively. This significance was retained across the 12-month follow-up period.

Conclusion
This 12-month clinical update on ABiC as both a standalone procedure and an adjunct to cataract surgery demonstrates stable efficacy and safety of both variants of the procedure in managing patients with mild-to-moderate POAG.

Reference
42 Long-term Clinical Outcomes of Supra-Tenons Placement of Baerveldt Glaucoma Drainage Devices

GEORGE TANAKA
California Pacific Medical Center

Purpose/Relevance
Glaucoma drainage devices (GDDs) have traditionally been implanted underneath Tenon’s capsule. Fibrotic encapsulation of the bleb around a GDD originates from Tenon’s capsule and leads to surgical failure. Supra-Tenon’s capsule implantation of GDDs to prevent plate encapsulation has been described with the Molteno 3,1,2 and Ahmed3 GDDs. In this study we compare the longer-term outcomes of supra-Tenon’s capsule placement of the 250mm² Baerveldt GDD to traditional infra-Tenon’s capsule placement of the 350mm² Baerveldt GDD in the surgical treatment of refractory adult glaucoma patients.

Methods
Twenty-two eyes with supra-Tenon’s placement (ST group) and 24 eyes with infra-Tenon’s placement (IT group) of a Baerveldt GDD by a single surgeon (GHT) were identified and retrospectively reviewed. Surgical success was defined as a post-operative IOP at last follow up of ≤ 18 mmHg and a 25% reduction from baseline IOP with or without additional medical therapy. Surgical failure was defined as IOP greater than 18 mmHg, less than 6 mm Hg, loss of light perception vision, or a return to the operating room for a second glaucoma procedure.

Results
No statistically significant differences in baseline characteristics of age, gender, number of prior surgeries, pre-operative IOP, number of medications, and best-corrected visual acuity (BCVA) were found between the two treatment groups (Table 1). Following surgery BCVA was 0.6 logMAR in ST group and 0.8 logMAR in IT group (p=0.36). The mean post-operative IOP was 11.5 mmHg in the ST group and 13.9 mmHg in the IT group (p=0.08). Number of medications were 1.3 in the ST group and 2.6 in the IT group (p=0.008). Surgical success was achieved in 95.5% of patients in the ST group and 62.5% in the IT group (p=0.006). Average length of follow-up was 20.8 months in the ST group and 25.3 months in the IT group (p=0.20). In a subset of 13 African-American patients (8 in ST group, 5 in IT group) surgical success was achieved in 100% in the ST group and 40% in the IT group (p=0.009).

Discussion
The results of this study suggest that supra-Tenon’s placement of the smaller 250 mm² Baerveldt implant can provide IOP control which is equivalent to the larger 350 mm² Baerveldt implant placed underneath Tenon’s capsule. This level of IOP control can be achieved over the long term with fewer glaucoma medications. In a small subset of African-American patients supra-Tenons placement resulted in a high rate of surgical success.

Conclusion
Supra-Tenons implantation of the Baerveldt GDD should be considered in patients at high risk of surgical failure with traditional infra-Tenon’s placement. A prospective, randomized trial comparing supra- and infra-Tenons implantation is warranted.
Table 1. Baseline Characteristics.

<table>
<thead>
<tr>
<th></th>
<th>ST group (N=22)</th>
<th>IT group (N=24)</th>
<th>P-value (t-test)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (Median)</td>
<td>Mean (Median)</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>71.9 (72)</td>
<td>68.6 (72)</td>
<td>0.36</td>
</tr>
<tr>
<td>Male to Female Ratio (M:F)</td>
<td>1.2:1</td>
<td>1.18:1</td>
<td>0.98</td>
</tr>
<tr>
<td>No. Prior Surgeries</td>
<td>1.3 (1)</td>
<td>1.7 (2)</td>
<td>0.20</td>
</tr>
<tr>
<td>Pre-operative IOP (mmHg)</td>
<td>23.6 (22)</td>
<td>23.7 (22.5)</td>
<td>0.98</td>
</tr>
<tr>
<td>No. IOP Lowering Medications</td>
<td>3.6 (4)</td>
<td>3.4 (4)</td>
<td>0.57</td>
</tr>
<tr>
<td>BCVA (logMAR)</td>
<td>0.4 (0.3)</td>
<td>0.5 (0.3)</td>
<td>0.29</td>
</tr>
</tbody>
</table>

ST= Supra-Tenon’s, IT = Infra-Tenon’s, IOP = intraocular pressure, BCVA = best corrected visual acuity

Table 2. Post-operative results.

<table>
<thead>
<tr>
<th></th>
<th>ST group (N=22)</th>
<th>IT group (N=24)</th>
<th>P-value (t-test)</th>
<th>P-value Chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (Median)</td>
<td>Mean (Median)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOP (mmHg)</td>
<td>11.5 (11)</td>
<td>13.9 (14)</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td>No. IOP Lowering Medications</td>
<td>1.3 (1)</td>
<td>2.6 (3)</td>
<td>0.008*</td>
<td></td>
</tr>
<tr>
<td>BCVA (logMAR)</td>
<td>0.6 (0.4)</td>
<td>0.8 (0.4)</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>Success (IOP≤18 and decr 25%)</td>
<td>21 (95.5%)</td>
<td>15 (62.5%)</td>
<td>0.006*</td>
<td></td>
</tr>
<tr>
<td>Failure = IOP &gt;18, IOP &lt;6, second glaucoma procedure, loss of light perception vision</td>
<td>2 (9.1%)</td>
<td>5 (20.8%)</td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td>Revision</td>
<td>5 (22.7%)</td>
<td>4 (16.7%)</td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>Second Glaucoma Procedure</td>
<td>2 (9.1%)</td>
<td>4 (16.7%)</td>
<td>0.46</td>
<td></td>
</tr>
<tr>
<td>Follow-up (months)</td>
<td>20.8 (23)</td>
<td>25.3 (25)</td>
<td>0.20</td>
<td></td>
</tr>
</tbody>
</table>

ST= Supra-Tenon’s, IT = Infra-Tenon’s, IOP = intraocular pressure, BCVA = best corrected visual acuity
* denotes statistically significant with p<0.05

References


43 Three-Year Outcomes of Canaloplasty Without Suture Placement for the Treatment of Open-Angle Glaucoma

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Purpose/Relevance
To evaluate 3-year safety and efficacy outcomes achieved among open-angle glaucoma patients who have undergone canaloplasty without suture tensioning to reduce intraocular pressure (IOP) and glaucoma medication dependence.

Methods
A single-center, non-randomized, retrospective chart review involving 33 open-angle glaucoma patients. All underwent a modified version of conventional (ab-externo) canaloplasty without use of a tensioning suture. Inclusion criteria were: primary open-angle glaucoma, pigmentary glaucoma or exfoliative glaucoma. Patients with more than two laser trabeculoplasties, neovascular disease, uveitis, peripheral anterior synchiae, angle recession, and developmental/secondary glaucoma were excluded. Primary endpoints were mean IOP and mean number of anti-glaucoma medications at 1, 3, 6, 12, 18, 24 and 36 months. Surgical and postsurgical complication rates were also assessed.

Results
Statistically significant reductions in both IOP and medication use occurred postoperatively. Specifically, mean IOP fell from 21.4 mmHg at baseline to 15.1 mmHg (p<.001), 13.3 mmHg (p<0.001) and 11.0 mmHg (p<0.006) at 1, 2 and 3 years respectively. The number of medications being used by each patient fell from a mean of 2.2 preoperatively to 1.0 at 1 year (p<0.001), 1.1 at 2 years (p=0.012) and 0.7 at 3 years (p=0.003). The frequency of surgical and postsurgical complications was low, with no serious adverse events recorded.

Discussion
Findings of this single-center clinical trial suggest that canaloplasty without suture placement effectively reduces long-term IOP dependence on anti-glaucoma medications in open-angle glaucoma patients. The safety outcomes achieved following the procedure are also favorable. Overall, the levels of reduction in IOP, in medication dependence, and in the rate of adverse events seen following the procedure are similar to those achieved after conventional ab-externo canaloplasty.

Conclusion
In light of the demonstrated IOP- and medication-dependence reducing efficacy of the procedure, alongside its low rate of adverse events, canaloplasty without suture placement appears to be a good clinical option for open-angle glaucoma patients unmanaged by medication alone.

Reference
Purpose/Relevance
Non-valved glaucoma drainage implants (GDI) require restriction of flow in the early postoperative period to prevent hypotony from excessive outflow prior to encapsulation of the endplate. This can be accomplished by ligating the tube with a 7-0 polyglactin suture, which will generally release between 4 and 6 weeks postoperatively. Control of the intraocular pressure (IOP) in the early postoperative period in the absence of flow into the device is frequently problematic. Numerous techniques have been described. Here, we report on the efficacy and safety of using a 10-0 polyglactin suture to stent a needle fenestration in the tube as a means of controlling the early postoperative IOP after placement of a non-valved Baerveldt GDI.

Methods
The medical records of 86 patients who underwent surgical implantation of a Baerveldt 350-mm² or 250-mm² with tube insertion into the anterior chamber and polyglactin stent placement between 2014 and 2016 were retrospectively reviewed. In all patients, a 10-0 polyglactin suture was used as the stent. A single fenestration was created with the suture needle and a segment of suture, approximately 3mm in length, was left in place to stent the opening. Visual confirmation of aqueous flow through the fenestration and along the stent was obtained in all patients. Early post-operative IOP, visual acuity, number of glaucoma medications and surgical complications were measured.

Results
The mean preoperative IOP was 30.8±9.7 mm Hg. Mean postoperative IOP at day 1 (19.0±12.5 mm Hg), week 1 (16.7±10.0 mm Hg), and month 1 (20.4 ± 10.2 mm Hg) were significantly lower than preoperative IOP, (p <0.01 at all time points). The mean number of glaucoma medications reduced at week 1 and month 1 (p <0.01). Hypotony (IOP < 5 mm Hg) was noted in 7 (8%) patients. None of the patients developed a shallow anterior chamber requiring reformation. Five patients developed choroidal effusion, which resolved with observation, and there were no cases of suprachoroidal hemorrhage.

Discussion
Intraocular pressure control in the immediate postoperative period following implantation of a non-valved GDI with a temporarily occluded tube can be challenging. The use of a suture stent of 10-0 polyglactin in conjunction with fenestration of the tube anterior to the occluding ligature allows for limited aqueous outflow. This allows for some IOP reduction while minimizing the occurrence of hypotony and related complication.

Conclusion
The use of a monofilament 10-0 polyglactin suture to create and stent a single fenestration proximal to the occlusive ligature of Baerveldt tube is effective and safe in controlling IOP in the early postoperative period.

References
45  Ab Externo SIBS Micro-Shunt with MMC
Efficacy and Safety: Early Results from a
Consecutive Prospective Interventional Case Series

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Purpose/Relevance
To evaluate prospectively the efficacy and safety of standalone ab
externo poly(styrene-block-isobutylene-block-styrene) (SIBS)
micro-shunt implantation¹ with MMC, as well as risk factors for
needling and failure in consecutive eyes from July 2015 onwards
in Mississauga, Canada.

Methods
Single-center interventional cohort study. 58 consecutive eyes
in 55 patients were identified who had no prior incisional
glaucoma surgery with more than 1 month of follow-up.
Primary outcome was IOP of 6-17 mm Hg with no glaucoma
medications, secondary outcomes included IOP of 6-14 and
6-21 on no medications, and then the same IOP cutoffs allowing
for medications. The number of needlings, complications, and
reoperations were also recorded. A Cox proportional hazards
model accounting for correlation between eyes was used to assess
risk factors for failure, including demographics, preoperative
vision, previous glaucoma laser, diabetes, glaucoma type, and
glaucoma stage.

Results
At 6 months follow-up, survival analysis yields an 82%
chance of achieving an IOP of 6-17 mm Hg (6 failures, median
follow-up 4.8 months [IQR 2.9-7.1]), 82% chance of 6-14,
and 83% chance of 6-21. Allowing for medications yields
success rates of 88%, 88%, and 90%. Survival analysis yields
an 11% chance of requiring needling (7 needlings in 6 patients).
Two patients had transient hyphemas, 3 patients had anterior
chamber reformations, and 1 patient received a second micro-
shunt implantation.

Discussion
Ab externo SIBS micro-shunt implantation with MMC had high
complete and qualified success rates 6 months post operatively,
comparing favourably to previously published early surgical
success rates with trabeculectomy.² Overall, the procedure was
well tolerated with few adverse events in this early post-operative
period.

Conclusion
Interim results show promising efficacy and safety of an ab
externo SIBS micro-shunt implantation with MMC. Longer
follow-up and larger sample size are required to further
investigate.

References
1. Pinchuk L, Riss I, Batlle JF, Kato YP et al. The use of poly(styrene-
46 Twelve-Month Follow-up of Ab Interno Canaloplasty as a Stand-alone Treatment and as an Adjunct to Cataract Extraction for the Treatment of Glaucoma

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¹ Dean McGee Eye Institute

Purpose/Relevance
To determine the efficacy and safety of ab-interno canaloplasty (ABiC) in reducing intraocular pressure (IOP) and glaucoma medication dependence in patients undergoing a standalone procedure and combined cataract extraction and ABiC (CE-ABiC).

Methods
This non-randomized, retrospective, single academic center study included adult patients with an open angle and mild-to-moderate glaucoma. Patients underwent either standalone ABiC or combined CE-ABiC and were analyzed within the respective subsets. Unlike traditional canaloplasty, ABiC involves ab interno viscodilation of Schlemm’s canal, without using a suture to stent Schlemm’s canal.¹ All eyes were analyzed for mean IOP and mean number of glaucoma medications over a 12-month period. Intra- and postoperative complications were assessed.

Results
There was a significant reduction in mean IOP in all eyes (n=121) from 19.0±5.9 mm Hg at baseline to 14.5±3.7 mm Hg at 12 months (p<0.001), with significant reduction achieved from 1 day (p=0.04). Mean medications reduced significantly at all visits from 2.0±1.1 at baseline to 0.6±0.9 at 12 months (p<0.001). In the standalone ABiC subset (n=32), mean IOP reduced significantly at 12 months, from 20.2±5.9 mm Hg at baseline to 16.3±4.3 mm Hg at 12 months (p=0.004). Mean medications reduced significantly at all visits from 2.3±1.0 at baseline to 0.9±1.0 at 12 months (p<0.001). In the CE-ABiC subset (n=89), mean IOP reduced significantly at all visits from 18.6±5.9 mm Hg at baseline to 13.8±3.2 mm Hg at 12 months (p<0.001). Mean medications reduced significantly at all visits from 1.9±1.2 at baseline to 0.5±0.8 at 12 months (p<0.001). An additional glaucoma procedure was performed after ABiC in 10/121 (8.3%) eyes. No serious adverse events were noted.

Discussion
Significant reduction in IOP and mean medications was achieved overall and in both subsets after a 12-month follow-up period, with reduction as early as 1 day postoperatively.

Conclusion
This study demonstrates efficacy and safety of ABiC as both a standalone procedure and as an adjunct to CE in managing patients with mild-to-moderate glaucoma and an open angle.

Reference
47 Personal Experience with Trabecular Micro-Bypass Stent Implantation During Cataract Surgery in Patients with Prior Medical and/or Surgical Therapy for Glaucoma

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Stiles Eyecare Excellence & Glaucoma Institute PA

Purpose/Relevance
This retrospective series assesses a single surgeon’s long-term clinical and safety outcomes following implantation of one trabecular micro-bypass stent during cataract surgery in patients with OAG and a history of prior surgical and/or medical treatment.

Methods
Patients from the author’s clinical population who had glaucoma and prior medical and/or surgical therapy were implanted with one trabecular stent during cataract surgery. Pre- and postoperative evaluations consisted of intraocular pressure (IOP), medications, cup to disc (CD) ratio, pachymetry, best corrected visual acuity (BCVA), visual field (VF), and adverse events. Here we summarize data through 3 years, and evaluation through 4 years is continuing.

Results
Of 41 qualified subjects (50 eyes) included in this study, 27 subjects (31 eyes) had data through 3 years postoperative. In these patients, mean preoperative IOP was $17.6 \pm 3.8$ mmHg, CD ratio was $0.7 \pm 0.1$, and VF mean deviation was $-5.1 \pm 6.6$ dB. Fourteen of these eyes (45%) were on 2 or more medications, and 14 eyes (45%) had previously undergone glaucoma surgery. Following stent-cataract surgery, mean IOP reduced to $14.8 \pm 3.9$ mmHg at 3 years postoperative, and mean medication burden reduced by 32% (with 45% of eyes on no medications). No intraoperative complications or postoperative device-related events occurred, and to date only 2 patients have had secondary surgical interventions (tube shunt at 1 year and trabeculectomy at 3 years).

Discussion
In eyes with OAG and a history of prior medical and/or surgical glaucoma, implantation of a single trabecular micro-bypass stent during cataract surgery resulted in safe and sustained IOP and medication reduction through up to 3 years.

Conclusion
Data from this single-surgeon series suggest that safe long-term IOP and medication reductions are possible following implantation of a single trabecular micro-bypass stent during cataract surgery in eyes that have undergone previous medical or surgical treatment for glaucoma.

Reference
1. Surgical options of a minimally invasive nature are needed to treat the different disease states of glaucoma.
48 Four-Year Results of Prospective, Randomized Study of 2 Trabecular Micro-Bypass Stents vs. Prostaglandin in Newly Diagnosed Open-Angle Glaucoma

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SUNY Upstate Medical University

Purpose/Relevance
To report long-term intraocular pressure (IOP) reduction and safety following implantation of 2 trabecular micro-bypass stents versus daily travoprost in eyes with newly diagnosed open-angle glaucoma (OAG).

Methods
This was a prospective, randomized, unmasked, long-term evaluation of subjects with OAG naïve to medical or surgical treatment. Preoperative inclusion requirements included IOP between 21 mmHg and 39 mmHg, and cup to disc ratio ≤ 0.9. Subjects were randomized to surgery with two trabecular micro-bypass stents or topical travoprost once daily. Additional topical ocular hypotensive medications were to be prescribed for postoperative IOP > 21 mmHg or concerning optic nerve findings. The primary outcomes included IOP reduction and use of additional medications following initial treatment. Safety measures included complications and adverse events, best corrected visual acuity (BCVA), and optic nerve assessment.

Results
Fifty-four eyes of 54 subjects comprised the 2-stent group, and 47 eyes of 47 subjects comprised the travoprost group. Baseline IOP by Goldmann applanation was 25.5 ± 2.5 mmHg in stent eyes and 25.1 ± 4.6 mmHg in travoprost eyes. Post-treatment IOP was 15.4 mmHg or less in both groups throughout the 3-year follow-up period. At 42 months, mean IOP was 16.2 ± 1.6 mmHg (n=48) in the stent group, with 11 subjects requiring post-treatment medication; and 16.1 ± 1.6 mmHg (n=41) in the travoprost group, with 15 subjects requiring additional medication. As previously reported, 2 intraoperative complications (hyphema and small iridodialysis), both attributed to subject movement during surgery, occurred and resulted in no postoperative ocular sequelae. BCVA and optic nerve parameters were stable over time.

Discussion
In this study of eyes newly diagnosed with OAG naïve to therapy, implantation of two trabecular micro-bypass stents or topical travoprost provided similar reductions in IOP with favorable safety over a 42-month period.

Conclusion
Data from this series suggest long-term IOP reduction and favorable safety can be achieved with two trabecular micro-bypass stents or prostaglandin in eyes with OAG naïve to surgical or medical therapy.

Reference
Purpose/Relevance
The efficacy of selective laser trabeculoplasty (SLT) for IOP control following glaucoma surgery is not well reported. The aim of this study was to investigate the efficacy of SLT treatment in patients with open angle glaucoma (OAG) who could not obtain target intraocular pressure (IOP) through glaucoma surgery.

Methods
This study is a retrospective chart review of all patients (ages 10-96) who underwent SLT at a single center from July 2011 to August 2015. Patients with a diagnosis of primary open angle glaucoma (POAG), pseudoexfoliation syndrome (PEX) or steroid-induced glaucoma who underwent their first SLT were studied. Eyes with OAG that underwent SLT before any surgery were included in the control group.

Patients with OAG who failed to achieve target IOP after glaucoma surgery and received SLT after the surgery were included in experimental group. The primary endpoint was the change in IOP measured from 0-24 months after SLT.

Results
Twenty seven eyes of 27 patients were included in experimental group. POAG, PEX and steroid-induced glaucoma was identified in 18, 8 and 1 eyes respectively. One, 5 and 21 patients underwent tube shunt, trabeculectomy and trabectome respectively. Average decrease in IOP at various time intervals after SLT is shown in figure 1. IOP measured at all intervals after SLT was significantly different from baseline IOP for all OAG patients (p<0.05 for all).

400 eyes of 263 patients with POAG were included in control group. IOP at all intervals after SLT in control group is shown in figure 2.

Discussion
SLT decreased IOP in open angle glaucoma after glaucoma surgery. The results in open angle glaucoma correlate well to previous studies.1

Conclusion
SLT is effective at decreasing IOP in open angle glaucoma, when performed after glaucoma surgery.
Reference

50 Topiramate-Induced Angle Closure Glaucoma: Evaluating and Enhancing Prescriber’s Knowledge of Ocular Side Effects of Topiramate

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¹ Icahn School of Medicine at Mount Sinai

Purpose/Relevance
Many cases of topiramate induced angle closure glaucoma (TiACG) have been highlighted in the literature.¹⁻³ Recognition of TiACG is essential to prompt treatment and optimal visual recovery. Common prescribers of this medication are not ophthalmologists and thus may not be aware of this entity. This study aimed to evaluate topiramate prescribing patterns and knowledge of TiACG among resident physicians in psychiatry and neurology at an academic institution.

Methods
Participants completed a pre-test on this topic. A 30-minute case-based educational intervention on TiACG followed. A post-test and post-survey were administered.

Results
A total of 10 psychiatry and 8 neurology residents participated in the study. Among psychiatry residents, 9/10 prescribed topiramate at least yearly, most commonly for depression and bipolar disorder. Pre-test evaluation indicated none of the psychiatry residents were familiar with the ocular side effects of topiramate nor did any of them obtain relevant ocular history prior to prescribing topiramate. On pre-test, only half knew when TiACG most commonly occurs following initiation of topiramate, and only 20% correctly selected the dosage at which TiACG frequently occurs. After the lecture, 9/10 psychiatry residents responded to these queries correctly.

Five out of 8 neurology residents prescribed topiramate monthly, mostly for migraine and epilepsy, though only 3 residents reported knowledge of its ocular side effects. Three-quarters were unclear about when and at what dosage TiACG presented on pre-test. After the lecture all neurology residents answered these queries correctly.

On post survey, all psychiatry and neurology residents indicated they found the lecture helpful and planned to counsel their patients on TiACG.

Discussion
While neurology and psychiatry residents reported prescribing topiramate, most were unfamiliar with TiACG. Following a brief educational intervention, residents showed an improvement in their understanding of this side effect and found the lecture helpful.

Conclusion
TiACG is a vision-threatening complication that is reversible when managed appropriately. Our study indicated prescribers of topiramate are often unaware of its ocular side effects and thus do not counsel their patients about it. We found that a brief lecture was effective in increasing prescriber’s understanding of the presentation and management of TiACG. Continued efforts are necessary to educate prescribers and thus lead to better patient selection and counseling when prescribing topiramate.

References
51 Aqueous Angiography in Intact Eyes of Living Subjects Shows Novel Aqueous Humor Outflow Patterns

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Purpose/Relevance
To evaluate aqueous humor outflow in intact eyes of living non-human primates (NHP) using aqueous angiography.

Methods
Aqueous angiography was performed in 6 non-human primates. After anesthesia, an anterior chamber (AC) maintainer was placed through a temporal 1 mm side-port wound. Indocyanine green (ICG; 0.4%) or 2.5% fluorescein was introduced (individually or in sequence) into the eye with a gravity-driven constant-pressure system. Aqueous angiography images were obtained with a Spectralis HRA+OCT suspended over the NHP eye using a custom designed surgical boom arm (Heidelberg Engineering). Anterior segment optical coherence tomography (OCT) images were taken comparing angiographically positive and negative regions.

Results
Aqueous angiography positive signal co-localized with episcleral veins as identified by infrared imaging (Fig. 1). Areas with aqueous angiography signal also showed intrascleral lumens using anterior segment OCT. Sequential aqueous angiography in individual eyes with ICG followed by fluorescein showed similar, segmental, and mostly stable patterns (Fig. 2). A pulsatile nature of angiographic AHO was sometimes seen. Aqueous angiographic patterns could also sometimes dynamically change. In some cases, regions without aqueous angiography signal could develop signal. Alternatively, angiographic signal could also suddenly disappear from regions in which angiographic signal was initially documented.

Discussion
Aqueous angiography in intact eyes of living NHPs demonstrated segmental and pulsatile patterns. The ability for angiographic outflow patterns to dynamically shift and move in the intact eye of a living subject was a new discovery.

Conclusion
Real-time imaging of AHO improves our understanding of the eye and may help improve minimally invasive glaucoma surgeries.

References

Figure 1. A) Infrared reflectance image of a NHP right eye shows episcleral veins (black arrows). B) Aqueous Angiography signal from the same eye (white arrows). C) Image overlap shows good correspondence between aqueous angiography signal and episcleral veins.

Figure 2. Aqueous angiography with ICG in the right eye of a living NHP primate shows segmental peri-limbal signal (arrowheads), segmental regions without peri-limbal signal (arrows), and distal signal (asterisks).
52 Imaging of iStent Placement Using UBM and AS-OCT

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Purpose/Relevance
MIGS procedures are quickly becoming a mainstay of therapy for mild-moderate glaucoma. As the most common MIGS procedure performed, studies have shown that compared with cataract extraction alone, iStent performed with phacoemulsification results in significant reduction in the post-operative IOP. There are no studies to our knowledge that have examined the positioning of a successfully implanted iStent (stent in the trabecular meshwork with the opening in Schlemm’s canal). This project provides critical information on the use of iStent. The location of the iStent has been verified by gonioscopy in prior trials1; however, there are times when it is difficult to identify the location of the stent, such as when there is corneal edema, peripheral anterior synechiae, or in a patient that can not tolerate gonioscopy. We are investigating an alternative method to identify its location.

Methods
All patients recruited for the study had undergone combined phacoemulsification and iStent placement within the last 3 years by a single surgeon who has performed over 200 procedures. Patient’s visual acuity (VA) and IOP were be measured. Gonioscopy was performed on all patients to identify the location of the stent. The patient then underwent imaging of the anterior chamber angle with Spectralis AS-OCT (Heidelberg) and UBM (80 MHz by Iscience).

Results
To date, we have examined a total of 8 eyes. The mean pre-operative IOP was 16.38 and mean post-operative IOP was 14.25, which trended toward significance (p = 0.062). Of the 8 eyes, 6 had one IOP lowering medication administered preop and 3 continued to be on one medication after surgery. Six of the 8 iStents were visualized with gonioscopy. Five of the 8 stents were identified with UBM, however we were unable to see the stents with AS-OCT in any of the patients.

Discussion
Proper placement of the iStent is critical for it to effectively lower IOP. If we aim to improve its effect in lowering IOP we must ascertain the optimal placement of the stent. As has been previously shown in an in vitro study of imaging iStents, AS-OCT was not a good imaging modality to properly visualize the stent. This is because only light that is reflected back in the direction of the OCT beam is detected.2 Also if there is intervening tissue between the stent and the beam (which is the case if the stent is placed properly in the angle), the reflected light will be scattered and light reflected from the stent surface will be lost. UBM, on the other hand was a useful modality to identify the stent.

Conclusion
Our preliminary results show promise in the use of UBM as a modality to view stents in the anterior chamber angle in vivo. We plan to continue imaging patients and hope that with better resolution, we will be able to identify a pocket of fluid distal to the stent in Schlemm’s canal and correlate this information with IOP reduction.

References
53 Biometry of Plateau Iris Configuration in Eyes with Open Angles and in Primary Angle Closure Configurations

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1 The University of Michigan, Kellogg Eye Center

Purpose/Relevance

The purpose of this study is to determine the biometry of plateau iris configuration (PIC) in eyes with open angles compared to primary angle closure configurations. Our hypothesis is that PIC is an anatomical risk for developing drug-induced ciliochoroidal effusions1 and ‘in the bag’ uveitis-glaucoma-hyphema (UGH) syndrome.2

Methods

This retrospective chart review was conducted at the University of Michigan and approved by the IRBMED. Subjects, who underwent high resolution ultrasound biomicroscopy (UBM), were identified by diagnosis codes for plateau iris3 or angle closure4 as searched in the electronic Ophthalmic Imaging Software. Age-matched controls, who had open angles, were identified on UBM images. A UBM protocol was established to characterize qualitative and quantitative parameters including anterior chamber depth, degree of angle opening, lens thickness, ciliary body thickness, interplicata distance, sulcus-to-sulcus distance, and typical versus atypical PIC. Measurements were taken from one eye of each subject. Comparison of measurements were analyzed by 1-way ANOVA and post-hoc Tukey HSD.

Results

Table. Biometry measurements (average + standard deviation) in control, PIC and PAC.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Age (years)</th>
<th>ACD (mm)</th>
<th>DAO (degrees)</th>
<th>Lens Thickness (mm)</th>
<th>IP (mm)</th>
<th>STS (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (n=20)</td>
<td>58.7±25.3</td>
<td>3.0±0.6*</td>
<td>34±8.0*</td>
<td>4.0±0.5</td>
<td>10.5±0.8*</td>
<td>11.1±0.7*</td>
</tr>
<tr>
<td>PIC (n=24)</td>
<td>53.5±12.8</td>
<td>2.4±0.5*</td>
<td>19.5±12.9*</td>
<td>4.0±0.4</td>
<td>9.9±0.8</td>
<td>10.5±0.8</td>
</tr>
<tr>
<td>PAC (n=18)</td>
<td>55.3±6.2</td>
<td>2.1±0.3*</td>
<td>6.2±8.6*</td>
<td>4.3±0.5*</td>
<td>9.7±0.9</td>
<td>10.3±1.8</td>
</tr>
</tbody>
</table>

PIC = plateau iris configuration; PAC = primary angle closure; DAO = degree of angle opening; ACD = anterior chamber depth; IP = interplicata distance; STS = sulcus-to-sulcus distance

*p<0.05 via 1-way ANOVA and post-hoc Tukey HSD

Discussion

Our preliminary results show the following observations on biometry. First, as expected the ACD and DAO were progressively and significantly smaller from PIC and PAC compared to controls. Second, PAC cases have thicker lenses than controls and PIC cases. Third, our new observation shows that PIC and PAC cases have significantly smaller IP and STS measurements compared to controls.

Conclusion

The preliminary observations begin to demonstrate differences in biometry between PIC, PAC, and controls. These quantitative measurements may provide us with better tools to advance our understanding of the clinical spectrum of PIC as an anatomical risk for developing drug-induced ciliochoroidal effusions1 and ‘in the bag’ UGH syndrome.2

References

Evaluation of Filtration Blebs by Anterior-Segment OCT After Conventional Trabeculectomy vs. Trabeculectomy with Antifibrotic Agents

1 Asociación para Evitar la Ceguera en Mexico

Purpose/Relevance
To evaluate the anatomical characteristics of filtering blebs in patients after conventional trabeculectomy vs trabeculectomy with antifibrotic agents (Mitomycin C and Collagen-polyvinylpyrrolidone) using anterior-segment optical coherence tomography.

Methods
A cross-sectional, retrospective, observational and descriptive study including patients who underwent either conventional trabeculectomy or trabeculectomy with MMC or collagen-polyvinylpyrrolidone (Ologen). Data recorded for comparison included IOP, and number of glaucoma drugs. OCT anterior segment was used to describe the morphology of all the filtering blebs.

Results
25 eyes were included in this study, 9 (36%) in the TBC + MMC group, 8 (32%) TBC+Ologen group, and 8 (32%) conventional TBC group. The mean age was 64.36 years (SD 16.7). A reduction in IOP of 11.1 mmHg was observed in the group of TBC+MMC, 9.88 mmHg in the group of TBC + CP and 7.13 mmHg in the group of conventional TBC.

We found a reduction in the number of ocular hypotensive drugs in the group of TBC + MMC 2.8, TBC+CP 2.1, and 0.8 in conventional TBC, being clinically significant (p=0.002). In anatomical assessment of the filtration bleb, the wall thickness of the bleb in the group of TBC+ MMC a median thickness of 51 microns was obtained, TBC+CP of 57 microns and conventional TBC 83 microns. The comparative analysis showed a statistical significance between the group of TBC+ MMC vs conventional TBC (p=0.001) and between the group of TBC+CP vs conventional TBC (p=0.021). In the group of TBC+MMC the presence of moderate microcysts was observed in 33.3%, abundant in 66.7%, cavities (subconjunctival lagoons) were formed in 67.7%, no fibrosis areas were observed. In the group of TBC+CP moderate microcysts were observed in 75% and 25% abundant, formation of cavities in 34%, no fibrosis was found and no scleral flap was evident. In the conventional TBC group few microcysts were found in 37.5%, moderate in 37.5% and 25% abundant, subconjunctival fibrosis was found in 37.5%.

Discussion
The presence of thinner walls inside the bleb, abundant/moderate microcysts and subconjunctival cavities were more frequently observed in patients with trabeculectomy plus an antifibrotic agent. These data correlates with the presence of lower intraocular pressure values and a decrease in glaucoma medications.

Conclusion
The use of antifibrotic agents such as MMC and Ologen in conventional trabeculectomy improve bleb survival rate and success.

Reference
Purpose/Relevance
We aim to utilize fractal dimensional analysis in optical coherence tomography angiography (OCTA) in eyes with primary open angle glaucoma (POAG) or normal tension glaucoma (NTG) compared to control patients.

Methods
A retrospective study was performed on 38 eyes with POAG, 26 eyes with NTG, and 28 control eyes. OCTA images were obtained using the RTVue XR Avanti (Optovue Inc., Fremont, CA, USA). Peripapillary scans of 4.5mm x 4.5mm diameter were obtained. Grayscale OCTA images were standardized and binarized using ImageJ (National Institutes of Health, Bethesda, Maryland, USA). Fractal box-counting analyses were performed using Fractalyse (ThéMA, Besançon Cedex, France). Statistical analysis was performed using one-way analysis of variance (ANOVA) with post-hoc Tukey’s multiple comparisons test. Further analyses were also performed on POAG subgroups (early, n=20; moderate, n=4; severe, n=14) and NTG subgroups (early, n=13; moderate, n=7; severe, n=6) based on the Hodapp-Anderson-Parrish Visual Field Severity Score.

Results
Comparison between the control, POAG, and NTG groups demonstrated a significantly lower (P<0.001) fractal dimension (FD) for eyes with POAG (1.554, SD=0.065) and NTG (1.559, SD=0.075) compared to controls (1.619, SD=0.074), but no significant difference in FD between NTG and POAG. Comparison of POAG subgroups demonstrated a significantly lower (P<0.01) FD between controls and moderate POAG (1.486, SD=0.055), and controls and severe POAG (1.544, SD=0.053). No difference was noted between controls and early POAG (1.574, SD=0.066). Comparison of the NTG subgroups demonstrated a significant difference in FD between groups (P=0.03), but post-hoc testing did not identify a pairwise difference in FD between controls and the subgroups with early (1.567, SD=0.074), moderate (1.535, SD=0.075), and severe (1.571, SD=0.083) NTG.

Discussion
The FD in OCTA images of eyes with POAG and NTG is significantly reduced compared to control eyes. Since fractal geometry mirrors the branching in the peripapillary microvasculature, this may correlate with reduced capillary density and provide further insight into pathogenesis of glaucoma. Further studies are required on larger sample sizes and to also investigate changes in FD during the clinical course of disease.

Conclusion
Utilizing fractal dimensional analysis in OCTA imaging has the potential to establish quantitative parameters for peripapillary microvasculature pathology in POAG and NTG.

Reference
56 Comparison of Optic Nerve Evaluation Between Smartphone Ophthalmoscopy and a Standard Mydriatic Fundus Camera

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Purpose/Relevance
In recent years, telemedicine has helped expand glaucoma screening to individuals living in locations with limited access to ophthalmic care1. The widespread use of smartphones along with the use of a novel smartphone camera adapter2 may facilitate glaucoma screening in the primary care setting. In this study, we evaluate the use of a novel smartphone camera adapter to obtain non-mydriatic optic disc photos and grade the vertical cup to disc ratio (VCDR) as compared to standard mydriatic optic disc photos.

Methods
All participants were recruited from a single center. Of the 40 participants, 20 were controls and 20 were known to have glaucoma. Participants underwent an ophthalmic exam including IOP measurement, gonioscopy, optic nerve imaging, and an sdOCT-RNFL. Two optic nerve images were taken for each participant. The first image was a non-mydriatic photo taken with a smartphone camera adapter (D-EYE adapter S.r.l., Padova, Italy; http://www.d-eyecare.com). The second image was a standard mydriatic optic disc photo. For each photo, two masked glaucoma specialists estimated the VCDR and classified the image as glaucomatous or normal.

The kappa statistic was used to assess agreement between smartphone and standard mydriatic disc photos.

Results
All 20 glaucoma patients and 20 controls were accurately classified by the glaucoma specialists using the non-mydriatic smartphone photos. There was no difference in the ability to distinguish glaucoma patients from non-glaucoma patients when using only the non-mydriatic smartphone photos.

Additionally, the difference between the mean VCDR estimated by each technique was not statistically significant.

Discussion
This study demonstrates that a glaucoma specialist can adequately assess optic nerve images obtained using a smartphone camera adapter as compared to standard mydriatic optic disc photos.

Conclusion
This non-mydriatic smartphone camera adapter provides an excellent cost effective method for mass screening patients for the presence of glaucomatous appearing optic nerves.

References
57 Comparison of Optic Nerve Head, Retinal Nerve Fiber Layer and Ganglion Cell Complex Parameters Among American Caucasian and Ethnic Chinese Using Spectral-Domain OCT

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1 University of California, San Francisco

Purpose/Relevance

To compare optic nerve head (ONH), retinal nerve fiber layer (RNFL) and ganglion cell complex (GCC) parameters between American Caucasian and American Chinese.

Methods

This was a prospective cross-sectional study. Normal subjects aged more than 40 years self-identified as being American Caucasian and Chinese were recruited from general ophthalmology clinics. They were evaluated with spectral-domain optical coherence tomography (RTVue-100, Optovue, Fremont, CA). Parameters related to the ONH, RNFL and GCC analysis protocols were acquired. Multivariate linear regression was carried out adjusting for potential confounders.

Results

Data from 81 and 91 subjects were available for American Caucasian and American Chinese subjects, respectively. Mean age was 64.4 (SD 10.7) years. There were 98 (57.0%) females and 74 (43.0%) males. Data on outcomes is shown in detail in Table 1. After adjusting for age, gender, and axial length, Chinese had significantly higher thickness in all RNFL parameters (all p<0.005) except the nasal quadrant (p=0.683). There was no statistically significant difference for any ONH parameters except horizontal cup-to-disc ratio (p=0.012), greater in Chinese. Chinese had higher average, superior and inferior GCC thickness, however, these differences did not reach statistical significance. Caucasians had significantly higher ganglion cell focal loss volume (FLV) (p=0.005).

Discussion

Previously published data suggests that ethnicity may have an influence on RNFL thickness. The present study suggests significantly higher RNFL thickness in Chinese which was independent of age, axial length and ONH parameters. Higher GCC-FLV in normal Caucasians may represent more localized thinning of GCC area. However, this parameter should be interpreted with caution in assessing for a glaucoma diagnosis.

Conclusion

Ethnic differences in RNFL thickness and the ganglion cell complex parameters can be considered in interpreting the OCT data related to a glaucoma diagnosis.

References


<table>
<thead>
<tr>
<th>Parameters</th>
<th>Caucasians</th>
<th>Chinese</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RNFL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Average RNFL (µm)</td>
<td>94.45±10.75</td>
<td>104.58±9.74</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>• Superior RNFL (µm)</td>
<td>94.38±11.59</td>
<td>103.09±10.66</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>• Inferior RNFL (µm)</td>
<td>95.55±11.66</td>
<td>106.06±11.57</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>• Temporal quadrant RNFL (µm)</td>
<td>72.90±11.90</td>
<td>81.12±9.46</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>• Nasal quadrant RNFL (µm)</td>
<td>77.90±13.60</td>
<td>81.13±11.05</td>
<td>0.683</td>
</tr>
<tr>
<td>• Superior quadrant RNFL (µm)</td>
<td>108.67±15.85</td>
<td>119.74±15.31</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>• Inferior quadrant RNFL (µm)</td>
<td>120.31±16.07</td>
<td>136.34±17.84</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>GCC</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Average GCC (µm)</td>
<td>91.01±8.96</td>
<td>92±8.42</td>
<td>0.812</td>
</tr>
<tr>
<td>• Superior GCC (µm)</td>
<td>91.30±9.14</td>
<td>92.35±8.69</td>
<td>0.747</td>
</tr>
<tr>
<td>• Inferior GCC (µm)</td>
<td>90.73±9.38</td>
<td>91.68±8.91</td>
<td>0.893</td>
</tr>
<tr>
<td>• GCC-FLV (%)†</td>
<td>1.07 (0.391-2.893)</td>
<td>0.46 (0.172-1.480)</td>
<td>0.005</td>
</tr>
<tr>
<td>• GCC-GLV (%)†</td>
<td>5.98 (3.203-10.580)</td>
<td>5.34 (2.149-10.053)</td>
<td>0.347</td>
</tr>
</tbody>
</table>

Data presented in mean±SD
†Data presented in median (interquartile range)
*Adjusting for age, gender, and axial length
58 Vessel Density in Glaucoma Patients with Unilateral Visual Field Loss

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Purpose/Relevance
To evaluate optical coherence tomography angiography (OCT-A) vessel density measurements in primary open-angle glaucoma patients with unilateral visual field (VF) loss.

Methods
Thirty-three glaucoma patients with VF defects in one eye (mean VF MD -3.91 ± 3.1 decibels [dB]) and normal VF test results in the other eye (mean VF MD -0.17 ± 0.9dB), and 33 healthy age-matched subjects enrolled in the Diagnostic Innovations in Glaucoma Study (DIGS). All subjects underwent OCT-A imaging using the Angiovue (Optovue, Fremont, CA), spectral domain (SD)-OCT imaging, and standard automated perimetry (SAP). OCT-A retinal vasculature was summarized as a vessel density map, and as vessel density (%), the percentage of vessel area over the total measurement area. For this report, we utilized whole image vessel density (wiVD), the vasculature within retinal nerve fiber layer (RNFL) measured from internal limiting membrane (ILM) to the RNFL posterior boundary over the entire 4.5x4.5mm scan field. Paired t-test was used to compare measurements between both eyes of glaucoma patients, and unpaired t-test was used to compare measurements between affected and unaffected eyes of glaucoma patients with healthy controls. Areas under the receiver operating characteristic (AUROC) curves were used to evaluate the diagnostic accuracy of wiVD, circumpapillary (cpRNFL) thickness, macular ganglion cell complex (mGCC) thickness, and rim area measurement for differentiating between unaffected eyes of glaucoma patients and healthy eyes.

Results
Mean wiVD in unaffected eyes of glaucoma patients (52.0%) was higher than in their fellow affected eyes (48.8%) but lower than in healthy eyes (55.9%; P<0.001). Mean cpRNFL thickness, mGCC thickness, and rim area measurement in unaffected eyes of glaucoma patients (87.5µm, 87.7µm, and 1.0 mm²) were also higher than those measurements in their fellow eyes (76.5µm, 79.5µm, and 0.8 mm²; P<0.001) and lower than in healthy eyes (98.0µm, 94.5µm, and 1.4 mm²; P<0.001). The AUROCs for differentiating unaffected eyes of glaucoma patients from healthy eyes were highest for wiVD (0.84), followed by rim area (0.80), mGCC (0.78) and RNFL (0.77).

Discussion
OCT-A is able to detect microvascular dropouts in fellow eyes of glaucoma patients with unilateral VF loss. The lower vessel density found in the glaucoma eyes suggests that quantitative OCT-A measurements reflect damage to tissues relevant to the pathophysiology of glaucoma. However, the prognostic values of attenuated microvasculature in the fellow eyes of glaucoma patients, as well as the temporal relationship between vascular and structural loss, could be addressed with further longitudinal studies on glaucoma eyes with unilateral VF loss.
Conclusion
Both affected and unaffected eyes of glaucoma patients showed sparser microvascular networks in the peripapillary region compared to healthy eyes. Moreover, wiVD had the highest diagnostic accuracy in differentiating perimetrically unaffected eyes of glaucoma patients from healthy eyes.

References
**59 Disparity Between Structure and Function in Glaucoma**

**YPAUL GOLDENMERRY**, Munsif Alsalem, Nishitha Reddy, Xilong Li, Beverley Adams-Huet, Karanjit Kooner

1 UT Southwestern Medical Center

**Purpose/Relevance**

To study correlation between structural damage assessed by OCT and functional damage based on visual field (VF) loss (mild, moderate and severe) in primary open-angle glaucoma (POAG).

**Methods**

In an IRB approved retrospective study, 109 glaucoma suspects (Group A) and 269 patients with POAG (mild, moderate or severe; Groups B-D, respectively) were studied (756 eyes). Collected data included: age, race, gender, systemic diseases, glaucoma meds, CCT, IOP, VF, surgeries, detailed Heidelberg SD-OCT scanning parameters: global and sectoral optic nerve fiber (NFL), macular thickness, as well as asymmetry analysis and extended depth imaging values. Tests for linear trends over groups A-D were made with mixed-effects models to account for correction between the two eyes of the same subject.

**Results**

OCT values correlated well with VF damage. However, based on internal normative database, global peripapillary NFL thickness values were abnormal in 20% of Group A subjects, and were normal in 44%, 33% and 7% respectively of Group B, C and D subjects. (Refer to table)

**Discussion**

OCT results suggest that 20% of subjects in Group A may have preperimetric glaucoma and need close scrutiny. Similarly, 44%, 33% and 7% of patients in Group B-D may also need to be reclassified and reevaluated for other causes of VF defects besides glaucoma. Peripapillary NFL, macular, macular NFL, ganglion cell layer and inner plexiform layer thickness all support clinical diagnosis and provide reliable quantitative data.

**Conclusion**

Our study has shown that 7% to 44% of patients may exhibit disparity between structure and functional loss in glaucoma which needs to be addressed. However, substantive and objective information provided by OCT may be incorporated to strengthen clinical classification and management of glaucoma.

**References**


<table>
<thead>
<tr>
<th>Thickness, µ</th>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
<th>Group D</th>
<th>p trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peripapillary NFL</td>
<td>90.0±11.7</td>
<td>79.2±13.7</td>
<td>74.2±17.8</td>
<td>55.2±15.7</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Macular</td>
<td>265.3±22.8</td>
<td>259.1±22.6</td>
<td>257.2±23.7</td>
<td>252.4±26.2</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Macular NFL</td>
<td>11.9±2.6</td>
<td>11.0±2.7</td>
<td>10.4±3.2</td>
<td>9.5±4.8</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Ganglion cell</td>
<td>13.7±4.0</td>
<td>12.4±3.7</td>
<td>12.0±4.1</td>
<td>10.5±4.4</td>
<td>&lt;.0001</td>
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<tr>
<td>Inner plexiform layer</td>
<td>19.7±3.5</td>
<td>18.2±3.2</td>
<td>19.6±14.4</td>
<td>16.5±3.5</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Asymmetry analysis</td>
<td>279.9±16.7</td>
<td>273.19±14.3</td>
<td>268±16.8</td>
<td>259.08±15.7</td>
<td>&lt;.0001</td>
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</tbody>
</table>
Using Image Registration and Averaging to Improve Radial Peripapillary Capillary Visualization on OCT Angiography: Implications for Glaucoma Diagnosis

SARWAR SALIM1, Erika Phillips, Brian Krawitz, Reena Garg, Shelley Mo1, Lawrence Geyman, Eleni Efstathiadis, Joseph Carroll, Richard Rosen, Toco Chui

1 Medical College of Wisconsin

Purpose/Relevance

Loss of radial peripapillary capillaries (RPC) has been reported in glaucoma,1,2 but their role in the pathogenesis of glaucoma is still poorly understood. In order to decipher this relationship, accurate quantification of RPC on available imaging modalities is needed. We analyzed the effect of registration and averaging of optical coherence tomography angiography (OCTA) images on image quality as well as vascular metrics.

Methods

Six healthy and two glaucomatous eyes with evidence of visual field loss were imaged with a commercial OCTA system (AngioVue, Optovue, Inc.). For each eye, ten 10x10° optic disc scans were obtained. On a superficial slab extending from the vitreous to 50 µm below the internal limiting membrane, five 2x2° regions of interest (ROI) located 1° from the edge of the disc were analyzed. Rigid registration and averaging of each 2-10 frames were achieved using ImageJ and custom software. Signal-to-noise ratio (SNR) and capillary density were calculated for the single-frame and each averaged ROI from the healthy eyes. In the glaucomatous eyes, capillary density was calculated on the 10-frame averaged OCTAs and compared to their most recent 24-2 SITA standard visual fields.

Results

SNR increased by 36-48% in the ROIs when comparing single-frame and 10-frame averaged, with the change plateauing at around 5-7 frames. In general, capillary density increased by 5-10%, with the changes plateauing at around 3-4 frames. Qualitatively, capillaries appeared increasingly more uniform with increasing numbers of averaged frames. In the eyes with glaucoma, the ROIs with lower capillary density compared to healthy eyes appear to correlate with regions of visual field defect (Fig 1).

Discussion

Our results indicate that image registration and averaging improves both image quality and capillary density measurements. Improvement in image quality allows for more accurate segmentation of these vascular images and thus more reliable data. Combined with regional ROI analysis, OCTA image averaging can provide a powerful tool to detect and study the focal progression of glaucoma.

Conclusion

Registration and averaging improve image quality, providing more accurate capillary density data. This technique will allow for better qualitative and quantitative evaluations of RPC, with potential clinical applications in glaucoma.

References


Fig 1: Comparison of averaged OCTAs and visual fields with total deviation. OCTA_0169 shows diffuse loss of RPC (A1) correlating with diffuse visual field deficits (A2 & A3). JC_10897 shows loss of RPC superior to the optic disc (arrow) correlating with an inferior arcuate visual field defect (B2 & B3).
Is Macular Pucker Associated with More Severe Glaucoma?

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Purpose/Relevance
Both macular pucker (MP) and glaucoma affect the elderly and impact visual function. Data suggests that both conditions may be associated with inflammatory mediators and glial proliferation. This study investigates the possible relationship between MP and glaucoma severity.

Methods
The records of all patients undergoing vitrectomy and membrane peel for MP from 2010 to 2016 at Columbia University Medical Center were reviewed. Inclusion criteria required a preoperative diagnosis of bilateral primary open angle glaucoma and severe unilateral MP that distorted the macula anatomically. Patients with uveitis, history of intraocular surgery other than uncomplicated cataract extraction, or coexisting optic nerve and other macular pathologies were excluded. For inclusion, patients must have had automated perimetry program 24-2 and Cirrus OCT optic disc cube 200x200 scans within 12 months of surgery. Two glaucoma specialists masked to the presence of MP independently evaluated disc photographs and assessed the relative degree of optic nerve cupping between eyes. Inter-eye comparisons between optic nerve parameters (Cirrus disc rim area, average cup to disc ratio, vertical cup to disc ratio), visual field index (VFI), and mean deviation (MD) were made using the Wilcoxon matched pairs signed-rank tests.

Results
Eight subjects were enrolled. The mean patient age was 72 yrs and 62.5% were women. All were European-derived. The two specialists independently agreed on the glaucoma asymmetry for all cases; in 7/8 cases the MP occurred in the eye with the worse glaucoma. The eye with MP had statistically significantly lower VFI (80.9 vs 93.0 %, p = 0.01) and higher average cup to disc ratio (0.78 vs 0.71, p = 0.04). The rim area between the two eyes approached statistical significance (0.79 vs 0.97, p = 0.06) as did the mean deviation (-7.2 dB vs -4.3 dB, p=0.10).

Discussion
This pilot study explores a potential association between MP and glaucoma severity, which had not been examined previously. The two share similarities in theories of pathogenesis including reactive gliosis and inappropriate cytokine activation. Our data suggests that in eyes with unilateral MP and glaucoma, MP is associated with more severe glaucoma. While one may suspect the visual field data could be confounded by the presence of MP, the optic nerve parameters should remain relatively unaffected.

Conclusion
In eyes with unilateral MP and glaucoma, MP occurs more commonly in the eye with worse glaucomatous disease.

References
62 Risk Factors, Lamina Cribrosa, and Choroid in Glaucoma

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1 UT Southwestern Medical Center

Purpose/Relevance
To understand correlations between glaucoma risk factors (family history, age, gender, central corneal thickness) and lamina cribrosa thickness and peripapillary choroidal thickness in primary-open angle glaucoma.

Methods
In an IRB-approved retrospective study, 109 glaucoma suspects (295 eyes, Group A) and 269 patients (452 eyes) with POAG (mild, moderate or severe; Groups B-D) were selected. Data collected included: age, race, gender, systemic diseases, BMI, family history, glaucoma meds, CCT, IOP, visual fields, surgeries, detailed Heidelberg SD-OCT scanning parameters: Bruch’s membrane opening (BMO), LCT, lamina cribrosa depth (LCD), cup depth (CD), cup width (CW), minimal rim width temporal (MRWT) and nasal (MRWN), peripapillary choroidal thickness (PCT), and choroidal area (CA). Tests for linear trends over groups A-D were made with mixed-effects models to account for correction between the two eyes of the same subject; results are shown as mean±SD. Mixed-effects multivariable regression models were used to evaluate predictors for PCT.

Results
Structural values of various variables are shown in Table 1, and except for LCT, respect clinical classification. Glaucoma severity, age, African-American (AA) race, and family history of glaucoma both unadjusted and controlling for covariates were associated with PCT (Table 2). No significant predictors were found for LCT.

Discussion
OCT provided clinically relevant information, and except for LCT, all structural components measured by OCT supported the clinical diagnosis of glaucoma. PCT has an important role in optic nerve vascular supply and was related to VF damage, age, and family history of glaucoma.

Conclusion
In this study, peripapillary choroidal thickness was associated with age, family history, and visual field damage in glaucoma. Lamina cribrosa thickness was unaffected by any known risk factors for glaucoma.

References

Table 1: Structural values of various variables

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Group A (N=295)</th>
<th>Group B (N=185)</th>
<th>Group C (N=109)</th>
<th>Group D (N=158)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCT</td>
<td>541.6±45.7</td>
<td>537.4±39.1</td>
<td>531.5±37.1</td>
<td>525.9±33.7</td>
<td>.002</td>
</tr>
<tr>
<td>MRWT</td>
<td>156.7±41.7</td>
<td>142.0±41.1</td>
<td>128.6±38.7</td>
<td>123.8±54.9</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>MRWN</td>
<td>251.0±73.6</td>
<td>227.1±62.5</td>
<td>205.9±61.4</td>
<td>156.9±74.1</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>LCT</td>
<td>173.0±30.7</td>
<td>172.2±28.0</td>
<td>165.4±26.2</td>
<td>166.4±29.4</td>
<td>0.27</td>
</tr>
<tr>
<td>LCD</td>
<td>466.0±122.9</td>
<td>456.2±144.1</td>
<td>521.3±148.1</td>
<td>513.5±190.1</td>
<td>.017</td>
</tr>
<tr>
<td>CD</td>
<td>358.8±168.8</td>
<td>352.9±166.7</td>
<td>444.2±178.4</td>
<td>424.0±232.2</td>
<td>.007</td>
</tr>
<tr>
<td>CW</td>
<td>886.6±306.6</td>
<td>910.3±341.5</td>
<td>987.1±303.5</td>
<td>1074.5±408.4</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>PCT</td>
<td>143.1±32.1</td>
<td>133.9±28.4</td>
<td>138.5±34.1</td>
<td>130.8±30.9</td>
<td>.036</td>
</tr>
</tbody>
</table>

Table 2. Regression analysis for PCT.

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Univariable model beta-coefficient (95% CI)</th>
<th>p</th>
<th>Multivariable model beta-coefficient (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group (D vs A)</td>
<td>-11 (-18, -3)</td>
<td>.008</td>
<td>-10 (-18, -2)</td>
<td>.01</td>
</tr>
<tr>
<td>Age, y</td>
<td>-0.5 (-0.8, -0.2)</td>
<td>.002</td>
<td>-0.5 (-0.9, -0.2)</td>
<td>.003</td>
</tr>
<tr>
<td>Gender (M vs F)</td>
<td>0.7 (-6.4, 7.7)</td>
<td>.85</td>
<td>-0.3 (-7.2, 6.6)</td>
<td>.93</td>
</tr>
<tr>
<td>Race (AA vs others)</td>
<td>7.6 (5.5, 14.8)</td>
<td>.04</td>
<td>6.7 (-0.6, 14.0)</td>
<td>.07</td>
</tr>
<tr>
<td>Family history of glaucoma</td>
<td>-11 (-18, -3)</td>
<td>.001</td>
<td>-10 (-18, -3)</td>
<td>.009</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>-0.3 (-0.8, 0.3)</td>
<td>.37</td>
<td>-0.4 (-1, 0.2)</td>
<td>.22</td>
</tr>
</tbody>
</table>
Purpose/Relevance
Impaired optic nerve blood flow may play a significant role in the development and progression of open angle glaucoma. Prior work has focused on the relationship between glaucoma and bulk blood flow or blood velocity, which has certain limitations in determining the metabolic activity and oxygenation of a given capillary bed. Erythrocyte Mediated Angiography (EMA) is a novel technique that permits direct visualization of ICG-labelled ghost erythrocytes in vivo, to study ocular blood flow. Prior work in Non-Human Primates (NHP) shows that NHPs with experimentally induced glaucoma show impaired vasomotion which manifests as proportionally fewer paused erythrocytes. EMA may prove to be a more sensitive marker of ocular blood flow than prior methodologies, and could potentially become a biomarker for development and progression of the disease. We present preliminary data on the safety and efficacy of this technique for assessment of erythrocyte pausing in the optic nerve head of glaucoma patients and healthy controls.

Methods
Glaucoma patients were recruited from glaucoma clinic and healthy controls from optometry clinic. EMA was performed using a Heidelberg HRA 2 Scanning Laser Ophthalmoscope (Heidelberg Engineering, Heidelberg Germany). Twelve to fifteen second angiograms of the optic disc of each individual were then graded to assess the presence and degree of erythrocyte pausing in the optic disc.

Results
Twenty-one eyes of twelve patients underwent Erythrocyte Mediated Angiography, 6 with diagnoses of glaucoma or glaucoma suspect and 6 normal controls. This was followed by conventional liquid ICG Angiography. One patient had a syncopal event associated with the conventional ICG angiography, but otherwise tolerated EMA without complication. Image quality was too poor in two eyes to determine if there was erythrocyte pausing in the optic nerve head. 17 of the remaining 19 eyes showed evidence of erythrocyte pausing in the optic nerve head (Figure 1, Figure 2).

Discussion
Vasomotion is the periodic pausing of erythrocytes in the capillaries. Impairment of vasomotion is thought to play a role in the pathogenesis of diabetic macular edema and other retinal vascular diseases. This is the first time that this physiologic phenomenon has been identified in the human optic nerve head in both patients with glaucoma and controls.

Conclusion
Erythrocyte Mediated ICG Angiography is a novel technique that can be used to assess erythrocyte dynamics directly in the optic nerve head. Further recruitment is required to determine the difference in erythrocyte dynamics between glaucoma patients and controls.
References


64  Arcade Retinal Nerve Fiber Layer (rNFL) Volume Acquired with an 88-µM Cut-Off Performs Better to Detect Glaucoma Than Standard rNFL Quadrant Thickness

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Purpose/Relevance
To evaluate cut-off values which provide the best diagnostic accuracy to detect glaucoma using arcade retinal nerve fiber layer (arcade rNFL) volume analysis of optic nerve spectral domain OCT (SD-OCT) images.

Methods
Cirrus SD-OCT 6x6 mm optic nerve scans of one eye from 50 glaucoma (25 early, 11 moderate, and 14 severe) and 98 healthy subjects from previous studies were included.¹ ² ³ 3D volumetric reconstruction of the peripapillary rNFL from each scan was obtained from Zeiss. We measured volume of the rNFL superficial to a series of cut-offs, i.e. arcade rNFL, using Image J software (NIH). Twenty-two cut-offs ranging from 45-108 µm were applied yielding 22 measurements of superior (S), inferior (I), and average (Avg) arcade rNFL for each subject. Area under the ROC curve (AUC) for S-, I-, and Avg- arcade rNFL volume for each cut-off was calculated and compared to the corresponding AUCs of the S, I, and Avg rNFL thickness from standard quadrant analysis of the same images. Results were validated using a separate cohort of 60 early glaucoma subjects. Statistical analysis to compare AUCs was performed; p<0.05 was considered significant.³

Results
The AUCs ranged from 0.963 to 0.979, 0.959 to 0.983, and 0.986 to 0.994, for volume S, I, and Avg arcade rNFL, respectively. The best AUCs were observed when thickness cut-offs between 78 and 108 µm were applied, peaking around 88 µm. Using the 88µm cut-off, the AUCs for S-arcade (0.978), I-arcade rNFL (0.982), and Avg-arcade rNFL (0.994) volume were greater than standard S quadrant (0.959), I quadrant (0.967), and average (0.976) rNFL thickness. The 88µm cut-off performed similarly well in a subgroup AUC analysis of control vs. early glaucoma or severe glaucoma. Superiority of arcade rNFL volume over rNFL quadrant thickness was validated in a separate early glaucoma cohort; AUCs using the 88 µm cut-off were greater for I-arcade rNFL vs. I rNFL (0.962 vs. 0.926, p=0.04) and avg-arcade rNFL vs. average rNFL (0.965 vs. 0.932, p=0.03), and similar between S-arcade rNFL and S rNFL (0.922 vs. 0.920, p=0.89).

Discussion
Arcade rNFL volume analysis improves the ability of SD-OCT to discriminate normal from glaucoma in the same set of images compared to standard rNFL quadrant analysis. A thickness cut-off around 88µm is best for detection of glaucoma regardless of severity.

Conclusion
Analysis of arcade rNFL volume using an 88µm cut-off has greater diagnostic accuracy than quadrant rNFL thickness for detecting glaucoma.

References
65 Ability to Detect Glaucoma Progression Using Retinal Nerve Fiber Layer (rNFL) Parameters

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Purpose/Relevance
To compare the ability of different rNFL parameters to detect glaucoma progression in a longitudinal cohort using Kaplan-Meyer survival curves.

Methods
Both eyes from 40 glaucoma and 20 healthy controls from the Pittsburgh Imaging Technology Trial (PITT) were included in the study; inclusion/exclusion criteria were previously described.¹ Cirrus OCT optic nerve scans were acquired every 6 months; rim area (RA), average and vertical cup:disc ratio (CDR and VCDR, respectively), and superior, inferior, nasal, and temporal quadrant rNFL thickness (S rNFL, I rNFL, N rNFL and T rNFL, respectively) were recorded. A progression event was defined as a drop from baseline in 2 consecutive visits that exceeded tolerance limits of variability of each parameter.² Median time to progression and number of events were recorded. From Kaplan-Meyer survival curves, glaucoma progression relative to control was compared using the Log-rank (Mantel-Cox) test, and different OCT parameters were compared using a paired-sample Cox regression test. P<0.01 was considered significant.

Results
Baseline age (mean ± standard deviation) was 60.0 ± 6.6 years in control and 71.4 ± 8.3 years in glaucoma, baseline VFMD was 0.15 ± 1.0 dB in control and -4.70 ± 5.4 dB in glaucoma, and follow up time was 38.7 ± 9.0 months in control and 69.0 ± 12.4 in glaucoma. Kaplan-Meyer survival curves for CDR, VCDR, N rNFL, and T rNFL in glaucoma were not significantly different than control (Figure 1). Kaplan-Meyer survival curves for RA, and S, I, and average rNFL had significantly greater decay than control (Figure 1; p= 0.002, 0.01, 0.005, and 0.01, respectively). Median time to glaucoma progression was shortest (2.5 months) and the number of events was greatest (39) for I rNFL. Detection of progression was significantly quicker with I rNFL compared to S rNFL or RA (p=0.01 for both).

Discussion
The previously reported tolerance limits of variability can be applied to detect interval change in glaucoma.² Using these tolerance limits, RA, S, I, and average rNFL are useful parameters to detect glaucoma progression using OCT. Out of these parameters, I rNFL appears to detect glaucoma progression quicker and with greater frequency.

Conclusion
Structural thinning that exceeds tolerance limits of variability of OCT imaging are suggestive of glaucoma progression. Out of all the rNFL parameters, inferior rNFL quadrant is most likely to detect progression.

References
Figure 1. Kaplan-Meier survival curves of probability of progression using different OCT parameters. Log-rank (Mantel-Cox) test P values are shown.
Optic Disc Perfusion Using OCT-Based Microangiography Before and After Intravitreal Anti-VEGF Injections

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Purpose/Relevance
Intravitreal anti-vascular endothelial growth factor (anti-VEGF) injections are often associated with a transient elevation in intraocular pressure (IOP) allowing a unique opportunity to study the eye under different IOP conditions. Elevations in IOP have been shown to decrease optic nerve head (ONH) perfusion in animal models as seen on optical coherence tomography-based microangiography (OMAG). We used OMAG to evaluate ONH perfusion immediately following intravitreal anti-VEGF injections during this temporary IOP elevation.

Methods
Patients who were scheduled to receive anti-VEGF injections were recruited from UW Eye Institute retina clinics. Pre- and immediate post-injection IOP and OMAG images were taken and measurements were compared including flux, vessel density and normalized flux.

Results
Eighteen eyes from 18 patients were enrolled. Mean age (± SD) was 65 ± 14 years and 6 were female. Most patients (13/18) were being treated for diabetic macular edema. None had glaucoma. Mean pre-injection IOP was 16.6 ± 4.7 mmHg, which increased to a mean of 40.3 ± 13.0 mmHg immediately post-injection (p<0.0001). No significant change was observed in flux, vessel density or normalized flux when comparing the OMAG pre- and post-injection images (p=0.28, 0.09 and 0.31, respectively, paired t-test).

Discussion
Millions of patients currently receive intravitreal anti-VEGF injections, which are often associated with temporary IOP elevations. ONH perfusion depends on ocular perfusion pressure, which is decreased with elevated IOP. We therefore sought to evaluate ONH perfusion using OMAG to assess for decreased perfusion following intravitreal injection. No significant difference was observed in any of the OMAG parameters though IOP increased significantly. This suggests that in the non-glaucomatous eye, sufficient auto-regulation exists to maintain ONH perfusion in spite of large increases in IOP.

Conclusion
Following an anti-VEGF injection, mean IOP increased significantly while OMAG imaging of the optic nerve did not demonstrate a significant change in ONH perfusion parameters.

References
Quantification and Structural Correlations of Peripapillary Microvasculature Defects in the Retinal Nerve Fiber Layer in Glaucoma by OCT Angiography

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1 USC Roski Eye Institute

Purpose/Relevance
We aimed to quantify microvascular defects from manually segmented optical coherence tomography angiography (OCTA) nerve head images in normal and mild, moderate, and severe primary open angle glaucoma (POAG) patients and correlate microvascular perfusion defects with retinal nerve fiber layer (RNFL) thinning.

Methods
6x6 mm scans of the optic nerve were obtained of POAG and normal patients using the Angioplex spectral-domain (SD) OCTA (Carl Zeiss Meditech, Dublin, CA), and scans of signal strength ≥6 (out of 10) were selected for study. Volumetric peripapillary retina scans were manually segmented and en face projections of vasculature at specific retinal layers were produced using prototype software. RNFL vascular en face images of the optic nerve head (ONH) were quantified using prototype software, measuring vessel area density (VAD), vessel complexity index (VCI), and skeletonized vessel density (VSD). Values for each perfusion parameter were compared between normal, mild-moderate glaucoma, and severe glaucoma (Kruskal-Wallis test). Correlational strength between each perfusion parameter and RNFL thickness (data from Cirrus 5000 SD-OCT) was determined globally and focally, for quadrants and Zeiss clock hours (Figure 1d and 1e), using Spearman’s rank correlation.

Results
Peripapillary microvascular perfusion defects worsened with POAG disease progression. Kruskal-Wallis testing showed differences between normal (n=9), mild-moderate glaucoma (n=12), and severe glaucoma (n=14) patients were statistically significant for VAD (p=0.0029), VCI (p=0.0025), and VSD (p=0.0131). Correlations between perfusion parameters and RNFL thickness for POAG patients (mild-moderate and severe; n=26) were significant overall, and strongest inferiorly (Quadrant I) and inferotemporally (Clock Hour 11) (Figure 2, Table 1).

Figure 1. 6x6 mm en face images of optic nerve head before (a.) and after (b.) manual segmentation of RNFL from volumetric OCTA scan; RNFL deviation map from OCT (c.) maps of quadrant (d.) and clock hour (e.) quantification sectors (shown for OD; OS sectors reflected on vertical axis); and heat map of vessel density from prototype quantification software (f.) for representative glaucoma patient.
Discussion

RNFL microvascular perfusion, measured by VAD, VCI, and VSD, declined with increasing POAG severity, and defects were well correlated with RNFL thinning globally and in certain focal areas of the ONH. Strong inferior and inferotemporal correlations were consistent with expectations of glaucoma diagnosis following the neuroretinal rim area rule (ISNT), which suggests that inferior defects should arise first.

Conclusion

Attenuation of peripapillary microvasculature at the RNFL was more pronounced in increasingly severe POAG, with perfusion defects correlating well with RNFL thinning. This method of OCTA segmentation and quantification will likely prove valuable in future investigation of pathophysiological mechanisms in POAG.

Reference

Quantification and Structural Correlations of Macular Microvasculature Defects in the Ganglion Cell-Inner Plexiform Layer in Glaucoma Using OCT Angiography

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Purpose/Relevance
Detection of macular perfusion defects in glaucoma may provide an important avenue of diagnosing and monitoring glaucomatous damage. We aimed to quantify the microvasculature defects in the macula in normal and mild, moderate, and severe primary open angle glaucoma (POAG) patients, as measured from manually segmented optical coherence tomography angiography (OCTA) en face images, and correlated perfusion defects in the ganglion cell-inner plexiform layer (GC-IPL) with GC-IPL thinning.

Methods
6x6 scans of the macula were obtained on POAG and normal patients using the Angioplex spectral-domain OCTA (Carl Zeiss Meditech, Dublin, CA), and images with signal strength ≥6 (out of 10) were selected for study. Prototype software was used: (1) to perform manual segmentation of the raw OCTA data to obtain a precise ganglion cell-inner plexiform layer (GC-IPL) en face image, and (2) to obtain quantification data of various perfusion parameters including vessel area density (VAD), vessel skeleton density (VSD), and vessel complexity index (VCI) for the entire macula as well as focal sectors of the macula, as demonstrated in figure 1. The values for each perfusion parameter were compared for normal, mild-moderate glaucoma, and severe glaucoma (Kruskal-Wallis test). Strength of correlation between each perfusion parameter measurement of the GC-IPL en face OCTA image and the GC-IPL thickness of the macula, both globally and sectorally (Figure 1, was determined using Spearman’s rank correlation coefficient.

Results
The study included 20 POAG patients (12 mild/moderate, 8 severe) and 9 normal patients. The macular microvasculature in POAG showed significant attenuation globally and focally. VAD, VSD, and VCI was significantly different between normal, mild-moderate glaucoma, severe glaucoma (3 P-values from Kruskal Wallis – one for VAD, one for VSD, one for...
VCI). In addition, correlation of perfusion parameters with GC-IPL thickness in focal sectors was significant globally, as demonstrated in the table in Figure 2. The Superior and inferior sectors showed the most significant reduction in perfusion.

Discussion

There was a significant reduction in microvascular perfusion of the GC-IPL layer, as determined by 3 parameters, in glaucoma patients as compared to normal, and this was further reduced with increasing severity of disease. Additionally, the reduction in microvasculature had strong correlation with the corresponding thinning of the GC-IPL layer.

Conclusion

Reduction in microvasculature in the GC-IPL layer was worse with increasing severity of POAG, and this reduction was well correlated with GC-IPL thinning in focal sectors of the macula. This method of segmentation and quantification will likely prove useful for future studies on diagnostic accuracy and vascular mechanisms in POAG.

Reference

Mitochondrial Flavoprotein Fluorescence in Ocular Hypertension and Healthy Controls

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Purpose/Relevance
Mitochondrial dysfunction and oxidative stress in the retinal ganglion cell (RGC) have been linked to the development of glaucoma by several authors. Mitochondrial dysfunction converts endogenous mitochondrial flavoproteins to their oxidized form, which may be detected by a visible increase in their flavoprotein fluorescence (FPF) level. In this study, we measured the level of FPF in eyes classified as ocular hypertension (OHTN) and compared them to healthy controls.

Methods
8 OHTN patients (8 eyes, mean age 60, range 47-76 years) and 12 age-matched controls (12 eyes, mean age 57, range 50-69 years) were imaged with the OcuMet Beacon retinal metabolic analyzer (OcuSciences, Ann Arbor, MI). Images were obtained over 13-degree circular fields centered at the macula and optic disc. A histogram curve of pixel intensities for each image was generated. Average FPF was calculated from all pixels within the circular field. FPF heterogeneity was determined from the width of the histogram curve at one-half the maximum FPF frequency (Fig. A). Mann-Whitney U tests were used to assess statistical significance.

Results
Average FPF was significantly higher in OHTN eyes compared to control eyes at the macula (440±47 vs 333±18, p<0.05) though not at the optic disc (447±45 vs 376±22, p=0.17). FPF heterogeneity was significantly higher in OHTN eyes compared to control eyes at the macula (202±20 vs 145±10, p<0.05), but not at the optic disc (203±18 vs 185±14, p=0.63) (Fig. B).

Discussion
FPF appears sensitive to underlying mitochondrial dysfunction in OHTN eyes at the macula though not at the optic disc. As the macula contains the highest density of RGCs, our results suggest that FPF may reflect mitochondrial dysfunction of the RGCs.

Conclusion
FPF may prove a useful metric for identifying the earliest evidence of glaucoma and for assessing which OHTN eyes are at greatest risk of developing glaucoma. Longitudinal studies to correlate clinical variables to changes in FPF will help to define potential roles for the RMA in the detection and management of glaucomatous change.

References
**Purpose/Relevance**

The goal of risk assessment for glaucoma is to identify patients at greatest risk for symptomatic vision loss and who are most likely to benefit from early treatment. It is unclear whether glaucoma is more severe in the dominant eye. The study aim is to determine whether ocular dominance is associated with glaucoma severity using vertical cup-to-disc ratio (VCDR) index in glaucoma patients.

**Methods**

Consented glaucoma patients underwent a complete standardized ophthalmological assessment including baseline ocular coherence tomography (OCT). Ocular dominance was determined using the Dolman Test (hole-in-the-card). OCT VCDR for each eye was extracted from the OCT printout and classified. Glaucoma severity was determined based on VCDR by using the standardized Glaucoma Staging System (GSS), as recommended by the Canadian Ophthalmological Society’s clinical practice guidelines for the treatment of glaucoma. Data was analyzed using SPSS Software v20.

**Results**

Patients (n=205) mean age was 67.8±10.6 years; 63.9% were female and 36.1% were male and approximately 88.8% Caucasian population. Right-eye dominance was observed in 58.0%, left-eye dominance in 39.0%, and 2.9% were both-eye dominant. The OCT VCDR was found to be higher in the non-dominant eye (0.64±0.18) and lower in the dominant eye (0.60±0.18). Glaucoma severity for VCDR was observed to have a greater proportion of dominant eyes within the suspect to early (63.8%) stages, whilst the non-dominant eye tended to have the greater proportions within moderate (38.7% non-dominant) to advanced glaucoma classification. The study also shows that the RNFL thickness was found to be higher and significant in the dominant eye (p<0.001); however, OCT VCDR measurements were higher in the non-dominant eye. Furthermore, there was an increase in the proportion of patients who progressed into more severe stages of glaucoma classification for both the dominant and non-dominant eye.

**Discussion**

Glaucoma appears to be more severe in the non-dominant eye using OCT-based VCDR parameters. The dominant eye tended to have a protective effect on glaucoma onset and severity based on higher RNFL thickness, lower VCDR and the occurrence of less severe glaucoma classifications in the suspect and early stage categories.

**Conclusion**

This study shows that glaucoma progression is independent of ocular dominance and occurs in either eye. However, further prospective clinical correlations studies will be carried out in future to confirm these observations.

**References**


71 A Combined Index of Contrast Sensitivity and Visual Acuity as a Novel Approach to Assess Visual Function in Primary Open-Angle Glaucoma

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Purpose/Relevance
Contrast sensitivity (CS) has the potential to monitor progressive vision loss despite preserved visual acuity (VA) in glaucoma. The purpose of this study is to evaluate the extent of letter CS deficits in primary open angle glaucoma (POAG) patients using the M&S Smart System (MSSS-II) and to compare letter CS measurements to standard clinical measures of visual function from standard automated perimetry (SAP).

Methods
109 subjects with POAG without other eye conditions participated. Each patient underwent 1) VA measurement, 2) CS testing, 3) SAP testing (Humphrey SITA 24-2). Inclusion criteria included best-corrected VA (BCVA) of 0.3 log MAR (equivalent to 20/40 Snellen) or better and reliable SAP testing (fixation losses, false positives, and false negatives < 33%). Contrast sensitivity functions (CSF) were estimated from the large letter CS and BCVA measurements. The area under the log CSF (AULCSF), a combined index of VA and CS, was derived and analyzed.

Results
CS and HVF MD correlated significantly ($r = 0.50, p < 0.001$). A subset as large as 28.4% of our total patient sample had minimal to no field loss ($\leq 6$ dB field loss) and minimal to no BCVA loss ($\leq 0.3$ log MAR), but still had poor CS (Fig 1). Although BCVA and large letter CS correlated significantly ($r = -0.31, p < 0.001$), BCVA did not correlate significantly with HVF MD ($r = -0.13$, $p = 0.19$). AULCSF correlated significantly with HVF MD ($r = 0.45, p < 0.001$) (Fig 2).

Discussion
Previous work has shown that CS is better related to ‘real-world’ function than VA in early glaucoma. Currently, SAP is most commonly used to assess visual function, but subject inattention and fixation losses lead to high rates of test-retest variability. The present study is the first to evaluate CS in glaucoma using the digital MSSS-II display. We show that large letter CS and AUCSF, a combined parameter of VA and CS derived for the first time in glaucoma patients, correlates with HVF MD. These findings suggest that CS can facilitate detection of central vision loss before VA is affected.

Conclusion
Large letter CS assessed with the MSSS-II correlates significantly with visual field loss suggesting that large letter CS may be a useful adjunct test of visual function in glaucoma patients. The advantage of CS testing is that it is quick and patient friendly, especially for patients with unreliable visual field measurements. Lastly, reduced central field CS may account for subjective complaints of poor vision in patients despite minimal field loss and preserved VA highlighting the need for more sensitive methods to detect functional vision decline. AULCSF, a novel approach, may be useful to assess this subjective vision loss in glaucoma.
Figure 1. Relationship between Mean Deviation and log letter Contrast Sensitivity in Subjects subdivided into: A) mild vs. advanced field loss, B) none vs. mild vs. moderate vs. severe field loss
Figure 2. Relationship between Area Under the Contrast Sensitivity Function and Mean deviation subdivided into: A) mild vs. advanced field loss, B) none vs. mild vs. moderate vs. severe field loss

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72 Dark Adaptation Problems in Glaucoma Patients

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Purpose/Relevance
To determine the extent to which patients with glaucoma have subjective difficulties with dark adaptation and correlate reported difficulties with severity of disease, specifically visual field loss.

Methods
Cross-sectional survey of 20 patients with glaucoma presenting in an outpatient subspecialty glaucoma clinic. Charts were prescreened to select patients with primary open angle glaucoma as their primary diagnosis with visual acuity greater than or equal to 20/40 and at least two reliable Humphrey visual field tests. Patients were excluded if they had any retinal disease or other cause of visual impairment. An 11 item survey was utilized which asked questions related to dark adaptation and night vision problems pooled from validated survey instruments, as well as four questions of our own design. A free-text option was also provided for comments. Completed questionnaires were collected in person. The response format was Likert-type (severe, moderate, mild, or no difficulty). The scale on the survey was from 1 - 4. The total dark adaptation score consisted of the weighted sum of questions to which patients responded. Correlations between main outcome measures (dark adaptation score and visual field indices) were determined.

Results
Subjects were 55% male and ranged in age from 47 to 82 years old. Increasing dark adaptation symptoms strongly correlated with visual field score among patients with mild, moderate and advanced primary open angle glaucoma. Dark adaptation score was strongly correlated with mean deviation p<0.01, pattern standard deviation p<0.05, and visual field index p<0.05. Mean age, gender, presenting Snellen visual acuity or intraocular pressure had no impact on dark adaptation score. On Multiple regression analysis, controlling for age and phakic status, the dark adaptation score remained significantly correlated with only the mean deviation p<0.05, but not the pattern standard deviation or visual field index. Free-text comments from the subjects revealed a variety of additional contexts in which patients manifested dark adaptation difficulties.

Discussion
Night vision problems are common in patients with glaucoma and demonstrate a strong correlation to total amount of visual field loss, reflected by the relationship between mean deviation and subjective impairment in dark adaptation. Our questionnaire on dark adaptation may be useful as a screening tool to help identify subjects with advancing glaucoma. Future studies will examine formal dark adaptometry in patients with glaucoma and investigate the predictive value of night vision difficulties with risk of glaucoma progression.

Conclusion
Screening patients with advancing glaucoma for dark adaptation and night vision problems may identify areas of unaddressed visual disability that need remediation through occupational and low vision services.

References
73 Utility of the Modified Isolated-Check Visual Evoked Potential Technique in Functional Glaucoma Assessment

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Purpose/Relevance
Standard achromatic perimetry (SAP), such as Humphrey visual field testing, can be limited by its subjective nature, eliciting fluctuating or unreliable measurements in a proportion of patients. With recent improvements in imaging, glaucomatous structural defects can often be detected before functional losses as determined by SAP. Isolated-check visual evoked potential (icVEP) is an objective, non-invasive electrophysiological technique that evaluates cortical activity primarily in the magnocellular pathway. The purpose of this study is to evaluate the utility of a modified icVEP technique, using the EvokeDx machine, in detection of functional glaucomatous damage.

Methods
Prospective case-control study. Subjects were enrolled from a single tertiary care center. Patients were categorized as controls, glaucoma suspects, or glaucoma based on pre-determined definitions. Additionally, inter-ocular comparison was performed when possible. icVEP testing was performed with 10 2-second runs per qualified eye using the EvokeDx testing software. Multivariate statistics were used to calculate signal-to-noise ratios (SNR) and perform outlier analysis.

Results
89 eyes met criteria (mean age 59 years, 53% female). ANOVA analysis revealed significantly different SNR amongst control, glaucoma suspects, and glaucoma patients (p<0.001). Intercocular comparison of patients revealed that SNR asymmetry corresponded to asymmetry in mean deviation (on Humphrey visual field), pattern standard deviation, and retinal nerve fiber layer thickness in 71%, 76%, and 63% of eyes, respectively.

Discussion
Modified icVEP testing using the EvokeDx device may provide utility as a functional assessment in glaucoma patients and suspects. Further longitudinal studies would provide greater understanding between icVEP measurements and glaucoma progression.

Conclusion
Cortical response to low contrast stimuli, as measured by icVEP technology, has the potential to provide early functional assessment that may complement standard achromatic perimetry.

References
Purpose/Relevance
To evaluate the macular capillary network density at different retinal layers using swept-source optical coherence tomography angiography (OCTA) in patients with primary open angle glaucoma (POAG) and to compare the results with those of normal subjects.

Methods
Macular OCTA images (a 6 × 6 mm cube centered on the fovea) were acquired in 24 eyes of 24 normal individuals and 24 eyes of 24 patients with mild to moderate POAG using a swept-source OCTA device (Triton, Topcon Inc., Tokyo, Japan). En face images of the retinal vasculature were generated from the superficial and deep retinal layers (SRL/DRL). Quantitative analysis of the vessel density (VD) was performed. Vessel density (VD) was assessed as the ratio of the retinal area occupied by vessels.

Results
The mean VD (ratio) at the SRL and DRL was statistically significantly lower in patients with POAG (SRL, P < 0.001; DRL, P < 0.001). The mean VD at SRL was significantly correlated with GCC thickness (r=0.421, p=0.04), but not with VF MD (r=0.4, p=0.06), and RNFL thickness (r=0.3, p=0.06). The mean VD at DRL did not show significant correlation correlated with any other glaucoma parameter (p>0.05).

Discussion
Our study evaluated the VD of the macular capillary network, using swept-source OCTA in patients with POAG. We observed a statistically significant lower VD of the capillary network in both SRL and DRL compared to healthy individuals. Previous studies have showed varying evidence of ocular blood flow abnormalities in patients with primary open-angle glaucoma (1-3). OCTA is a new technology that has great potential for use in the clinical setting of glaucoma. Compared with FA and ICGA, the current retinal angiographic gold standards, advantages of OCTA are that it is non-invasive, acquires volumetric scans that can be segmented to specific depths, uses motion contrast instead of intravenous dye, can be obtained within seconds, provides accurate size and localization information, visualizes both the retinal and choroidal vasculature, and shows structural and blood flow information in tandem. Disadvantages of OCTA are its limited field of view, increased potential for artifacts (blinks, movement, vessel ghosting), and inability to detect blood flow below or above the detectable flow.

Conclusion
The assessment of macular hemodynamics by OCTA may offer additional information for detection, differentiation, and diagnosis of glaucoma.

References
Optic Disc Hemorrhage and Subsequent Central Visual Field Loss in the African Descent and Glaucoma Evaluation Study (ADAGES)

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Purpose/Relevance
Disc hemorrhage (DH) is a significant predictor of localized visual field (VF) progression.¹² We investigated the association between optic disc hemorrhage (DH) and subsequent global vs. central VF loss on standard automated perimetry.

Methods
406 eyes of 246 participants with glaucomatous optic neuropathy and at least four 24-2 and 10-2 VF tests were included from the ADAGES cohort. Participants had stereoscopic disc photos taken annually for up to 13 years and underwent 24-2 VFs every 6 months, while 10-2 VF tests were performed in the last 5 years of follow-up. Disc photos were reviewed for the presence of DH by two masked investigators. Rates of VF progression (dB/yr) after the date of the DH were assessed using mixed effects linear models with 3 different outcomes: (i) 24-2 mean deviation (MD), (ii) 24-2 central mean deviation (CMD, based on the total deviation values of points within the central 10 degrees), and (iii) 10-2 MD.

Results
A total of 24 eyes (6%) of 20 patients (8%) had at least 1 DH and a sequence of at least 4 VFs (24-2 and 10-2) after DH detection. Based on 24-2 MD rates, there was a non-significant difference between DH and non-DH eyes (difference between groups β= -0.06 dB/yr, 95% CI: -0.18 to 0.05, P= 0.303). However, there was a significant difference based on 24-2 CMD rates (β= -0.16 dB/yr, 95% CI: -0.28 to -0.03, P= 0.012). Similarly, DH eyes progressed significantly faster than non-DH eyes based on 10-2 MD rates (β= -0.59 dB/yr, 95% CI: -1.11 to -0.07, P= 0.026).

Discussion
DHs often occur in the inferior-temporal sector, where RNFL defects are strongly associated with macular damage.³ Moreover, we found that DH is a predictor of subsequent focal, central VF progression and this effect can be missed with a global 24-2 MD. Clinical identification of DH should prompt more intensive surveillance of the central VF and can be enhanced by 10-2 VF testing.

Conclusion
In this cohort, the 10-2 and central 10 degrees of the 24-2 VF could detect significant differences in rates of progression due to DH that were concealed by the global 24-2 MD.

References
The Relation Between Exercise and Glaucoma in a South Korean Population-Based Sample

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Purpose/Relevance
To investigate the association between exercise and glaucoma in a South Korean population-based sample.

Methods
A total of 18,386 subjects, 19 years and older who underwent health care assessment of the 2008-2011 Korean National Health and Nutrition Examination Survey were included. Variables regarding the duration (total minutes per week), frequency (days per week), and intensity of exercise (vigorous, moderate exercise and walking) as well as glaucoma prevalence were ascertained. Demographic, comorbidity, and health-related behavior information was obtained via interview. Multivariable logistic regression analyses were performed to determine the association between the exercise-related parameters and odds of a glaucoma diagnosis.

Results
Overall, 420 (2%) subjects met diagnostic criteria for glaucomatous disease. After adjustment for potential confounding variables, subjects engaged in vigorous exercise 7 days per week had higher odds of having glaucoma compared with those exercising 3 days per week (Odds Ratio [OR] 3.03, 95% confidence interval [CI] 1.21-7.62). There was no association between other exercise parameters including frequency of moderate exercise and walking, total minutes of exercise per week, and the intensity of exercise categorized by the guidelines of the American College of Sports Medicine (ACSM), and the prevalence of glaucoma. In sub-analyses stratifying by gender, the association between frequency of vigorous exercise 7 days per week and glaucoma diagnosis remained significant in men (OR 4.65, 95% CI 1.38-15.69) but not in women (OR 1.64 95% CI: 0.50-5.41). The intensity of exercise was also associated with glaucoma in men only (OR 1.66, 95% CI 1.13-2.45 for low intensity versus moderate intensity; OR 1.72, 95% CI 1.01-2.96 for high intensity versus moderate intensity).

Discussion
Ocular blood perfusion is maintained constantly and adequately by autoregulation during the perfusion pressure changes from the effect of exercise. At high levels of exertion ocular perfusion pressure can increase by 40-60% at which point limits of regulation are exceeded and blood flow has been demonstrated to increase. Autoregulation could also be dysfunctional in some populations with autonomic dysfunction. Therefore, it is possible that excessive exercise could cause dramatic retinal hemodynamic changes leading to optic nerve ischemic reperfusion injury. Multiple lines of evidence also exist for vascular dysregulation in patients with open-angle glaucoma. In a population with a high prevalence of normal tension glaucoma such as in South Korea, vascular disease etiology may be implicated as contributing to this chronic disease process.

Conclusion
In a South Korean population sample, daily vigorous exercise was associated with a higher risk of glaucoma; the intensity of exercise was positively associated with glaucoma diagnosis in men but not women.

References
Longitudinal Relationship of Electronically Measured Medication Adherence with Vision-Related Quality of Life in Glaucoma

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Purpose/Relevance
To investigate whether electronically measured medication adherence is associated with vision-related quality of life (VRQoL) in open angle glaucoma patients over time.

Methods
Three-year prospective cohort study of open angle glaucoma patients at the Durham VA Medical Center’s Eye Clinic. Subjects were enrolled if they returned their medication event monitoring system (MEMS) device after three months of use and had at least two glaucoma visits within the three-year study period. Interviews were done at baseline and once per year during the study with the National Eye Institute’s Visual Functioning Questionnaire-25 (VFQ-25). Non-adherent subjects were defined as taking less than 80% of prescribed doses. Descriptive statistics and trajectory plots for VFQ-25 composite scores and all subscales are reported. Standardized mean difference (SMD) effect size and t-test were used to quantify how adherent versus non-adherent subjects differed on the VFQ-25 scores at baseline and at 3-years of follow-up.

Results
Thirty percent (30.38%, N=24/79) of subjects took less than 80% of prescribed doses of their glaucoma medications. Adherent and non-adherent subjects had similar baseline demographics and clinical characteristics. Subjects who did not adhere to their medications had lower baseline mean composite VFQ-25 scores [70.66(S.D. 20.50) vs. (75.91(S.D. 19.12), SMD=0.27] and subscale scores. This relationship remained stable over the 3-year study period for the composite score [71.68(S.D. 21.93) vs. 76.25(S.D. 21.67), SMD=0.21] and a majority of the subscales (Figure 1). Overall, the SMD for ocular pain and peripheral vision increased substantially from baseline at the three-year mark. The mean peripheral vision score decreased for non-adherent relative to adherent subjects over three years (t-test p=0.05).

Discussion
Non-adherent subjects reported lower mean VQF-25 scores than adherent subjects at baseline and three years. The SMD between non-adherent and adherent subjects in VRQoL related to ocular pain and peripheral vision substantially changed over time. Mean peripheral vision score significantly decreased for non-adherent subjects over time.

Conclusion
Poor baseline adherence to glaucoma medications was associated with worse vision-related quality of life and this difference persisted over time. VRQoL is an important patient-centered outcome and should be evaluated in efforts to improve medication adherence.1,2
References

78 Diabetes, Body Mass Index, and Glaucoma
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Purpose/Relevance
To examine the systemic conditions associated with different types of glaucoma.

Methods
Consecutive 143 narrow angle and 127 open angle glaucoma patients were enrolled.
In addition to ocular examination findings, body mass index (BMI), and diabetes (DM) status, use of anticholinergic were recorded.

Results
Half of the narrow angle subjects and 70% of open angle subjects were African-American, remaining were white. Mean age was 72.4 in open angle versus 71.1 in narrow angle, predominantly male population. BMI was similar in both groups (28.2 in open angle vs 28.7 in narrow angle; p=0.45). Percentages of DM were higher in subjects with narrow angles than those in open angles (63% vs 37%, p=0.001; Chi-square test). After controlling for BMI, the odds of having DM was 1.97 times more (95% confidence interval: 1.17-3.30) in narrow angles than the odds in open angles (Logistic regression, p=0.01). Hyperopia was not associated with either BMI or DM. More subjects with narrow angle glaucoma were on anticholinergic medications than subjects with open angle glaucoma (16% versus 9%).

Discussion
Both groups in our study were considered overweight by CDC criteria. Obesity has been associated with glaucoma previously. Regardless of BMI, diabetes was found to be associated with narrow angles. Accelerated scleral rigidity as shown in diabetic animal model and choroidal thickness difference that is susceptible to serum osmotic pressure could be some of the contributing factors to this finding. Choroidal thickness studies by Spectral-domain OCT in diabetic patients with narrow angles may provide further information.

Conclusion
Diabetes may be a risk factor for narrow angle glaucoma. It is advisable to utilize gonioscopic exam more often before dilated fundus eye exam in subjects with diabetes.

References

Table. Frequency and Percentage of DM by Narrow Angles

<table>
<thead>
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<tr>
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Purpose/Relevance
Currently, the only known modifiable risk factor for the development and progression of primary open angle glaucoma (POAG) is intraocular pressure (IOP). No clear environmental factors have been identified as significantly associated with POAG. Several prostaglandin metabolites synthesized from omega-3 and omega-6 families of polyunsaturated fatty acids have been shown to reduce IOP in animal models.\textsuperscript{1,2} Prior studies of omega fatty acids in POAG have produced conflicting results, been limited by sample size, or had a lack of objective fatty acid analysis. This study sought to determine if there are any associations between omega-3 and omega-6 fatty acid levels and the presence or severity of POAG through quantifiable means.

Methods
Levels of arachidonic acid (AA), eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), total omega-3, total omega-6, and the omega-6:omega-3 ratio percentages were measured in 48 patients with POAG and 49 controls. Controls were patients without evidence or history of glaucoma, ocular hypertension or other optic nerve disorders. Patients who had any form of glaucoma other than POAG were excluded. Three POAG patients were excluded for incomplete blood collection. All participants submitted a finger stick whole blood sample which were sent to OmegaQuant\textsuperscript{®} Analytics for analysis. Disease status and severity were determined by review of visual field testing using standard methods. A Wilcoxon-Mann-Whitney test was used to test differences between POAG and controls and repeated measures analysis was used in assessing the relationship of fatty acid levels and disease severity.

Results
Of the 90 POAG eyes from 45 patients, 27 (30.0\%) were mild, 18 (20.0\%) were moderate, 44 (48.9\%) were severe and 1 (1.1\%) was indeterminate in severity. There was no significant difference in any measured levels between POAG patients and controls. Amongst eyes with POAG, higher omega-6:omega-3 ratio and lower omega-3 and DHA levels were significantly associated with worse disease severity (p<0.01). Levels of omega-6, EPA, and AA were not associated with disease severity.

Discussion
Understanding the role of omega fatty acids in glaucoma pathogenesis is in its infancy. By using a simple finger stick blood analysis of fatty acid levels, we were able to identify a significant association of omega-3 levels with POAG severity. Our findings suggest that these essential polyunsaturated fatty acids may play a role in disease pathogenesis and should be studied further.

Conclusion
In patients with POAG, whole blood levels of omega-3 fatty acid and DHA are significantly associated with disease severity through quantifiable means. Future studies involving larger sample sizes are needed to better elucidate this relationship and determine if fatty acid supplementation has potential for disease modification.

References
Purpose/Relevance
As a progressive condition, glaucoma may impair quality of life (QOL), mainly due to central vision loss and peripheral visual field impairment. The aim of the present study was to assess QOL trend over one-year follow-up, in a cohort of newly diagnosed primary open-angle glaucoma (POAG) patients, and to examine its association with clinical-demographic characteristics.

Methods
Multicentre, prospective, cohort study. POAG patients aged >45 years were considered eligible. The cohort of newly diagnosed POAG patients was followed-up for 12 months, and evaluated every 6 months. At baseline and subsequent visits, patients underwent comprehensive ocular examinations, and QOL questionnaires [25-item of the National Eye Institute Visual Function Questionnaire (NEI-VFQ-25) and Glaucoma Symptom Scale (GSS)] were administered. Statistical analyses were performed using linear mixed-effects model.

Results
27 patients were enrolled for the study, and 178 newly-diagnosed patients were longitudinally analyzed. The mean age was 66.9 years (Standard Deviation (SD) 12.2). At baseline the mean values of mean defect (MD), and visual field index (VFI) were -4.5 dB (SD 5.3), and 89.2 (SD 15.4) respectively. At baseline, NEI-VFQ-25 and GSS mean subscale scores were both >75.0, except for NEI-VFQ-25 “general health” (60.4) and “general vision” (65.8) scores. An increment of the scores over one-year for both questionnaires was observed. Changes of QOL scores from baseline, adjusted for glaucoma severity, were statistically significant for GSS (2.15 for 6 month increase; 95%CI: 1.12-3.18) and NEI-VFQ-25 total scores (0.69 for 6 month increase; 95%CI: 0.14-1.23) (Fig.1). When the association between clinical-demographic features and QOL trend over time was analysed, a statistically significant interaction between time and new concomitant treatments on GSS (p=0.028) and VFQ (p=0.034) total scores was observed. A statistically significant interaction between time and diabetes on GSS total score (p=0.035) was detected (Fig.2).
Discussion
The present study evidences an increase of QoL scores after one year follow-up in newly-diagnosed POAG patients. On the contrary, the concomitant presence of diabetes determines a negative influence on QoL trend over-time.

Conclusion
The increase in QoL scores of newly-diagnosed POAG patients over 1-year follow-up is likely the result of multiple factors, including the reassurance associated with receiving treatment, regular clinical follow-up, more knowledge about the low risk of blindness with treatment, adaptation to the diagnosis, or a combination thereof. Careful evaluation of general health seems to be crucial in maintaining good levels of QOL in glaucoma patients.

Reference

Figure 2
Evaluating Patient Perceptions of Marijuana Effectiveness on Glaucoma

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Purpose/Relevance
Marijuana (MJ) has been proposed as an alternative therapy to reduce intraocular pressure (IOP), a risk factor for developing glaucoma.1 However, its negative effects include cognitive impairment and increased risk of cancer. Thus, the safety and effectiveness of MJ treatment for glaucoma compared to other alternative therapies should be studied.2 The study’s purpose was to determine the proportion of glaucoma patients self-medicating with MJ, their perceived effectiveness, and compliance to regular glaucoma treatment following MJ and/or other substance use.

Methods
Recruited glaucoma patients in Hamilton, ON, were asked to anonymously fill out a survey about their glaucoma medication and use of MJ, alcohol, cigarette, and other substances. Effectiveness and compliance were reported using a Likert Scale. Data was analyzed using SPSS Statistics v20.

Results
463 patients completed the survey (43% Male, age 68±15). Results showed the current use of glaucoma medication (53%), MJ (3%), vitamins & herbal therapies (55%), alcohol (40%), cigarettes (8%), and illicit drugs (2%). When asked how MJ users (n=14) perceive MJ effectiveness on glaucoma (1=NOT, 5=VERY), 3 scored 3 and 1 scored 5. All 4 believed stopping MJ would worsen their glaucoma (p=0.18). However, all those who used glaucoma medication still reported consistent use despite also using MJ. No other substance was reported effective at managing glaucoma, and only 3 cigarette smokers reported not using glaucoma medication after smoking. All patients were asked about medication compliance (1=NOT, 5=VERY), and 84.1% scored ≥4.

Discussion
3% of glaucoma patients in our clinic report MJ use, which is less than the Canadian population use of 9%.1 We also did not observe a significant difference between those who found MJ effective with those who did not. Other studies have shown that people who use multiple substances were 56.8% adherent to medications, which is lower than our result.3

Conclusion
While studies have shown MJ to reduce IOP, our results demonstrate that the perceived effectiveness is limited in the clinical setting and may not be the most appropriate therapy compared to proven pharmaceuticals or other alternative therapies. Limitations include the older study cohort and patient hesitation to report private information about their drug use. Studies in other populations are warranted to confirm our results, and more marijuana users should be recruited to adequately determine a difference in effectiveness.

References
82  The Incidence of Retinal Vein Occlusion in Patients with Pseudoexfoliation Glaucoma: Retrospective Case Control Study

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Purpose/Relevance
Pseudoexfoliation (PXF) syndrome is a systemic disorder with a risk to develop glaucoma and cardiovascular disorders.1 Whether pseudoexfoliation or glaucoma are independent risk factors for retinal vein occlusion (RVO) is need to be explored.2,3

Methods
A retrospective case control study on patients who underwent ophthalmic and systemic evaluation. Patients were divided to Pseudoexfoliation Glaucoma group (PXF group), other glaucomas group and non glaucoma group (control group). Demographic, ocular and co morbidities parameters were compared and analyzed by logistic regression based on propensity score.

Results
Three hundred consecutive patients in each study group and 599 patients in the control group were included (N=1199). Mean age, diabetes mellitus, cardiovascular diseases and cataract were significantly (p<0.001) more common in both glaucoma groups.

Univariate analysis of the association between the groups and the outcomes revealed RVO in 22/300 (7.3%) [Crude OR 3.08 (95% CI (1.57-6.03)], 26/300 (8.7%) [Crude OR 3.69 (95% CI (1.93-7.09)] and 15/599 (2.5%) patients [Crude OR 1] of the PXF group, other glaucomas and control group, respectively (p<0.001). CRVO was found in 5.3%, 5.0% and 1.2% of the corresponding groups (p< 0.001). Multivariate analysis adjusted by age, gender, demographic and co morbidities parameters for the control and study groups resulted in significant probability for RVO in the PXF [p=0.01; OR 2.4 (1.18-4.89)] and other glaucomas groups [p=0.001 OR 3.09 (1.58-6.07)], relative to the control group. Higher probability was found for CRVO in the PXF [p=0.004; OR 4.02 (1.55-10.44)] and other glaucomas group [p=0.004; OR 3.95 (1.55-10.08)].

Excluding neovascular glaucoma patients and relative to other glaucomas group, a significant incidence of CRVO (p=0.022) was found in the PXF group with no significant difference regarding BRVO (p=0.092). Branch and central retinal artery occlusions were also significantly associated with the PXF group relative to other glaucomas (p=0.01).

Discussion
Pseudoexfoliation as well as other types of glaucoma is strongly associated with retinal vein occlusion, mainly CRVO. Excluding neovascular glaucoma, pseudoexfoliation is a significant independent risk factor for CRVO and retinal artery occlusion relative to other glaucomas.

Conclusion
Awareness and a serious approach are needed to prevent a potential retinal vein or artery occlusion in pseudoexfoliation glaucoma patients.

References
83 The Association Between Systemic Hypertension, Antihypertensive Medications, and the Risk of Developing Open-Angle Glaucoma

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Purpose/Relevance
There is conflicting evidence in the literature as to whether systemic hypertension (HTN) is a risk factor for open-angle glaucoma (OAG), and whether different classes of antihypertensives increase or reduce the risk of OAG among persons with HTN.1 Many prior studies assessing these relationships do not adequately adjust for potential confounding factors such as diabetes mellitus and hyperlipidemia and medications used to treat these conditions. The purpose of this study is to use a large health care claims database containing over 1 million enrollees to assess whether HTN is a risk factor for OAG, whether treatment of HTN reduces the risk of OAG, and whether certain classes of antihypertensives are more or less protective than others.

Methods
Claims data from a large managed-care network (OptumInsight) were analyzed to identify all enrollees age ≥ 40, with continuous enrollment in the plan for ≥ 4 years, with ≥ 2 visits to an eye-care provider. Enrollees with pre-existing OAG were excluded. Cox proportional hazards regression was used to assess the potential association between systemic arterial HTN and OAG adjusting for potential confounding factors. Among a subset of enrollees with HTN, we performed a second regression model to determine whether use of each of 5 classes of antihypertensives, severity of HTN, and other medical comorbidities affected the hazard of developing OAG.

Results
There were 1,191,118 enrollees eligible for the analysis. These persons were enrolled in the plan for a mean ± SD of 7.9 ± 2.5 years. 863,556 (72.4%) of these enrollees had HTN and 43,356 (3.6%) developed OAG. Enrollees with uncomplicated, complicated, treated, or untreated HTN all had an increased risk of developing OAG compared to those without HTN (p<0.001 for all comparisons). For enrollees with HTN, only those using systemic beta-blockers had a decreased risk of developing OAG (adjusted HR=0.98 [CI 0.97-0.1.00], p=0.04) compared to those not using beta-blockers.

Discussion
After adjusting for confounders, HTN increases the risk of open angle glaucoma. Persons with uncomplicated, complicated, treated, and untreated HTN have an increased hazard compared with normotensive patients. Only systemic beta-blockers were associated with decreased risk of developing OAG.

Conclusion
Patients with HTN are at risk for developing OAG. For those patients with HTN, systemic beta-blockers may reduce the risk of developing OAG.

Reference
The Relationship Between Uveitis in Patients with Arthritis and Demographic and Clinical Characteristics: A Population-Based Study

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Purpose/Relevance
To assess the relationship between self-reported uveitis in patients with diagnosed arthritis and purported demographic and clinical risk factors, of a population extracted from the National Health and Nutrition Examination Survey (NHANES).

Methods
For our study we used the NHANES database of the Centers for Disease Control and Prevention (CDC) for the year 2009-2010. A national representative sample of 5,106 subjects diagnosed with arthritis, extracted from a pool of 10,537 patients, were asked if they had ever been diagnosed with uveitis. The demographic analysis included age, gender and ethnicity. The main outcome was the presence of uveitis. Potential predictors were type of arthritis, history of smoking and mental health measures. Univariate and multivariate analyses were conducted using RStudio (Version 0.99.903, RStudio, Inc., Boston, MA).

Results
Of the 5,106 participants with arthritis, 27 had reported a diagnosis of uveitis and 19 received ophthalmological treatment. Among those patients with self-reported uveitis, 73% were female and 37% male, and the mean age was 52.8 ± 13 years. The distribution of ethnicity was 29.6% Hispanic, 37.1% non-Hispanic white, 22.2% non-Hispanic black and 11.1% others. Positive smoking history was reported in 37.5% of the patients, the univariate analysis comparing smoking with the presence of uveitis in the arthritis population showed an OR of 1.82 (95% CI 1.11-2.96; p=0.02) and the multivariate analysis adjusting for age and gender showed an OR of 1.65 (95% CI 0.95-2.88; p=0.07). A greater age was correlated with higher uveitis prevalence (OR = 1.04, 95% CI 1.01-1.07; p=0.02). Additional analyses were performed regarding different types of arthritis (rheumatoid arthritis, osteoarthritis and psoriatic arthritis) and mental health status (anxiety and depression) and there was no correlation with uveitis.

Discussion
Our study has found that age is positively correlated with self-reported uveitis among those with an arthritis diagnosis and that positive smoking history has a borderline correlation with uveitis. There is previous evidence that smoking1 and female gender2 are positive risk factors for uveitis, as well as evidence that African-American ethnicity3 may be a prognostic factor (worse prognosis) for arthritis-associated uveitis in children. However, there are no prior studies that have utilised a population-based sample to validate these findings. The present study appears to support that smoking may be a risk factor, which can have clinical relevance since this is a modifiable habit.

Conclusion
Age has a positive correlation and current smoking status a borderline correlation with the diagnosis of uveitis in the arthritis cohort of a population-based study and may be risk factors for the prevalence of this disease.

References
85 Association Between Self-Reported Vegetarian Diet and Visual Field Defects

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Purpose/Relevance
To evaluate the relationship between vegetarian diet and the prevalence of visual field defects.

Methods
Cross-sectional study of all participants of the 2007-2008 National Health and Nutrition Examination Survey. Participants over 60 years old who underwent frequency doubling technology testing were included. Those with known diabetic retinopathy were excluded. Participants were assessed with regard to self-reported vegetarianism and prevalence of visual field defects.

Results
Amongst the 1,430 participants included in the study, a logistic regression model that adjusted for potential confounding variables showed a greater likelihood of a visual field abnormality in self-identified vegetarians compared to non-vegetarian controls (OR 2.12, 95% CI 1.06, 4.25).

Discussion
Nutritional deficiencies have been shown to cause optic neuropathy, nerve fiber layer atrophy and visual field changes.¹ Self-reported vegetarians in the NHANES database showed a greater likelihood of visual field abnormalities. Though the causes of visual field deficits are unclear, one hypothesis is that vegetarian diet may associated with a higher risk of glaucomatous disease due to nutritional deficits or other causes.

Conclusion
Self-reported vegetarian diet may be associated with an increased prevalence of visual field abnormalities. This hypothesis warrants further study.

Reference
Primary Open-Angle Glaucoma (POAG) and Uric Acid (UA) Levels in the Veteran Patient Population

KRISTIN BIGGERSTAFF¹, Benjamin Frankfort, Silvia Orengo-Nania, Jennifer Kramer, Donna White
¹ Baylor College of Medicine

Purpose/Relevance

It has been shown that gout, a disease characterized by high uric acid levels, may be protective in neurodegenerative diseases such as Parkinson’s disease.¹,² However there are only two small studies exploring the relationship between uric acid and POAG.³,⁴ Within a nationwide cohort of cases with POAG and matched POAG-free controls, we examined the association of a history of gout, UA levels, and other systemic diseases with a diagnosis of POAG.

Methods

We conducted this study using a nationwide cohort of patients with and without glaucoma (cases and controls) between 2000 and 2013 diagnosed at the Department of Veterans Affairs (VA). We used incident density matching based on age at index date, fiscal year of index date, fiscal year of first VA visit, and gender. The association of gout and uric acid levels on the development of POAG was determined by comparing differences in exposures in POAG cases and matched controls using separate multivariable logistic regression models adjusting for race and other chronic medical conditions.

Results

There were 1,144,428 POAG cases and 1,144,428 controls. The mean age was 64.0 ± 10.9 years and 96% were male. The cases were more likely to be Black (23.6 vs. 12.3%) and less likely to be White (57.1 vs. 65.3%) compared with controls. POAG cases were slightly less likely to have a history of gout (OR 0.98, 95% CI 0.97-.99) and other conditions associated with high UA levels, including oral diuretic use, arterial disease, chronic kidney disease, hematopoietic malignancies, and hyperthyroidism. Median UA levels in the highest quartile (>7.3mg/dL) was found to have no effect the development of POAG (OR 1.02, 95% CI 0.998-1.04). Hypertension was found to carry an increased risk for POAG development (OR 1.11, 95% CI 1.08-1.13), and interestingly diabetes was found to be protective (OR 0.82, 95% CI 0.81-0.84).

Discussion

These results show that gout and other conditions associated with higher UA levels likely have little effect on the development of POAG. Hypertension was found to increase the risk of POAG; however, diabetes was found to be protective against the development of POAG.

Conclusion

High UA levels have little effect on the development of POAG; however, diabetes may be protective.

References

87 Incidence of Hyperemia in the Trabodenoson Monotherapy Clinical Development Program Through Phase 2

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¹ Inotek Pharmaceuticals

Purpose/Relevance
To describe the incidence of hyperemia in the Phase 1 and 2 clinical program of trabodenoson, a highly selective adenosine mimetic targeting the adenosine A₁ subreceptor under investigation for lowering intraocular pressure (IOP) in primary open angle glaucoma (POAG) and ocular hypertension (OHT). Hyperemia is a common and bothersome side effect of current glaucoma therapies and is frequently implicated in drug discontinuation.¹ The mechanism of action (MOA) of trabodenoson is not associated with hyperemia, which may make it a viable new treatment option with a favorable side effect profile.

Methods
Three clinical trials were evaluated: Phase 1 single installation (P1SI; unpublished study), Phase 1 Safety (P1S),² and Phase 2 Dose Ranging (P2).³ Hyperemia was categorized by the investigators using a standard scale across trials: 0 = none/trace, 1 = mild, 2 = moderate, and 3 = severe. Hyperemia was measured between 1 and 12 hours post-dosing at various days up to 28 days of treatment. The subjects (total N = 298; 183 trabodenoson, 115 placebo) included those with POAG or OHT (IOP ranging from ≥ 24 mmHg to ≤ 36 mmHg (P2, n = 144; 85 trabodenoson, 59 placebo)), healthy older adults (P1S, n = 70; 42 trabodenoson, 28 placebo) and healthy adult volunteers with normal IOP (P1SI, n = 84; 56 trabodenoson, 28 placebo). Descriptive statistics noted the frequency and percent of patients who were deemed by the investigator to have any hyperemia (incidence). Incidence was also evaluated by drug dose in each trial.

Results
The percent of patients noted to have hyperemia at one or more assessments was 8.24% (5.36% in P1SI, 4.76% in P1S, and 11.90% in P2). Hyperemia was not rated as severe in any trial and only 3 total cases of moderate hyperemia were observed. Hyperemia was more frequently recorded in higher doses tested in the 500mcg group of P2 at Day 28 (12.1%), but this percentage was unchanged from baseline hyperemia in the same group (12.5% at Day -1). There were no discontinuations attributed to hyperemia in any trial, and through Phase 2 there have been zero trabodenoson related early discontinuations.

Discussion
In patients exposed to trabodenoson monotherapy in three clinical trials, the incidence of hyperemia was very low, and hyperemia was not associated with dose. The cause of hyperemia in some available and investigational drugs is linked to their MOA and localized vessel dilatation, which does not occur with trabodenoson.

Conclusion
There was a very low incidence of observed hyperemia in the trabodenoson monotherapy clinical program to date, which may make trabodenoson a preferable option for patients with POAG and OHT, and for clinicians seeking a once-daily option with a favorable side effect profile. The absence of trabodenoson-related hyperemia may be a contributing factor in not observing any trabodenoson related drop outs in any trial through Phase 2.
References


**88 Small Molecule Delivery to the Optic Nerve in an In Vivo Rat Model**

**SHANDIZ TEHRANI**, Lauren Davis, William Cepurna, Elaine Johnson, John Morrison

1 Oregon Health & Science University

**Purpose/Relevance**

Glaucoma is a chronic optic neuropathy involving axon degeneration that begins at the level of the optic nerve head (ONH).1,2 Small molecule delivery to the optic nerve would allow probing of cellular and molecular pathways involved in glaucomatous optic neuropathy and provide a tool for screening therapeutics in models. This study was designed to show quantitative, in vivo delivery of small molecules to the optic nerve in a rat model.

**Methods**

Brown Norway rats were anesthetized and the orbital and ocular soft tissue was dissected to expose the superior junction of the optic nerve and globe. The superior optic nerve sheath was dissected to expose the superior optic nerve at its junction with the globe, followed by placement of a 1.5 x 5mm absorbable foam pledget, soaked in a solution of 500mM cytochalasin D (a small molecule actin inhibitor, n = 8). Control animals underwent the same procedure with placement of a pledget soaked in vehicle solution only (n = 8). Animals were sacrificed after 4 hours. For analytical quantification of cytochalasin D delivery, the anterior 2 mm of the optic nerve and ONH were isolated, sonicated in phosphate-buffered saline, analyzed for total protein content by absorbance spectroscopy, followed by cytochalasin D quantification by liquid chromatography and mass spectroscopy. For morphologic analysis of cytochalasin D effects on optic nerve and ONH actin structure, globes were fixed, imbedded, frozen, sectioned, and labeled with fluorescent-tagged phalloidin (an actin filament marker). Standard errors of the mean were calculated for each group.

**Results**

Cytochalasin D content within the optic nerve (ng) was normalized to total protein content within the sample (mg). 44.3 ± 16.1 ng/mg of cytochalasin D was detected within the optic nerve tissue (n=4). Total actin fluorescence intensity within the optic nerve trended toward a reduction after exposure to cytochalasin D relative to controls (71.6 ± 11.4 a.u. versus 84.5 ± 9.0 a.u., n = 4). Mean actin filament length within the ONH trended toward a reduction after exposure to cytochalasin D relative to controls (15.0 ± 0.6 mm versus 16.9 ± 0.8 µm).

**Discussion**

Total cytochalasin D delivery to the optic nerve and ONH is equivalent to a final concentration of approximately 20 mM cytochalasin D within the optic nerve tissue (assuming equal distribution and a standard volume of the ONH and optic nerve).

**Conclusion**

Local, quantitative, in vivo small molecule delivery to the optic nerve in a rat model is feasible in this proof of principle experiment. This approach may be useful in testing various modulators of ONH cellular activity.

**References**

89 The Glaucoma Italian Pediatric Study: One-Year Interim Analysis

LUCIANO QUARANTA1, Elena Biagioli, Ivano Riva, Francesca Galli, Davide Poli, Eliana Rulli, Robert Weinreb
1 University of Brescia

Purpose/Relevance
Although surgery is the treatment of choice for patients with pediatric glaucoma, topical medications are usually needed as adjunctive therapy. Aim of the current study was to investigate the efficacy of a treatment strategy with latanoprost and dorzolamide in primary pediatric glaucoma (PPG).

Methods
PPG after a surgical procedure with intraocular pressure (IOP) between 22-26 mmHg were eligible. At baseline, patients were allocated to latanoprost once-daily. Depending on IOP reduction, patients were allocated to one of three groups: continuation of latanoprost monotherapy, addition of dorzolamide twice-daily, or switch to dorzolamide three-times daily. Patients in the dorzolamide monotherapy group with IOP reduction <20% from baseline were considered non-responders (Fig 1). Study treatment continued for three years or until treatment failure. The primary endpoint, is the percentage of responders. Secondary endpoints are time to treatment failure and frequency of adverse events.

Results
A total of 35 patients (57 eyes) were analysed. The mean age was 4.0 years (SD 3.8), the female/male ratio was 1/1.7, and the majority of patients were Caucasian. Eighty percent of patients had bilateral glaucoma. 51 eyes were included in the efficacy analysis. 43 eyes (84.3%; 95% CI: 74.3 - 94.3) were considered as responders: 29 on treatment with latanoprost, 11 with the association and only 3 on treatment with dorzolamide. The efficacy of pharmacological treatment seemed to be inversely related to the age at the time of surgery. The IOP reduction was 8.7 mm Hg (SD 2.2) for latanoprost, 7.5 mm Hg (SD 1.4) with the combination, and 8.7 mm Hg (SD 2.1) for dorzolamide (Fig 2). There were no adverse events that resulted in therapy withdrawal.

Discussion
High percentage of patients had a significant reduction of IOP with latanoprost alone or in combination with dorzolamide. Non-responders were mainly patients with early presentation of the disease. Latanoprost and dorzolamide alone or in combination were generally well tolerated with no major adverse events local and systemic events.

Conclusion
Latanoprost is a useful drug in reducing the IOP after surgical treatment of PPG. If target IOP is not reached with latanoprost alone, the concomitant administration of dorzolamide can further reduce the IOP.

Figure 1
### Reference


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**Figure 2**

<table>
<thead>
<tr>
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<th>Latanoprost + dorzolamide</th>
<th>Dorzolamide</th>
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</thead>
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<td><strong>Baseline IOP (mm Hg)</strong></td>
<td>n = 29</td>
<td>n = 11</td>
<td>n = 3</td>
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<tr>
<td><strong>Median (Q1 - Q3)</strong></td>
<td>23.0 (22.0 - 24.0)</td>
<td>24.0 (23.0 - 24.0)</td>
<td>26.0 (23.0 - 26.0)</td>
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<td>22.0 - 26.0</td>
<td>23.0 - 26.0</td>
</tr>
<tr>
<td><strong>IOP decrease (mm Hg)</strong></td>
<td>n = 29</td>
<td>n = 11</td>
<td>n = 3</td>
</tr>
<tr>
<td><strong>Median (Q1 - Q3)</strong></td>
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<td>8.0 (6.0 - 9.0)</td>
<td>8.0 (7.0 - 11.0)</td>
</tr>
<tr>
<td><strong>Min - Max</strong></td>
<td>3.0 - 13.0</td>
<td>6.0 - 10.0</td>
<td>7.0 - 11.0</td>
</tr>
</tbody>
</table>
Changing the Paradigm of PGA Dosing in Glaucoma with Extended-Release Formulations: Continuous PGA Release Results in Significant Drug Sparing Compared to Topical PGAs and Achieves Sustained IOP Lowering for 9 Months Without Any Attenuation in IOP-Lowering Effect

TOMAS NAVRATIL, Virginia Conley, Rozemarijn Verhoeven, Iqbal Ike Ahmed, Thomas Walters, Steven Mansberger, Benjamin Yerxa

1 Envisia Therapeutics

Purpose/Relevance
Topical PGAs are the most prescribed class of therapies for glaucoma in the US but possess several shortcomings, including generally low compliance and relatively high incidence of hyperemia. Topical PGA administration results in very high transient intraocular drug concentrations that are far above the EC50 value for FP receptor activation, consequently leading to tachyphylaxis as shown previously with twice a day bimatoprost administration. Intracameral ENV515 travoprost XR was used to answer whether the long-term, sustained release of PGAs can achieve both long term IOP lowering without tachyphylaxis and significant dose sparing compared to topical drops.

Methods
Intracameral ENV515 travoprost XR was formulated with a target duration greater than 6 months. To measure intraocular levels of travoprost, 17 glaucoma patients scheduled for cataract surgery were enrolled and low and high doses of ENV515 travoprost XR were administered 28 days before the surgery followed by safety and IOP evaluations. During cataract removal, the aqueous humor and ENV515 implant were collected. To evaluate the duration of ENV515 travoprost XR’s IOP lowering efficacy and the potential for tachyphylaxis, five glaucoma patients were enrolled in a separate 12-month study of a single intracameral administration of low dose ENV515. After washout, patients received a single unilateral dose of ENV515 in the study eye with timolol used as active comparator in the contralateral eye.

Results
In the 28-day study, low and high doses of ENV515 lowered IOP in a dose related manner, demonstrating timolol-like and TRAVATAN-like efficacy, respectively. Importantly, this IOP lowering effect was achieved at significantly lower aqueous humor levels of travoprost compared to the drug levels that were observed following topical dosing: high dose ENV515 resulted in mean ± SD of 95 ± 41 pg/ml travoprost (n=10) compared to ~1,800 pg/ml measured in aqueous humor following TRAVATAN Z topical dosing. In the long term 12-month study, low dose ENV515 demonstrated an IOP-lowering effect for 9 months after a single dose without any loss of efficacy over this period and matched the pre-study PGA and in-study timolol IOP-lowering effects in these patients. ENV515 decreased the mean ± SD 8 AM IOP by 6.7 ± 3.8 mmHg (p < 0.005) or 26% over 9 months (mean of all 8 AM IOPs over 9 months).

Discussion
In a short term study, ENV515 intracameral travoprost XR demonstrated IOP lowering effect similar to TRAVATAN Z at significantly lower intraocular travoprost levels. In a long term evaluation, ENV515 lowered IOP consistently for 9 months after a single dose without any tachyphylaxis, matching in-study timolol and pre-study topical PGAs with a dose that was significantly lower compared to the ~ 300 µg of topical travoprost patients would have taken over this time period.

Conclusion
Intracameral sustained release of travoprost results in a sustained IOP lowering effect over a period of 9 months without any loss of treatment effect and achieves significant drug sparing.

Reference
91 Effect of Glaucoma on Identification of Ophthalmic Medications

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¹ University of Kentucky

Purpose/Relevance
To elucidate the effect of varying degrees of glaucoma on color vision and patients’ ability to distinguish bottle cap color of commonly used ophthalmic medications.

Methods
Prospective, nonrandomized, observational trial. Patients were recruited from a university glaucoma service, and each eye was tested independently for the ability to correctly identify the bottle cap color of ten commonly used ophthalmic medications. These results were correlated with most recent logMAR visual acuity (VA), visual field mean deviation and pattern standard deviation.

Results
117 eyes from 60 patients were evaluated. A negative relationship was found between VA and cap color score \(-3.06±0.810\) (p<0.0001), and with seven of ten colors individually (p<0.01). A lower mean deviation was correlated with decreased likelihood for correctly identifying green caps \(0.149±0.111\) (p=0.0024). GSS" did not show relationship with cap color score (p=0.567). Multiple linear regression showed the effect of mean deviation (p=0.212) did not correlate with cap color score when effect of VA was considered.

Discussion
Recognition of bottle cap color is a common method by which patients distinguish medications, and this color scheme was developed as a tool to aid in medication compliance. This study attempted to measure the effect of glaucoma on discrimination of these colored caps. Results showed that patients were less likely to correctly identify the color of caps presented as visual acuity and mean deviation worsened. Multivariate analysis demonstrated that this effect was due to visual acuity and could not be independently attributed to markers of glaucoma. The clinical significance of these findings is that relying on cap color to distinguish medications may be reasonable in patients with advanced disease provided visual acuity remains adequate.

Conclusion
Increasing degrees of glaucoma are not correlated with a decline in a patient’s ability to recognize medication bottles by the color of bottle cap; however, this approach should be used cautiously in patients with limited visual acuity.

References
92 Comparison of Patient Reported Compliance in Obtaining Intraocular Pressure Lowering Medication and Actual Pharmacy Dispensation

ALEXANDER ZABANEH1, Gregory Zegarek, Lili Farrokh-Siar
1 University of Chicago

Purpose/Relevance
Patient compliance with topical intraocular pressure (IOP) lowering medications plays a vital role in the treatment management of glaucoma. There are limitations to assessing patient compliance objectively. Using electronic monitoring devices, Okeke et al reported that 45% of patients who were aware that their administration was being monitored were compliant less than 75% of the time.¹ In a multicentered study, Kholdebarin et al reported 27.9% non-compliance with IOP medication use through questionnaires.² In this study, we compare the patient reported time of IOP medication dispensation with patients’ pharmacy reported dispensation in patients using topical IOP medication seen in the glaucoma clinic.

Methods
Data was collected from the patients through a survey style questionnaire and from the patient reported pharmacy for actual dispensation of medication. Patients receiving medication from mail order pharmacies or patients who did not recall the date of medication dispensation were excluded from the study. Patients were considered to be compliant if the reported date of medication dispensation was within 1 week of actual pharmacy reported dispensation.

Results
Preliminary results of the first 30 patients included in the study revealed that 22 patients (73%) were non-compliant. The mean difference between reported medication dispensation and actual pharmacy dispensation was 23.9 weeks, with a range of 1.3 to 163.7 weeks. The average age of compliant patients was 62.3 years old compared to 68.9 years old with non-compliant patients, which was not statistically significant (p = 0.08). The average number of topical medications used was 2.3 in the compliant group compared to 2.5 in the non-compliant group, which was not statistically significant (p = 0.25).

Discussion
There are many limitations to reliably assess patient compliance with topical IOP lowering medications. Our study found a non-compliance rate of 73% in the early preliminary data, which has been higher than most reported non-compliance rates.¹² However, by using documented dispensation from patients’ pharmacies, we are able to objectively determine patient compliance with topical medications. Patients will continue to be enrolleed in the study through November 2016, with the final data to be determined at that time. In addition, a follow-up patient survey assessing barriers to compliance and access to medication is in process.

Conclusion
Patient compliance with topical medications presents several challenges to the management and treatment of our glaucoma patients. The compliance rate of our patients may be overestimated when data is gathered only from our patients’ reported history. We plan to continue to continue are investigation and report additional data in the later part of 2016.

References
93 Novel Device to Assist Patients with Eyedrop Administration

TRISA PALMARES¹, Julia Song, Alice Song, Michael Song
¹ Southern California Eye Physicians and Surgery Center for Oculofacial & Orbital Surgery

Purpose/Relevance
Patients have difficulty using topical ophthalmic medications. Although color-coded, if patient has difficulty seeing, the patient may not be able to see the bottle. Furthermore, the frequency of the eyedrop may be difficult for the patient to remember. A medication sheet can be helpful, but if the patient is illiterate, the sheet may not be of much use. We devised a method by which patients can remember how frequently to take their medications.

Methods
Case control study. Patients utilized a method in which the sides of the bottles had sticks indicating how frequently to use the medications. The patients were provided surveys on their opinion on the new technique.

Results
There was a total of 11 patients who utilized the new technique. All patients stated that they were able to use their eyedrops without difficulty. They reported better compliance with this method.

Discussion
Bottle cap colors has been utilized to assist in ease of patient eyedrop medication identification. However, the accuracy of eyedrop bottle identification was found to be less than 11%, especially in individuals who acquired color vision deficiency from glaucoma.¹ Braille is a tactile writing system used by people who are blind or visually impaired. In 1960, 50% of legally blind, school-age children were able to read braille in the U.S. Early braille education is crucial to literacy for a blind or low vision child. In the United Kingdom, it is required that medicines have the name of the medicine in Braille on the labelling.² We utilized a similar method to assist patients with poor vision identify how frequently to utilize their eyedrops. Instead of a Braille system, which has a learning curve, we utilized sticks. Patients were able to count the sticks on the bottle to inform them how frequently to use the medication.

Conclusion
This novel method of identifying eyedrop bottle dosing has been useful for patients who were not able to see or who were illiterate and unable to read a medication sheet. All of the patients surveyed reported ease in eyedrop use and less confusion. In the future, patients can be offered this method of eyedrop bottle labeling to assist with multiple eyedrop use.

References
94 Effect of Timolol on Episcleral Venous Pressure in Normal Human Eyes

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1 Mayo Clinic, Rochester, MN

Purpose/Relevance
Episcleral venous pressure (EVP) is an important determinant of intraocular pressure (IOP) and can be measured by estimating the pressure required to compress an episcleral vein to a predetermined endpoint. Timolol reduces intraocular pressure (IOP) by suppressing aqueous humor flow. However, the effect of timolol on EVP is unknown. In this study we evaluated the effect of timolol on EVP by using an automated episcleral venomanometer.

Methods
Forty-two eyes from 21 healthy participants (5 males and 16 females; 20 Caucasians and 1 African American), ages 41 to 68 years (52 ± 8 years, mean ± SD) were included in the study, which was a part of a clinical trial (NCT01677507, ClinicalTrials.gov). IOP was measured in both eyes in the sitting position by pneumatonometry (Model 30 Classic, Medtronic). EVP was measured by using a computer-controlled slit-lamp mounted episcleral venomanometer1 that recorded a video sequence of the vessel as it was compressed. Pressure measurements were synchronized with the video stream and image analysis software was used to determine the pressure required to collapse the vein to a pre-determined degree. Aqueous humor flow was measured in both eyes by fluorescein clearance. Each subject instilled timolol 0.5% in both eyes twice per day for 7 days, and then IOP, EVP, and aqueous humor flow were remeasured. Changes in IOP, EVP and aqueous flow in response to timolol were determined by using generalized estimating equation models to account for possible correlation between fellow eyes of the same subject. The relationships between the change in IOP and the changes in EVP and aqueous flow were determined by linear regression.

Results
Timolol decreased IOP from 12.6 ± 2.4 mmHg to 10.9 ± 1.8 mmHg (mean ± SD, P < 0.001) and decreased aqueous humor flow from 2.61 ± 0.54 µl/min to 1.55 ± 0.35 µl/min (P < 0.001). EVP decreased from 6.5 ± 1.4 mmHg to 6.2 ± 1.4 mmHg (P = 0.03). The reduction in IOP was not correlated with either the reduction in EVP (r = 0.01, P = 0.93) or the reduction in aqueous humor flow (r = 0.17, P = 0.45).

Discussion
The primary mechanism of IOP reduction by timolol is the suppression of aqueous humor production through β-adrenergic receptors on ciliary body epithelium. However, it has been reported that there is poor concordance between the reduction of IOP and the reduction of aqueous humor flow after timolol.2 Changes in other parameters of aqueous humor dynamics may have a role in the IOP-lowering action of timolol. It is not known if the small decrease in EVP is due to β-blocker activity of timolol on episcleral vessels or a systemic effect on blood pressure.

Conclusion
Timolol lowers IOP mainly through its effect on suppression of aqueous humor flow. However, a decrease in EVP could be a secondary effect of timolol in normal human eyes. Further evaluation of aqueous humor dynamic traits in ocular hypertensive and glaucoma patients would be useful for better understanding of its full mechanisms of action.

References
The Efficacy of Lifitegrast (Xiidra) for Symptomatic Relief of Dry Eye in Glaucoma Patients

CONSTANCE OKEKE¹, Christopher Kruthoff
¹ Virginia Eye Consultants

Purpose/Relevance
To describe the efficacy of use of lifitegrast (Xiidra) for relief of dry eye symptoms in glaucoma patients on 1 to 4 topical medications.

Methods
We included glaucoma patients with active complaints of dry eye that were not fully relieved with their current dry eye therapy, which at minimum had included use of artificial tears. All patients were taking between 1-4 topical glaucoma medications in one or both eyes. A Dry Eye Speed II Questionnaire (DESQ) was administered to each patient in clinic before the use of any lifitegrast treatment. All patients were given a prescription of treatment. Patients were asked to stop all other modes of topical dry eye therapy, but allowed to use artificial tears if needed. After 3-4 weeks usage of the medication, patients were called to assess continued use of treatment, symptomatic relief, adverse reactions, change in reaction to current glaucoma therapy and whether they wanted to continue use of lifitegrast. The same dry eye speed questionnaire was administered via phone or in clinic.

Results
Fifteen patients filled out a pre-treatment-DESQ, but only 10 patients were able to be contacted at least 3 weeks after the initial DESQ. Out of the 10 patients, 9 (90%) had a lower post treatment-DESQ score. Based on results of Wilcoxon test we found a statistically significant (p=0.016) decrease on DESQ scores (pre-test average: 17.2±6.8 and post-test average: 9.6±7.4). Two of the 10 patients discontinued use and/or would not continue with lifitegrast due to blurred vision. Of those who used lifitegrast for at least 3 weeks, 8 of 10 (80%) would continue to use it. Fifty percent (5/10) reported that they could discontinue use of all artificial tears due to positive relief of dry eye symptoms. Four of 10 (40%) patients who were on 1-3 glaucoma drops reported positive relief of burning and/or stinging associated with instillation of glaucoma drops.

Discussion
Dry eye is a significant problem for glaucoma patients who chronically use medications that can cause or exacerbate ocular surface issues. Untoward side effects from these medications can negatively impact quality of life,¹ as well as become a reason for non-adherence, which can potentially worsen glaucoma. In this patient population, not only did lifitegrast improve dry eye symptoms in the majority, it also allowed for reduction of AT usage, and improved adverse symptoms related to glaucoma drops.

Conclusion
Lifitegrast was efficacious in reducing symptoms of dry eye in our patients actively using 1-3 glaucoma medications. Improvement of glaucoma medications side effects with lifitegrast may offer a role in improving adherence with glaucoma therapy, as well as contribute to increasing quality of life.
TABLE. Patient Findings on Lifitegrast

<table>
<thead>
<tr>
<th>Patient #</th>
<th>Prior Dry Eye Treatment</th>
<th>Pre DESQ Score</th>
<th>Post DESQ Score</th>
<th># Topical Glaucoma Drops</th>
<th>Reaction to Lifitegrast</th>
<th>Adverse Events</th>
<th>Use of ATs?</th>
<th>Continue Use of Lifitegrast?</th>
<th>Glaucoma drop symptoms?</th>
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<td>001</td>
<td>AT</td>
<td>3</td>
<td>0</td>
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<td>stinging upon instillation</td>
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</table>

AT – artificial tears, DESQ – Dry Eye Speed II Questionnaire (range 0 -35)

Reference

Improved Function of Retinal Ganglion Cells by Topically Administered Trabodenoson in a Rat Model of Optic Nerve Crush Injury

ADAM BROCKMAN¹, David Albers, James Tsai, Cadmus Rich, Rudolf Baumgartner, William McVicar
¹ Inotek Pharmaceuticals

Purpose/Relevance
Glaucoma is an optic neuropathy accompanied by progressive loss of retinal ganglion cells (RGCs). Raised intraocular pressure (IOP) is a risk factor for glaucoma and current therapies target lowering IOP with topical eye drops. Trabodenoson (TRABO), an adenosine mimetic, lowers IOP in glaucoma patients by selectively binding the adenosine A₁ receptor leading to increased conventional outflow facility.¹ The A₁ receptor has been postulated to have neuroprotective properties attributed mostly due to its synaptic modulatory actions.² We sought to determine if topical ocular administration of TRABO would have beneficial effects on RGC function/survival in an experimental glaucoma rat model.

Methods
Optic nerve crush (ONC) was performed in Long Evans rats (n=8/group) unilaterally (left eye) with contralateral (right) eye serving as control as previously described.³ Twice daily, topical ocular administration of vehicle, TRABO (3% or 6%) or brimonidine (BRIM; 0.2%) were initiated 3 days prior to ONC, after pre-study in vivo imaging using SD-OCT and baseline values of pattern ERG (pERG) were obtained. After 14 days from ONC, pERGs were measured and SD-OCT images obtained. Retinal wholemounts were immunolabeled with RBPMS, a RGC marker, and stereological counts were obtained.

Results
Normalized to the contralateral eye, there was a statistically significant difference in pERG responses between the vehicle group and groups treated with 0.2% BRIM, 3% and 6% TRABO, 14 days after ONC. From SD-OCT, inner retinal thickness (IRT) significantly decreased in all treatment groups in ONC eyes; no differences across treatment groups were observed. Stereological counting of RBPMS-labeled RGCs revealed ONC eyes receiving vehicle treatment were decreased approximately 85% relative to the contralateral eye. Neither TRABO nor BRIM treatments affected RGC cell counts in ONC eyes as compared to vehicle treatment.

Discussion
Twice daily, topical ocular administration of TRABO (3% or 6%) in rats significantly improved RGC function, as measured by pERG, 14 days after ONC as compared to vehicle-treated rats. This functional improvement of RGCs by TRABO was not accompanied by any preservation of ONC-induced structural or histological effects. Similar findings of functional recovery in the absence of any structural/histological benefit were observed in BRIM-treated rats.

Conclusion
Twice daily, topical ocular instillation of TRABO to rats significantly enhanced RGC function 14 days after ONC as compared to vehicle-treated rats.

References
1. Myers et al. (2016) JOPT, DOI: 10.1089/jop.2015.0148
97 Design and Development of ENV515 Intraocular Applicator Including Custom Needle for Intracameral Injections of ENV515 Travoprost Extended Release (XR) Therapy for Glaucoma

AKSHAY NADKARNI, Jessie Delgado, Andres Garcia, Gretchen Willard, Andrew Corson, Rozemarijn Verhoeven, Leo Trevino, Iqbal Ike Ahmed, Thomas Walters, Tomas Navratil, Steven Mansberger
1 EG-GILERO

Purpose/Relevance
ENV515 intraocular applicator was designed and manufactured to facilitate safe and effective administration of ENV515 travoprost XR currently in clinical development for glaucoma. ENV515 travoprost XR is an extended release formulation of travoprost using a biodegradable polymer drug delivery system that is administered via intracameral injection. Interim evaluation of low dose ENV515 in a Phase 2a clinical study in glaucoma patients indicated a sustained IOP-lowering effect that lasted for 9 months after a single dose and matched in-study timolol in the contralateral eye and pre-study topical prostaglandin analogs. The ENV515 intraocular applicator was designed and is being developed solely for co-distribution with the ENV515 XR therapy for glaucoma, not as a standalone medical device.

Methods
The ENV515 intraocular applicator was designed based on a new custom beveled, singlelumen hypodermic needle and molded or machined from medical grade materials. A stainless steel metal shaft actuated via a scroll wheel was designed to advance the rodshaped ENV515 implants from the lumen of the needle. The ENV515 applicators manufactured for the use in ENV515 Phase 2 and Phase 3 clinical studies were terminally sterilized via gamma irradiation and underwent design verification testing post-sterilization.

Results
The gamma sterilized applicators were evaluated for low endotoxin levels (all samples below 0.05 EU/injector); low particulate matter (all samples passed USP specifications); biocompatibility including cytotoxicity, intracutaneous reactivity, irritation and skin sensitization and acute systemic toxicity (all samples passed); and sterility (all samples tested sterile). Needle sharpness was evaluated using artificial membrane injection force measurements, ex vivo rabbit cornea force measurements, and injections in intact rabbit eyes with consistently low insertion force. Functional testing for the fully assembled and sterilized implant applicator included actuation of the device, and injection of all preloaded implants.

Discussion
For the ENV515 intraocular applicator, a new custom beveled, singlelumen hypodermic needle was designed and optimized specifically for intracameral injections. This approach resulted in excellent sharpness and overall performance during intracameral injections in animal models.

Conclusion
ENV515 intraocular applicator was designed, manufactured, sterilized, and design verification testing was successfully performed. The new custom beveled needle design demonstrated superior sharpness and corneal penetration in preclinical testing compared to other commercially available needles. Based on this outcome, ENV515 intraocular applicator is being used in a 12-month long term evaluation of safety and efficacy of ENV515 travoprost XR across clinical sites in the US.

Reference
98 Optimal Time for Visualization with Minimally Invasive Glaucoma Surgeries: Before or After Phacoemulsification?

REBECCA EPSTEIN¹, Jeffrey SooHoo, Mina Pantcheva, Malik Kahook, Leonard Seibold

¹ University of Colorado, Denver

Purpose/Relevance
To determine whether or not it is more advantageous to perform angle based micro-invasive glaucoma surgery (MIGS) before or after phacoemulsification.

Methods
Retrospective study of surgical video images from 11 eyes of 11 patients who were undergoing phacoemulsification with or without angle surgery. Video recordings of intraoperative gonioscopy visualizing the anterior chamber angle were taken before and after phacoemulsification surgery. In each case, a standard method of angle visualization was used including adequate rotation of the microscope and the patient’s head away from the surgeon. The angle was adequately inflated with viscoelastic to optimize surgical view and a Swan-Jacobs direct gonioscope was used to visualize the angle. After review of the surgical videos, the best possible still images of the angle were captured from before and after cataract surgery. The paired images were presented side-by-side in random order, and rated by four fellowship trained, glaucoma specialists who were masked as to the timing of each image. A Likert response scale and comments section were used to rate reviewer preference for each set of images. The scale used was as follows: 1- pre-phacoemulsification image is significantly better, 2- pre-phacoemulsification image is somewhat better, 3- no difference, 4- post-phacoemulsification image is somewhat better, and 5- post-phacoemulsification image is significantly better.

Results
Four surgeons completed all 11 image comparisons. The most common response was “no difference” between each photo (34.1%). This was followed in frequency by “post-phacoemulsification image somewhat better” (27.3%) and “pre-phacoemulsification image somewhat better” (22.7%). Only 9.1% of responses found pre-phacoemulsification image significantly better and 2.3% found post-phacoemulsification images significantly better. The average rating for all reviewers was 2.88 ± 0.98, approximately the “3-no difference” response.

Discussion
There has been much debate regarding optimal timing of MIGS procedures involving intraoperative gonioscopy. Due to the potential for corneal edema after cataract surgery, some surgeons advocate for angle surgery before cataract removal while others prefer to perform these procedures after lens removal when the angle may be deeper and trabecular meshwork identification can be simpler due to blood in the canal of Schlemm. Despite opposing views, there has been no published study comparing the visualization for angle surgery before and after phacoemulsification. Our study suggests that when MIGS surgeons are masked to the timing of images, there is little difference in surgical view before and after phacoemulsification.

Conclusion
For most combined cataract and MIGS procedures, there is minimal difference in the view of the angle before and after phacoemulsification. Certain patient specific factors, such as a history of corneal pathology, could produce different results and should be investigated in the future.

Reference
Management of Angle Closure Glaucoma From Plateau Iris Syndrome with Laser Iridoplasty Combined with Phaco/IOL/Goniosynechialysis/ ECP: Surgical Outcomes

KRISHNA SHANMUGAM1, Ramesh Ayyala
1 Tulane University School of Medicine

Purpose/Relevance
The purpose of this study was to better examine the surgical outcomes including changes in IOP control, visual acuity, and angle anatomy using a fixed combination of pre-operative laser iridoplasty followed by Phaco/IOL/Goniosynechialysis (GSL)/Endocyclophotocoagulation (ECP) in the management of patients with angle closure glaucoma secondary to plateau iris syndrome (PIS).

Methods
All patients with angle closure glaucoma related to plateau iris syndrome presenting to the Tulane Glaucoma service between 2010-2016 were analyzed in this retrospective study. Diagnosis was confirmed in all patients with complete eye exam, gonioscopy and high frequency ultrasonography. All patients were treated with the combination of laser iridoplasty on initial presentation followed by Phaco/IOL/GSL/ECP, performed by a single experienced surgeon, and were followed for 3 months postoperatively. Statistical significance was calculated using the unpaired student t-test.

Results
14 patients (20 eyes) with angle closure glaucoma with plateau iris syndrome were included in this study. Mean improvement in visual acuity pre-op to post-op in logMAR units was 0.10; P < 0.0001. Mean reduction in IOP pre-op to post-op was 8.8 mm Hg; P < 0.0001. Mean increase of angle on gonioscopic view in degrees was 14.74 degrees ; P < 0.0001. One patient developed malignant glaucoma and required core vitrectomy with opening of posterior capsule; otherwise, there were no other major complications.

Discussion
This study successfully elucidates the role of laser peripheral iridoplasty combined with phaco/IOL/GSL/ECP. Managing angle closure in a plateau iris syndrome patient can be challenging and should be tackled in a stepwise approach. Medical and laser options are helpful, but ultimately this frequently becomes a surgical disease. Phaco/IOL can be a great tool and may cure the angle closure, but other techniques like goniosynechialysis and ECP are pivotal to this mechanism of angle closure. Goniosynechialysis helps peel the peripheral synechiae, while ECP helps directly deal with the plateau iris mechanism by shrinking the anteriorly displaced ciliary processes. Given the above data, one can confidently state that this algorithm is efficacious for those with angle closure glaucoma with a plateau iris syndrome.

Conclusion
Iridoplasty combined with Phaco/IOL/GSL/ECP yields a statistically significant increase in visual acuity, drop in IOP, and increase in degrees of the gonioscopic evaluation of the angle, while avoiding the multiple potential complications that can be associated with primary trabeculectomy and other modes of traditional glaucoma surgery.

References
100 Safety and Efficacy of Micropulse Transscleral Cyclophotocoagulation Diode Laser in Treating Glaucoma: Intermediate Term Results

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¹ Tulane University

Purpose/Relevance
To report the intermediate term safety and efficacy of micropulse transscleral cyclophotocoagulation (MP-TSCPC; IRIDEX IQ810 Laser Systems, CA) system using a diode laser in treating glaucoma.

Methods
This is a retrospective multi central study. Tulane IRB permission was obtained. Glaucoma patients who underwent MP-TSCPC were analyzed. A transscleral diode laser, the Cyclo G6 laser system (Iridex) with a P3 probe, is used. The laser settings used averaged at 2,000 mW at 80 second arc treatment each, with a total of two arcs to complete the treatment. All procedures were performed under monitored anesthesia. Topical steroids and cycloplegic drops are used for 2 weeks. Pre and post procedure VA, IOP, medications and complications were recorded and analyzed.

Surgical success was defined as IOP > 6 mm Hg < 18 mm Hg or 20% reduction in IOP from baseline. Failure will be defined as (1) IOP < 6 mm Hg or > 18 mm Hg with (qualified ) or without medications (complete), (2) Vision loss of LP or Loss of 3 or more lines attributable to laser procedure, and (3) necessity of further surgical intervention.

Results
237 eyes of 207 patients (117 men, 90 women) (29% white, 11% AA, 35% Hispanic, 1% Asian, 22.7 % other) with mean age of 72.9 (SD 11.9) and 86% POAG, 6.7% NVG, 6.7% others) were followed for mean of 203 days. Mean pre and post treatment results were as follows: IOP (p<0.01), glaucoma medications (p<0.01), VA (p=0.88). The pre and post treatment IOP was 22.39 mmHg (sd 9.74) and 17.29 mmHg (sd 7.745) with mean % reduction 14.88 (sd 47.47). Surgical success based on IOP was 81% (192 patients) and overall success rate (78%). Complications were 0% (intraop) and dry/itchy eyes (2%), pain (37%), inflammation (41%) in the immediate postoperative period with no long term sequelae.

Discussion
Micropulse Transscleral Cyclophotocoagulation is a relatively new technology in the treatment of refractory glaucoma. Micropulse laser application delivers a series of repetitive short pulses of energy with rest periods in between pulses thus achieving targeted tissue damage and minimizing collateral thermal injury to adjacent tissues. Our study suggests that this procedure can lower IOP with limited side effects compared to conventional transscleral cyclophotocoagulation.

Conclusion
Micropulse Transscleral Cyclophotocoagulation is a safe and effective procedure in the treatment of refractory glaucoma. Further studies are needed to document the long term success.

Reference
Purpose/Relevance
The purpose of this study is to evaluate the consistency of grading glaucoma progression among masked providers. Various team care models for glaucoma management have been described in the literature in other countries like the United Kingdom\(^1\) and Canada.\(^2\) However, limited studies have assessed this team approach in the United States, particularly when providers are given results from multiple testing modalities. The Mayo Clinic Glaucoma Team Model of Care uses consensus definitions of glaucoma severity, testing and treatment algorithms in line with AAO Preferred Practice Patterns. Both glaucoma sub-specialists and optometrists with a special interest in glaucoma participate in the glaucoma care team. New and uncontrolled patients are evaluated and treated by a sub-specialist, and glaucoma team optometrists manage stable patients.

Methods
Two masked team glaucoma sub-specialists and two masked glaucoma team optometrists analyzed data collected from 25 patients, or 50 total eyes, with any form of glaucoma over the age of 18. Subjects were enrolled in the study from 2014 to 2016. Grading was based on virtual visit data from at least two consecutive visits, including historical data, visual acuity, intraocular pressure, disc examination, visual fields, nerve fiber layer OCTs and disc photos. The providers rated subjects as stable or progressed. Agreement on progression among providers was assessed in multiple groups, including within optometry, within ophthalmology, and across all raters. Stata v. 13 was used for statistical analysis.

Results
Agreement and kappa statistics were calculated to determine level of agreement among masked graders. The simple agreement among the two glaucoma specialists was 68% and among the two optometrists was 88%. Complete agreement across the 4 providers was 44% with a kappa of 0.36.

Discussion
A moderate to strong amount of agreement was found within ophthalmologists and within optometrists. Similar levels of agreement (54 to 90%) have been found in the literature. Complete agreement among all four providers was fair.

Conclusion
This suggests that a team based approach with shared definitions of glaucoma severity and progression could be an effective and safe way to co-manage patients and deliver healthcare in a setting where sub-specialist availability is limited. Further studies will be needed to evaluate outcome measures such as the rate of visual field progression or the need for surgical intervention in a team care setting compared to a traditional care approach.

References
**102 Clinical Results of Endocyclophotocoagulation in Glaucoma Refractory**

**MARIA CORINA PONTE-DAVILA¹,**
**Juan Carlos Izquierdo Villavicencio,**
**Fabiola Patricia Quezada, Ana Luisa González Méndez, Rocio Araujo**

¹ Oftalmo Salud

_**Purpose/Relevance**_

Clinical results of endocyclophotocoagulation (ECF) surgery, valuing changes in intraocular pressure (IOP), visual acuity (A.V), reduction of drugs and surgical complications during a year of follow-up.

_**Methods**_

Retrospective interventional case series of 50 eyes diagnosed with medically uncontrolled glaucoma who underwent surgery ECF, between 2014 and 2015 in the OftalmoSalud Institute in Lima. Track 1, 6 and 12 months, 24 months was performed, evaluating the A.V, IOP, antiglaucoma medication and early and late surgical complications. Inclusion criteria were patients with open-angle glaucoma, angle closure glaucoma associated with cataract, narrow-angle glaucoma associated with plateau iris, penetrating keratoplasty glaucoma secondary to that presented IOP greater than or equal to 21 mmHg not controlled maximal medical therapy, besides being pseudophakic and history of previous trabeculectomy with or without antimetabolites or valvular drainage device. Exclusion criteria were less follow-up 24 months after surgery NPL or endocyclophotocoagulation. Surgical success was defined as less than or equal to 21 mmHg and greater than or equal to 6 mmHg with or without antiglaucoma agent PIO.

_**Results**_

The sample included 50 eyes of 39 patients with different subtypes of glaucoma with a mean age of 65.00 years (18-93). Preoperative mean IOP was 22.3 ± 8.73 mmHg. The mean IOP post operative for the first month was 14.80 ± 5.57 mmHg; At 6 months of 14.28 ± 4.65 mmHg, a year of 14.28 ± 4.01 and two year of 13.02 ± 4.01. The anti-glaucoma medications increased from 2.08 ± 0.88 preoperatively to 2.2 ± 0.87 in the first year after surgery. The V.A was stable without significant change. The follow-up showed a reduction in mean IOP of 22.3 mm Hg to 13.96 ± 2.73 (37.3%) (P = 0.000) in the first year. However the reduction in the use of antihypertensive drugs in the ECF group was 9.32% (pre post 2.08 1.60) (P 0.016). Within Choroidal bleeding complications (1.9%), pupillary membrane (3.8%) and hypertensive Peak 50 mmHg (1.9%).

_**Discussion**_

The endocyclophotocoagulation is a technique that combines cyclodestruction and endo visualization of the ciliary processes to decrease the production of aqueous humor and in this way decrease the intraocular pressure. Its main advantage over other techniques is that it allows us to visualize the ciliary processes at the time of allowing cycloablation be sure intraoperatively that meets the objective is achieved and reduce the number of complications. In our study it was evident a decrease of the intraocular pressure statistically significant that persists up to two years follow-up.

_**Conclusion**_

Our results suggest that the ECF provides a safe and adequate IOP lowering preserving visual acuity, with a very low rate of complications and reoperations, which can be performed alone or combined with cataract surgery.
References


103 Pressure-Induced Stromal Keratopathy (PISK) After LASIK: Acute and Late-Onset Presentations

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\(^1\) Conde de Valenciana

Purpose/Relevance
To report a series of 4 cases of pressure-induced stromal keratopathy (PISK) after LASIK procedure.

Methods
Four patients (5 eyes) with history of LASIK consulted for poor visual acuity and ocular pain due to ocular hypertension. At examination, all cases revealed corneal haze and a space filled with fluid between the surgical flap and the residual stromal bed. All cases were managed with topical hypotensive treatment and every one of them was treated with a valve drainage device.

Results
Topical steroids restriction was indicated in all cases. Intraocular pressure (IOP) was normalized in all cases resulting with subsequent interface fluid resolution and a significant improvement of visual acuity in most cases.

Discussion
In PISK, the amount of fluid may vary from a mild haziness to a stock of fluid that creates a gap between the anterior flap and the posterior stroma; for this reason, it seems to be more challenging to diagnose compared to the other interface complications.

Falsely measured low IOP, from readings taken overlying the interface fluid, may cause a delay in diagnosis and treatment, resulting in significant visual loss. Measuring the IOP in the corneal periphery, outside the area of interface fluid, will reveal a more accurate assessment of the true elevated IOP and aid in the diagnosis.

PISK could lead to visual field defects and severe glaucomatous optic neuropathy with decreased visual acuity, as presented in some of our cases.

Conclusion
In conclusion, falsely measured low IOP from readings taken post-LASIK interface fluid may cause a delay in diagnosis and treatment. Peripheral corneal IOP measurement will reveal a more accurate assessment of a true elevated IOP and aid in the diagnosis. We emphasize the importance of measuring IOP peripherally to the flap, since PISK may lead to visual field defects and severe glaucomatous optic neuropathy. PISK is an important sight-threatening interface complication to be aware of after LASIK.

References
104 SLT Efficacy Affected by Ethnicity

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Purpose/Relevance
Glaucoma is a progressive optic neuropathy that is the leading cause of irreversible blindness worldwide. Decreasing intraocular pressure (IOP) can slow the progression of glaucoma. Laser treatment has been shown to be successful in reducing IOP. Argon laser trabeculoplasty (ALT) was efficacious in lowering IOP in both whites and blacks. Selective laser trabeculoplasty (SLT) has been proven to be efficacious in a variety of ethnicities. The aim of the study is to determine whether ethnicity an influence on the success rate of SLT.

Methods
Retrospective chart review of 296 patients who underwent SLT. They were divided into 4 groups based on their ethnic diversity: White, black, Latino, Asian.

Results
296 eyes were studied by their response or failure to SLT. Response to SLT was defined as a 3mmHg IOP decrease or a 30% decrease from baseline. Response difference has been noted between different ethnic groups.

Discussion
The Asian population had the largest reduction in IOP at 3.5 mmHg, compared to whites (3 mmHg), blacks (3.1 mmHg) and Latinos (3.1 mmHg) (p<0.05). There were no serious side effects except for one case of corneal edema and opacity with a hyperopic shift in an Asian patient and one case of a myopic shift in a white patient.

Conclusion
Ethnic diversity may play a major role in response or failure of SLT. There are implications in genetic predictors of failure and gene therapy in the future.

References
105 Micropulse Trans-scleral Cyclophotocoagulation for the Treatment of Glaucoma

ALEXANDER NGUYEN, Robert Noecker
1 Yale School of Medicine

Purpose/Relevance
To evaluate the efficacy and safety of Micropulse transscleral cyclophotocoagulation for the treatment of glaucoma.

Methods
Retrospective chart review of 95 consecutive glaucoma patients (95 eyes). Retrobulbar block was given. Micropulse transscleral cyclophotocoagulation was given using the Micropulse P3 device at 2.0-2.5 Watts, with a total duration of 90 seconds per hemisphere for a total time of 180 seconds, at a 31.3% duty cycle. If retreatment was needed, the same treatment parameters were used for retreatment with an increase in duration to a maximum of 180 seconds. Patients were given post-operative medications including topical steroids QID with a taper over a month. IOP lowering medications were withdrawn as indicated. Patients were seen at post-operative day 1, post-operative week 1, and post-operative month 1, 3, 6, and 12. Follow up time was at least one year. Hypotony was defined as an IOP less than 6 mmHg.

Results
55 of the 95 patients were female. Average age was 69.2 years. Mean follow up time was 14.1 months. Mean pre-operative IOP was 25.1 mmHg ± 5.3. Mean post-operative IOP at 12 months was 17.4 mmHg ± 5.1. Mean medications used were 3.0 medications preoperatively and 1.5 medications post-operatively. 20 patients needed more than one treatment. The most common side effect was anterior chamber cell at one week. No anterior chamber cell was observed in any patient at the 12 month follow up time. No long term hypotony was observed.

Discussion
Micropulse transscleral cyclophotocoagulation is a potential treatment modality for glaucoma, that, unlike the continuous transscleral cyclophotocoagulation, may be associated with fewer ocular adverse effects. With micropulsed delivery of energy, the indications for using of transscleral cyclophotocoagulation may broaden.

Conclusion
Micropulse transscleral cyclophotocoagulation may be a safe and effective treatment for glaucoma.

Reference
1. D Aquiano MC, Barton K, Tan AM et al. Micropulse versus continuous wave transscleral diode cyclophotocoagulation in refractory glaucoma: a randomized exploratory study.
Evaluation of Postoperative Intraocular Pressure After Femtosecond Assisted Cataract Surgery

DAVID TERRELL1, Meenashki Chaku, Brian Sullivan

1 Loyola University Chicago

Purpose/Relevance
To investigate postoperative intraocular pressure after Femtosecond assisted Cataract surgery as compared to incisional corneal surgery. Currently there have been a limited amount of studies that have sought to define post-operative intraocular pressure after Femtosecond cataract surgery, and studies that have been conducted retrospectively have suggested that Femtosecond assisted cataract surgery is not associated with either increased or decreased post operative Intraocular pressure.

Methods
An IRB approved prospective study was conducted at Hines VA (Hines, IL) from 2014 through 2015. The study involved 150 patients who were chosen to either receive Femtosecond assisted cataract surgery or incisional cataract surgery. Goldmann applanation was used to measure the patient’s IOP on POD #1 in the Femtosecond assisted cataract surgery group or patients and our traditional incisional cataract surgery patient group.

Results
Our preliminary results suggest that Femtosecond laser assisted cataract surgery is associated with a higher IOP as compared with traditional cataract surgery at Post operative week 1 and post operative month 6. Statistical analysis was performed by the statistics core at Loyola University.

Discussion
Femto-second laser assisted cataract surgery is known to be associated with intraoperative elevations of intraocular pressure. The postoperative effects that use of femtosecond laser technology have on intraocular pressure are less defined with few studies existing that have looked at post operative time points beyond 1 day. In this study we prospectively looked at multiple postoperative time points (including post op day 1, post op week 1, post op month 1 and 6 months). We have preliminarily found that femtosecond cataract surgery appears to be associated with higher post operative IOPs.

Conclusion
Our preliminary results suggest that Femtosecond laser assisted cataract surgery is associated with an increased post operative IOP. The mechanisms behind this difference remain undefined. We hope to further elucidate these mechanisms in future studies.

Reference
107 Long-term Follow-up of Combined Phacoemulsification and Endoscopic Cyclophotocoagulation in the Treatment of Mild to Moderate Glaucoma

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Purpose/Relevance
To evaluate the long-term effects of combined endoscopic cyclophotocoagulation (ECP) and phacoemulsification (phaco) on intraocular pressure control and medication reliance in the treatment of mild to moderate glaucoma.

Methods
Retrospective chart review in a private practice setting by glaucoma fellowship trained surgeons. A total of 261 eyes in the combined phaco-ECP. Non-comparative study of the effects of phaco-ECP on intraocular pressure and medication reliance over 72 months.

Results
The mean pre-operative intraocular pressure in the combined phaco-ECP group was 17.23 mmHg. At 12 months the mean pre-operative intraocular pressure was 14.70 mmHg. At 48 months it was 15.56 mmHg, and at 72 months the mean intraocular pressure was 13.92 mmHg; a 19.2% reduction in intraocular pressure. Mean medication reliance was 1.26 pre-operatively and was reduced to 0.23 after 72 months. The mean pre-operative best corrected visual acuity (BCVA) was 20/40 at baseline and was 20/30 at 72 months.

Discussion
These results lead to an interesting discussion regarding the utilization of phaco-ECP as a means of lowering intraocular pressure in patients with mild to moderate glaucoma. Treatment for patients with coexisting glaucoma and cataracts remains challenging, with options varying from least invasive to the most invasive. Utilizing combined ECP and phacoemulsification more routinely in this patient population may offer a solution that allows patients to benefit from the long term intraocular pressure reduction as well as decreased financial burden and compliance issues associated with glaucoma medication.

Conclusion
Combined phaco-endoscopic cyclophotocoagulation effectively lowers or maintains intraocular pressure and results in ocular hypertensive medication reduction up to 72 months. Our study demonstrates that phaco-endoscopic cyclophotocoagulation has sustained long term results which may help to reduce glaucoma progression in mild to moderate glaucoma.

References
108 Postoperative Inflammation After Endoscopic Cyclophotocoagulation: Racial Distribution and Effect on Outcomes

ANNA EDMISTON1, Jeffrey SooHoo, Leonard Seibold, Malik Kahook, Mina Pantcheva, Alan Palestine
1 University of Colorado

Purpose/Relevance
To evaluate the presence of persistent anterior uveitis (PAU) and its effect on intraocular pressure (IOP) and visual acuity (VA) after endoscopic cyclophotocoagulation (ECP) in primary open angle glaucoma (POAG).

Methods
A retrospective cross-sectional study of all patients with POAG who underwent combined phacoemulsification cataract extraction (phaco)/ECP or ECP alone from January 1, 2007 to October 31, 2015. The presence of anterior chamber and vitreous cells at 3 months after surgery, steroid treatment, VA, and IOP were analyzed. Patients were categorized according to self-reported race. Patients with a previous diagnosis of uveitis, glaucoma other than POAG, or with subsequent surgeries were excluded. Treatment, VA, and IOP were compared in patients with and without PAU.

Results
Three hundred fifty patients were reviewed; 134 patients did not meet the inclusion criteria. Of the 216 patients analyzed, 155 were Caucasian, 38 African American, 15 Hispanic, and 8 Asian. Average preoperative VA was 0.43 ± 0.42 logMAR and average preoperative IOP was 15.9 ± 4.7 mmHg with no significant differences amongst races. PAU was present in 23/155 Caucasians (14.8%), 19/38 African Americans (50%), 4/15 Hispanics (26.6%), and 2/8 Asians (25%). PAU was significantly higher in African Americans than Caucasians (p<0.0001). There were no significant differences in VA or IOP amongst races, between those with and without PAU or between those treated with topical steroids or not.

Discussion
This study investigates the presence of PAU and its effect on VA and IOP after ECP. Our study shows that African Americans have a significantly higher incidence of PAU than Caucasians after ECP. However, PAU was not associated with poorer VA or IOP, and its treatment with topical steroids did not change these outcomes.1 PAU was treated at the physician’s discretion based on severity and presence of symptoms. The study limitations include its retrospective nature and the lack of standardized treatment protocols and data collection.

Conclusion
Our study found a higher incidence of PAU in African Americans compared to Caucasians after ECP. However, PAU did not have an effect on postoperative VA or IOP at 3 months regardless of treatment. Additional studies are needed to determine if these findings are sustained.

Reference
**109 Micropulse Transscleral Diode Laser Cyclophotocoagulation: Mid to Long-term Results**

**MARISSE MASIS**, Shan Lin, Kelly Babic

1 University of California, San Francisco

**Purpose/Relevance**

To evaluate the mid-longterm results of Micropulse transscleral diode laser cyclophotocoagulation (MP-TCP).

**Methods**

MP-TCP (MP3, Irیدex Corporation, Mountain View, CA) was performed in 40 patients. Exposure time was 80 seconds for each 180° hemisphere, for a total of 160 seconds and 360° with a power of 2000mW. Some eyes were double treated or retreated at a later time. UBM and AS-OCT were performed in selected patients before and 7 days after treatment. Intraocular pressure (IOP) was monitored.

**Results**

Success was defined as IOP lowering ≥20% with medications and was achieved in 66% of the cases, with a mean follow-up of 258 days. Diagnoses included primary open angle glaucoma, pigmentary glaucoma, pseudoexfoliation glaucoma, glaucoma associated with steroid use, neovascular glaucoma and normal tension glaucoma. Suprachoroidal space, scleral spur, and angle dimensions were assessed by UBM in 8 patients. AS-OCT was performed in 12 patients to evaluate anterior chamber and angle structures, iris features, and the anterior capsule of the lens. No presence of suprachoroidal fluid or anatomical change was found, and objective parameters did not significantly change.

**Discussion**

In our study, we found that the majority of eyes (66%) treated by the new MP-TCP achieved IOP reduction of at least 20%, with a mean follow up of over 8 months. There were no serious complications such as phthisis, persistent hypotony, or cystoid macular edema. Furthermore, anterior segment imaging with UBM and AS-OCT did not reveal any anatomic damage or significant change in anterior segment parameters. A small number of cases required retreatment and a very small minority required subsequent filtration surgery.

Previous evidence suggests that transscleral micropulse may be a good alternative to surgical treatment in selected cases, with reasonably good success rates. Our study reports a success rate at the last follow up (66%) which is comparable to another study using standard diode TCP and the same definition of success.

A differentiating characteristic of our study is that our baseline IOP is substantially lower (24 ± 5 mmHg) compared to the available evidence for continuous wave diode TCP. Thus, these studies compared to our results are not necessarily applicable. The reason for the difference in pre-treatment IOP is that the indications and diagnoses in our series were in large part very different from those found in the prior studies. Very often, the reason for use of the MP-TCP was to lower IOP in a case with POAG and good vision, but maximally tolerated medical therapy and an IOP that was above the target range.

In terms of complications there was only one case of early hypotony but otherwise no vision-threatening sequelae which are common after continuous wave diode TCP. In the hypotony case, resolution of the hypotony and vision reduction was accomplished by removal of the topical glaucoma therapy in that eye with subsequent rise in the IOP.

**Conclusion**

MP-TCP is effective at lowering IOP in the majority of patients, and appears safe without major complications.

**References**

110 Outcomes in Micropulse Transscleral Diode Cyclophotocoagulation for Treatment of Refractory Glaucoma

ASTRID WERNER1, Cynthia G. Mattox, Bradley Hansen, Adrian Elfersy
1 Tufts New England Eye Center

Purpose/Relevance
The purpose of this study was to examine the efficacy and side effect profile of micropulse CPC in the treatment of refractory glaucoma.

Methods
This is a retrospective chart review study of patients who underwent micropulse CPC (mCPC) at the Tufts New England Eye Center and Ophthalmic Consultants of Boston between October 2015 and June 2016 (N=33 eyes). Included patients had refractory glaucoma, defined as IOP above target on maximal tolerated medical therapy. Subtypes of glaucoma included were inflammatory, pseudoexfoliation, primary open angle, neovascular and chronic angle closure glaucoma. Patients with or without prior glaucoma surgical procedures were included. The laser settings used were 2000 mW of 810 nm infrared diode laser radiation set on micro-pulse mode delivered over a minimum of 160 seconds. Patients were seen at 1 week, 1 month, 3 months and 6 months, and at each visit, the intraocular pressure, visual acuity, number of glaucoma medicines were recorded. Visual acuity decline, prolonged anterior chamber inflammation, post procedure CME, or pain from the procedure were recorded as complications. Success of the procedure was defined as a drop in IOP to 21mmHg or lower and 20% or more decrease in IOP at 3 months. Failure was defined as IOP greater than 21mmHg or less than 20% reduction, or need for incisional surgery. Repeat mCPC within the follow up period was not considered failure.

Results
24 eyes of the original 33 completed 3 month follow up. The average IOP change was 25% (-7.8 mmHg) at 3 months. The success rate as defined by an IOP \(\leq\)21mmHg and drop in IOP of 20% or more at 3 months was 50%, and the failure rate was 50%. 6 month data collection is not yet complete; however, based on available results, the average IOP drop was 21% (-7.2mmHg) at 6 months. No patients developed post-procedural CME or prolonged anterior chamber inflammation. 6 patients were able to reduce the number of medications used to control IOP. Only one patient experienced a decline in visual acuity of greater than 2 Snellen lines (from 20/40 to 20/70) at 3 months. One patient developed hypotony with choroidal effusions that resolved after 2 weeks. No patients developed pain after the procedure. Three patients had repeat mCPC during the first 6 months after initial treatment. Of these patients, one had a repeat mCPC early (within 2 weeks of initial mCPC) and this successfully lowered IOP at 3 months. The other two had repeat mCPC at 3 and 4 months respectively, and in both cases, repeat mCPC was ineffective in lowering IOP.

Discussion
Micropulse CPC appears to be reasonably effective in reducing IOP in patients with glaucoma that is refractory to medical therapy. Our early experience of micropulse CPC yielded success rates of 50% - lower than success rates reported in prior studies.1,2,3 Postoperative results show that micropulse has a good safety profile with few associated complications and is well tolerated by patients, in contrast to traditional CPC which is typically reserved for end stage glaucoma due to potential associated complications.

Conclusion
Micropulse CPC is a safe and reasonably effective method for lowering IOP in patients with refractory glaucoma who have failed medical therapy. Further study should be directed to identify predictive characteristics of patients who will respond optimally to treatment.

References
1. D Aquino, MC et al., Micropulse versus continuous wave transscleral diode cyclophotocoagulation in refractory glaucoma: a randomized exploratory study, Clinical and Experimental Ophthalmology 2015; 43: 40-46.

<table>
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<tr>
<th>% IOP Change At Each Follow Up Visit</th>
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-35.00% -30.00% -25.00% -20.00% -15.00% -10.00% -5.00%  0.00%
Transscleral Laser Induces Aqueous Outflow Pathway Motion and Reorganization

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1 University of Washington

Purpose/Relevance
To study aqueous outflow system responses to a transcleral µP laser (Iridex™) in an ex vivo system using visually guided positioning & real time observation of tissue responses. Such responses are highly relevant because outflow system tissue configuration determines aqueous flow and IOP, parameters that become abnormal in glaucoma.

Methods
Microscope, video system, micrometer, 1 mm thick radial limbal segments from 4 quadrants (Qd) of primate (m. fasc.), cornea, sclera, ciliary body pinned to paraffin base in Petrie dish, micromanipulator, 810 nm µP laser, Duty Cycle 31.3%. Paired parameters of stepwise power (mw) range: 500-3000 mw and stepwise duration range: 125-3,000 msec; Resultant energy level range: .08-2.35 joules. (Clinically ~ 1.59 joules are applied per location) Cannon Live Image Video capture. ImageJ automatically quantitates laser induced tissue motion.

Results
Ciliary muscle (CM) contraction & relaxation was visible at ≥ 0.08 J in the IN and SN Q but at ≥0.16 J in the IT and ST Q. CM contraction caused the CM facing the AC to transiently move inward and posteriorly at ≥0.75 Joules in all Q. The scleral spur (SS), and trabecular meshwork (TM) moved posteriorly with a change in Schlemm’s canal shape (Fig. 1) (Videos - www.youtube.com/user/ibmurray). After contraction the CM relaxed/recovered to near its pre µP configuration at low energies with a progressive reduction in the recovery response as energy increased (Fig. 2). E.g. in the SN Q CM fascicles turned white at 2.35 joules with a lack of recoil/relaxation resulting in a persistent change in CB, SS and TM configuration.

Discussion
Transcleral µP laser induces contraction of the CM, a well-characterized muscle response to µP lasers. CM shortening causes posterior and inward movement of the SS changing TM and aqueous outflow pathway shape. Currently used clinical parameters are sufficient to induce outflow system pathway changes generally associated with improved aqueous flow. The above described system permits systematic assessment of probe location posterior to the limbus, power, duration and focal depth, all parameters subject to optimization.
**Conclusion**

A transcleral 810 nm µP laser can induce CM shortening, SS rotation, TM movement and SC changes, types of outflow pathway anatomic changes thought to improve aqueous flow that in turn reduces IOP. This pilot effort suggests that systematic studies can help determine optimal parameters necessary for providing a non-incisional glaucoma surgical (NIGS) procedure to alter aqueous flow and IOP.

**References**

112 Phacoemulsification Combined With Trabecular Microbypass Stent (iStent) and Endolaser Cyclophotocoagulation (ECP)

RONALD CARONIA
Ophthalmic Consultants of Long Island

Purpose/Relevance
To evaluate the safety and efficacy of the iStent, cataract surgery, ECP procedure (ICE) in patients with glaucoma. Minimally invasive glaucoma surgery (MIGS) is not as effective in controlling intraocular pressure (IOP) as more invasive procedures. I evaluated ICE to see if further IOP control can be obtained.

Methods
Retrospective consecutive case series from 1/2013 to 12/2015. Preoperative (pre-op) data collected included peak IOP (prior to starting therapy), IOP at last pre-op visit, number of glaucoma medications (#GlMeds), and visual acuity (VA). This same data was collected at 3, 6, and 12 months postoperatively (post-op). Sequelae were also documented.

Results
Forty six cases on 38 patients were performed. Peak pre-op IOP was obtained on 22 (49%) cases. The average age was 76.7 years and 31 were female. The mean pre-Peak IOP was 25.1 mm Hg and the mean pre-op IOP was 18.2 mm Hg. The mean pre-op #GlMeds was 2.3. Post-op mean IOP at 3, 6, 12 months were: 16.9, 16.6, 16.5 mm Hg respectively. Post-op #GlMeds at 3, 6, 12 months was 1.1, 1.0, 1.0 respectively.

Discussion
Since all patients had their IOP at target prior to surgery and were on multiple drops, the main purpose of offering ICE was to reduce the #GlMeds. There was a slight decrease in IOP compared to pre-op IOP, but 18 of the 37 (49%) patients were on no drops and 26 (70%) were on 0 or 1 drop at 12 months. The main objective was met. There was a significant decrease in IOP compared to Peak IOP. The higher than expected incidence of post-op inflammation was likely secondary to the use of ECP that resolved with extended post-op steroid use.

Conclusion
Phacoemulsification combined with iStent and ECP is effective in lowering IOP and decreasing the #GlMeds while maintaining a high safety profile. Combining multiple MIGS warrant further investigation.

Reference
113 Outcomes of Micropulse Transscleral Cyclophotocoagulation in Medically Uncontrolled Glaucoma

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¹ University of Pittsburgh

Purpose/Relevance
The goal of this study was to describe our experience with the micropulse transscleral cyclophotocoagulation (MP-TSCP; IREIDEX IQ810 Laser Systems, CA) in patients with uncontrolled glaucoma.

Methods
All patients who presented to the University of Pittsburgh, Department of Ophthalmology who underwent MP-TSCP for medically uncontrolled glaucoma between 12/11/2015 and 4/25/2016 were included in our study. Laser settings were 2000 mW of 810 nm diode laser set on micropulse delivery mode. The laser was delivered using the transcleral probe over 360° for 100-180s. The duty cycle was set at 31.3% in 0.5 ms of “on time” and 1.1 ms of “off time” pulse trains.

Results
34 eyes of 32 patients underwent MP-TSCP. 18 eyes had POAG; 5 had mixed mechanism glaucoma, 4 had NVG, and the rest had pigmentary glaucoma, uveitic and steroid induced glaucomas. Mean IOP dropped from 29.2±10.4 mmHg on 3.3 glaucoma drops preoperatively to 16.6±9.7 mmHg on 3.3 drops at 2 week follow-up, representing 41±30 % drop in IOP. The 3 month mean IOP was 19.3±9.2 mmHg on 2.7 drops. While at 6 months, the mean IOP was 13.2±5.1 mmHg (p<0.001) on 2.4 drops (p=0.006), representing 42±23 % drop in IOP. Five patients underwent a second MP-TSCP treatment after a mean duration of 64.8 days after the initial treatment. Four patients underwent continuous wave diode within 52 days and 2 required incisional surgery. No complications were reported in this series.

Discussion
The MP-TSCP laser treatment resulted in a significant IOP reduction at up to 6 months of follow up with a significant reduction in the amount of required anti-glaucoma drops.

Conclusion
The efficiency, technical simplicity and safety of MP-TSCP may suggest a growing role for this innovative technology in patients with uncontrolled glaucoma especially prior to considering incision surgery. Further work is needed to determine its place in the glaucoma management algorithm. Long term results and outcomes of re-treatment are yet to be evaluated.

References
114 Excimer Laser Trabeculostomy (ELT), a Laser Based MIGS Procedure with No Implants, Enables Consistent Intraocular Pressure-Lowering in Glaucoma Patients Over 8 Years, Both Stand-Alone and Combined With Phacoemulsification

MICHAEL BERLIN1, Marc Töteberg-Harms, Vigan Roka, Lea Kleineberg, Richard Stodtmeister, Ulrich Giers, Michael Riggs

1 Glaucoma Institute of Beverly Hills

Purpose/Relevance
To evaluate the long term intraocular pressure lowering efficacy and safety of Excimer Laser Trabeculostomy (ELT) both as a stand-alone procedure and combined with phacoemulsification (ELT+Phaco) in patients with open-angle glaucoma (OAG).

Methods
46 eyes with open angle glaucoma or ocular hypertension treated medically underwent ab-interno Excimer Laser Trabeculostomy. 37 eyes with open angle glaucoma or ocular hypertension treated medically with surgical cataract underwent ELT combined with phacoemulsification. Patients were followed at 1 day, 1 month, 3 months, 6 months, 1 year, 2 years, 3 years, 4 years, 5 years, 6 years, 7 years, and 8 years. The primary outcome measures are mean change in IOP (without washout) and number of glaucoma medications from baseline. Secondary outcome measures are change in visual acuity (BCVA), surgical complications, and adverse events (AE).

Results
At 8 years, the mean IOP in the ELT group was reduced by 29.7% from a pre-op IOP of 22.9±5.4mmHg to 16.1±3.4mmHg (p-value IOP <0.001). In the ELT+Phaco group, the mean IOP was reduced by 43.4% from a pre-op IOP of 25.1±6.1mmHg to 14.2±3.1mmHg (p-value IOP <0.001). The number of glaucoma medications at 8 years for the ELT group was 1.2±1.2 medications compared to 1.6±0.7 medications at pre-op (p-value meds 0.152). The number of medications for the ELT+Phaco group was 1.8±0.8 medications compared to 1.3±0.7 medications at pre-op (p-value meds 0.087).

Discussion
ELT both as a stand-alone MIGS procedure and ELT+Phaco are clinically safe and effective and enable long-term, consistent, significant reductions in IOP in patients with OAG. Glaucoma medication requirements decreased with ELT alone and were similar to pre-op in ELT+Phaco with marked, consistent, significant IOP lowering. 8-year post ELT IOP reduction with no implants was equivalent to 1- and 5-year IOP-lowering data following combined phacoemulsification with iStent implants.

Conclusion
ELT and ELT+Phaco enable consistent IOP lowering for at least 8 years without implants. This study presents the longest post MIGS procedure data which validates the concept of MIGS procedures for long-term IOP lowering.

References
ELT ALONE

n = 21/46

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ELT + Phaco

n = 19/37

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115 Trypan Blue for the Assessment of Filtering Bleb Function During Cataract Surgery: Results of a Pilot Study

EDWARD YUNG1, Kamran Rahmatnejad, Arjun Patel, Marlene Moster
1 Wills Eye Hospital

Purpose/Relevance
Trabeculectomy is a filtering surgical procedure commonly used to reduce intraocular pressure (IOP). Inflammation after cataract surgery theoretically has a negative impact on bleb survival. The purpose of this study is to explore VisionBlue (trypan blue) as a means of intraoperatively assessing function during phacoemulsification of an existing filtering bleb and predict future bleb failure.

Methods
Prospective, cross-sectional study of patients with a history of trabeculectomy placed for glaucoma undergoing phacoemulsification were enrolled in the study. Patients with any intraocular surgery or laser within 3 months of scheduled cataract surgery, active ocular inflammation, history of tube shunt placement, or allergy to ophthalmic dyes were excluded. 0.5 cc of VisionBlue was injected intraoperatively during cataract surgery and photographs were taken. Bleb staining was graded as 1+ through 4+ by the investigators based on a standard set of photos. Patients were grouped into 1+ to 2+ (mild staining) and 3+ to 4+ (diffuse staining) for final analysis. Decrease in bleb function was defined as a greater than 20% increase in IOP from baseline, need for additional IOP lowering medications, and need for additional surgical intervention.

Results
14 patients were enrolled into the study and had complete post-operative month 1 data. 8 patients were categorized as mild staining, and 6 were categorized as diffuse staining. Mean baseline IOP was $11.43 \pm 2.90$ mmHg in the mild staining group and $9.71 \pm 3.49$ mmHg in the diffuse staining group ($p=0.18$). IOP at one month post-operatively increased by $2.85 \pm 5.63$ mmHg and $4.29 \pm 7.98$ mmHg in the two groups, respectively ($p=0.36$). Decreased bleb function occurred in 75% and 33%, respectively ($p=0.07$).

Discussion
No statistically significant difference was seen in mean change in IOP or number of medications needed to control IOP after cataract surgery between the two groups. A greater trend towards decreased bleb function was seen in the mild staining group by post-op month 1, though it was not statistically significant.

Conclusion
Intraoperative VisionBlue during phacoemulsification allows visualization of filtering bleb function at the time of surgery. Greater bleb staining may predict a trend towards decreased risk of early bleb failure after cataract surgery. This potentially allows us to predict the need for concurrent glaucoma procedures such as bleb needling during phacoemulsification.

Reference
Bio-modulation of Primary Human Tenon’s Capsule Fibroblasts Using a Novel Application of Coated Magnesium

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¹ Ivey Eye Institute

Purpose/Relevance
To examine the ability of coated magnesium to modulate the fibroblastic activity of human Tenon’s capsule fibroblasts.

Methods
Primary cultures of human Tenon’s capsule fibroblasts (HTCFs) were established from tissue specimens obtained during ophthalmic surgery. Characterization of the cells was performed through immunostaining. Cells were cultured on a glass surface or one of three types of coated magnesium: hydroxyapatite, dicalcium phosphate dihydrate (DCPD), or dicalcium phosphate dihydrate conjugated with stearic acid (DCPD-SA). Fluorescence imaging was used to assess cell adhesion and spreading. Metabolic activity (MTT), proliferation (BrdU), cytotoxicity (LDH), apoptosis (ELISA), and protein secretion (fibronectin ELISA) cellular assays were completed.

Results
Cells grown on all coated magnesium displayed poor spreading and adhesion. Those grown on DCPD and DCPD-SA coated magnesium had significantly lower metabolic, proliferative, and protein secretory activity than control. HA coated magnesium had a lesser effect on these activities. None of the treatments resulted in increased apoptosis or necrosis consistent with the potential biocompatible nature of the materials tested.

Discussion
Trabeculectomy is currently the most common surgical method for the treatment of glaucoma, but has only a moderate success rate due to unpredictable and variable wound healing responses. Newer ab interno bleb forming procedures also rely heavily on the modulation of the wound healing response. A hallmark of wound healing is increased deposition of extracellular matrix by Tenon’s capsule fibroblasts which become activated following injury. The present adjunctive use of antimetabolite drugs inhibits wound healing but cannot be precisely dosed and adds risks. Novel techniques to regulate Tenon’s fibroblastic activity continue to be of high interest. Magnesium has several enticing properties that may render it a useful adjunct to bleb forming procedures.

Conclusion
Coated magnesium has varying degrees of modulatory effect on Human Tenon’s Capsule Fibroblasts and appears to be biocompatible in vitro. The data support the further investigation into magnesium as a novel adjunctive approach to wound modulation in bleb forming glaucoma surgery.

References
Outcomes of Micropulse Cyclophotocoagulation: A Multicenter Review

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1 Private Practice, Ngoc Nguyen MD

Purpose/Relevance

Background: Micropulse cyclophotocoagulation was FDA approved in 2015 and is considered a gentler form of cyclodestruction that can be placed earlier in the management algorithm than incisional surgeries such as trabeculectomy. Previous studies on this procedure had relatively small sample sizes (19-40 eyes) and only included advanced, refractory, or end-stage glaucoma.1,2 The purpose of this study is to report the efficacy and complications of micropulse cyclophotocoagulation in a larger series of patients with all stages of glaucoma and with or without previous glaucoma surgery.

Purpose: To report the efficacy and complications of micropulse cyclophotocoagulation (MPCP).

Methods

Retrospective review of patients from 3 clinical sites. Treatment was considered a failure if any one of the following criteria were met 1) Additional IOP lowering intervention 2) Less than 20% IOP reduction from baseline (with medication) except if target IOP was met or number of medications was reduced by 2 or more despite less than 20% IOP reduction.

Results

166 eyes of 144 patients (mean age 70.6±14.3yrs, 52% female, 58% Asian, 31% Caucasian) were reviewed. 60% had POAG, 64% were pseudophakic, 38% had prior glaucoma surgery (mean number of procedures was 0.7±1.1, range 0 to 6). Mean VCDR was 0.85±0.16 and average Humphrey visual field mean deviation (MD) was -11.6±8.5dB. Treatment duration was 160 seconds in 23.5%, 240s in 31.3%, and 320s in 45.2% of eyes. Mean follow-up was 4.5±2.9 months (range 1 week to 10.7 months). Post-operative data was available for 92%, 74% and 42% of eyes at 1, 3, and 6 months respectively. Mean IOP decreased from 22.0±8.4 to 16.7±6.9mmHG at last follow-up (21% decrease, p<0.0001). Mean number of medications decreased by 0.6±1.1 (p<0.0001). There was no significant change in mean logMAR visual acuity. Additional intervention was required in 36 eyes (21.7%) and 34 eyes (20.5%) did not meet the IOP lowering criteria such that the total number of failures was 70 (42.2%). Using Cox proportional hazards models, the factors associated with decreased risk of failure by criterion 1 (additional intervention) were female gender (48% decrease in failure rate compared to males) and longer duration of treatment (50% decrease in failure rate with 320s versus 160s and 240s). Each mm Hg increase in baseline IOP was associated with a 9.6% increase in failure rate. When using combined criteria 1 and 2 to define failure, the only predictive factor was MD; eyes with MD ≥ -6.0 dB had a 2.2 times higher failure rate than those with MD < 6dB. Complications included mydriasis (n=18,10.8%), SPK (n=11,6.6%), fibrinous AC reaction (n=5, 3%), CME (n=4, 2.4%), decreased accommodation (n=3,1.8%), IOP ≥ 40 on POD 1 requiring AC tap (n=3, 1.8%), and other (n=9, including 1 eye (0.6%) each with intraoperative conjunctival laceration, abducion restriction, chemosis, recurrent iritis, vitreous in AC, myopic shift, hyphema, and intumescent cataract). 19 eyes (11.4%) had persistent complications at last follow-up; these included mydriasis (n=11, 6.6%), SPK (n=5,3%), myopic shift (n=1,0.6%), and CME (n=1, 0.6%). One patient who developed hyphema, severe fibrinous reaction, corneal edema, and intumescent cataract following a 160s MPCP treatment subsequently required cataract surgery with anterior vitrectomy followed by combined PKP with pars plana vitrectomy. None of the eyes developed hypotony and 73% had no complications. Factors associated with higher odds of developing mydriasis after MPCP were Asian race (odds ratio 13.07, p<0.001) and phakic status (OR 3.12, p=0.014).

Discussion

MPCP was useful for IOP lowering in this series of eyes that comprised all stages of glaucoma and nearly two-thirds without prior glaucoma surgery. None of the eyes developed hypotony. Mydriasis and SPK were the most common complications. Although nearly three quarters had no adverse effect, one patient had very severe complications leading to permanent reduction in visual acuity, and 11.4% had persistent complications. Potential complications should be discussed in detail especially when the procedure is being considered for those with good visual acuity and early stage disease.

Conclusion

MPCP was successful in 58% of eyes in this case series within short follow-up. Longer duration of treatment and female gender were associated with decreased failure rate, whereas higher baseline IOP and worse MD were associated with increased failure rate. Nearly three-quarters had no complications after MPCP. Asian race and phakic status were associated with higher odds of developing mydriasis, which was the most common complication. In 11% of eyes, complications had not resolved at the time of last follow-up.

References


Results of Endocyclophotocoagulation in a Predominantly Haitian and Hispanic Population

COREY WALDMAN1, Efren Gonzalez, Manishi Desai, Babak Eliassi-Rad
1 Boston University, Boston Medical Center

Purpose/Relevance
To explore the results of endocyclophotocoagulation (ECP) combined with cataract surgery in a predominantly Haitian and Hispanic population.

Methods
A retrospective chart review of combined phacoemulsification and ECP cases at Boston Medical Center from October 2015 until August 2016 was performed. 20 cases by 2 surgeons were reviewed. 4-6 clock hours of ciliary body were treated with .20-.25mw power. Patient demographics and outcomes such as age, ethnicity, glaucoma type, previous ocular surgeries, pre and postop visual acuity (VA), pre and postop intraocular pressure (IOP), pre and postop number of glaucoma medications and complications were noted. Primary outcomes were postop IOP, number of glaucoma medications and postop VA. Success was defined as a ≥20% decrease in IOP at the last visit when compared to baseline, regardless of medications. Complete success was defined as ≥20% decrease in IOP without the use of medications.

Results
80% of patients were Haitian or Hispanic. 15% of patients had undergone prior trabeculectomy. 20% had undergone prior SLT. The average pre-op VA was 20/80 which improved to 20/30 by the last visit. The average pre-op IOP was 18 mmHg on an average of 2.4 drops. The average IOP at the last follow up visit (varying from 1 to 9 months) was 15.8 mmHg (12.2% decrease in IOP with an average of 1.25 medications). Success occurred in 6/20 (30%). A 20-63% decrease in IOP occurred in these patients. Complete success occurred in 2/20. While 9/20 were not on any glaucoma medications at the last postop visit. Complications included an IOP spike of >30 on postop day 1 in 3/20. One patient developed a steroid response requiring a Baerveldt glaucoma implant. No patients developed hypotony, post-op inflammation or lost light perception. VA improved in 19/20 patients.

Discussion
ECP of 4-6 clock hours is effective, resulting in a decrease in IOP and requiring less medication than pre-op. Additionally it is safe with minimal complications. Vision improved in nearly all cases. It can be used effectively in all stages of glaucoma. The population studied is unique compared to other studies. Less clock hours of treatment compared to other studies still showed success and no inflammation. Thus less treatment may be safe and effective. ECP may be a successful adjunct to patients who are post-trabeculectomy as robust IOP lowering occurred. Limitations include retrospective study and no long term follow up.

Conclusion
ECP is a safe, effective procedure to lower IOP in Haitian and Hispanic patients and treating 4-6 clock hours may be sufficient.

Reference
119 Clinical Efficacy of Micropulse Transscleral Cyclophotocoagulation in Advanced Glaucoma

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1 Wills Eye Hospital

Purpose/Relevance

To investigate the clinical efficacy and safety profile of micropulse transscleral cyclophotocoagulation (MP-TSCPC, IRIDEX IQ810 Laser Systems, CA) in patients with advanced glaucoma.

Methods

Patients with advanced glaucoma who underwent MP-TSCPC at the Wills Eye Hospital from 3/23/2014 – 6/23/2016 and who had at least 3 months of follow-up were included in this retrospective chart review. Laser settings were 2000mW of 810nm infrared diode laser with a duty cycle of 31.3%, which translated to 0.5 milliseconds of “on time” and 1.1 milliseconds of “off time.” The laser was delivered over 360 degrees for 120-320 seconds. Treatment success was defined as an intraocular pressure (IOP) of 6-21 mmHg or a reduction of IOP by 20%. Failure was defined as an inability to meet the criteria for success, or need for re-treatment > 3 times. Outcomes were assessed at 3 months, 6 months, and the last available follow-up visit for those followed longer than 6 months.

Results

81 patients were included in the study with mean follow-up time of 7.5 ± 4.5 months. 12 patients (15%) underwent no more than two repeat MP-TSCPCs during the follow-up period. Treatment success rates were 91% at 3 Months, 85% at 6 months and 83% at last follow-up. IOP was reduced by 50% at last follow-up and the mean number of IOP lowering medications was reduced from 2.3 at baseline to 1.6 at last follow-up. Complications of MP-TSCPC included 5 patients with early hypotony (<1 month, 6%), 4 patients with late hypotony (>1 month, 5%), 25 patients with prolonged anterior chamber inflammation (1+ cell or flare for >3 months, 33%) and 8 patients with a loss of 2 or more lines of Snellen visual acuity (10%).

Discussion

MP-TSCPC has a high rate of treatment success through 6 months of follow-up in patients with advanced glaucoma. Visually significant complications do occur in a minority of patients.

Conclusion

Further research is needed to compare the clinical efficacy and safety profile of MP-TSCPC to continuous wave transscleral diode cyclophotocoagulation. It would also be helpful to identify which patients are at higher risk of developing complications as a result of MP-TSCPC treatment.

References


120 Micro-pulse Cyclophotocoagulation Reduces IOP Faster Compared to G-Probe-Cyclophotocoagulation

MARC TOETEBERG-HARMS¹, Jens Funk, Drazen Jurjevic
¹ University Hospital Zurich

Purpose/Relevance
The aim was to evaluate efficacy of standard G-Probe transscleral cyclophotocoagulation (TS-CPC) in patients with advanced glaucoma in comparison to Micro Pulse P3 (MP3-CPC) cyclophotocoagulation.

Methods
A retrospective chart review was conducted. Efficacy, i.e. reduction of intraocular pressure (IOP) and number of anti-glaucoma medications (AGD), was evaluated with a follow-up of 6 months. Data was collected at baseline, 1, 3, and 6 months after the cyclophotocoagulation procedure.

Results
34 eyes were included (16 eyes had MP3-CPC and 18 TS-CPC). Median age was 70.8±17.1 years. IOP at baseline was 28.8±7.8 in the TS-CPC groups and 29.0±8.2 in the MP3-CPC group respectively (P=0.493). Values for IOP and AGD at baseline, 1, 3, and 6 months are shown in table 1 along with P values.

Discussion
Both cyclodestructive procedures, TS-CPC and MP3-CPC, reduced IOP and AGD simultaneously. However, MP3-CPC reduced IOP significantly at 1 month already whereas TS-CPC reduced IOP significantly not before 3 months. Analysis of data with longer follow-up and larger sample size is ongoing.

Conclusion
MP3-CPC was non-inferior to TS-CPC regarding IOP and AGD reduction. Furthermore, MP3-CPC reduced IOP faster compared to TS-CPC.

References

<table>
<thead>
<tr>
<th></th>
<th>G-Probe TS-CPC</th>
<th>MP3-CPC</th>
<th>P value (TS-CPC to MP3-CPC)</th>
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<tbody>
<tr>
<td></td>
<td>IOP ± SD</td>
<td>AGD ± SD</td>
<td>IOP ± SD</td>
</tr>
<tr>
<td>Baseline</td>
<td>28.8 ± 7.8</td>
<td>-</td>
<td>29.0 ± 8.2</td>
</tr>
<tr>
<td>1m</td>
<td>23.3 ± 14.9</td>
<td>0.114</td>
<td>2.3 ± 1.8</td>
</tr>
<tr>
<td>3m</td>
<td>14.9 ± 6.7</td>
<td>&lt;0.001</td>
<td>2.9 ± 1.8</td>
</tr>
<tr>
<td>6m</td>
<td>19.1 ± 8.5</td>
<td>0.048</td>
<td>3.6 ± 1.1</td>
</tr>
</tbody>
</table>

(m = month, IOP = intraocular pressure, AGD = anti-glaucoma drugs, SD = standard deviation, t = time point x)
Purpose/Relevance
To evaluate the outcome and efficacy of micropulse transscleral cyclophotocoagulation (MP-TSCPC) in pediatric glaucoma patients and compare the results to those in adult glaucoma patients.

Methods
Consecutive 36 eyes (9 eyes from 9 pediatric patients and 27 eyes from 25 adult patients) with glaucoma that underwent MP-TSCPC were included in this retrospective observational study. Laser settings for MP-TSCPC was 2000 milliWatts with the duty cycle of 31.33%, delivered over 180 degrees for 80-160 seconds. The patients were followed for 6 months. The primary outcomes were the change in intraocular pressure (IOP) and rate of success, defined as either IOP of less than 21 mmHg or more than 20% deduction from the baseline IOP and not requiring additional glaucoma surgery by the last follow-up.

Results
Preoperatively, the mean IOP in adult patients was 28.41±8.32 mmHg. Postoperatively, the mean IOP was decreased to 14.44 ±6.38 mmHg at 1 month (P<0.001), 18.56 ± 7.66 mmHg at 3 months (P<0.001), and 18.62 ± 6.64 mmHg at 6 months (P<0.001). In pediatric patients, the mean IOP was 34.28±9.92 mmHg (n=9) preoperatively. Postoperatively, the mean IOP decreased to 20.44 ±13.41 mmHg at 1 month (P=0.021), 23.56 ± 10.10mmHg at 3 months (P=0.093) and 23.00 ± 8.31mmHg (P=0.018) at 6 months. The success rate in adults was 74.07%, while only 33.33% in pediatric patients (P=0.045) as 66.67% of pediatric patients needed additional glaucoma surgery at either POM# 3 or POM#6. No significant complication was noticed in either group. Due to the limited outcome of MP TSCPC in the 9 pediatric patients in this study, we stopped actively recruiting pediatric patients thereafter.

Discussion
In previous studies, MP-TSCPC was shown to be safe and comparable in efficacy to the traditional continuous wave TSCPC for adult glaucoma patients.1,2 Pediatric glaucoma is well known for its difficulty of management. MP-TSCPC, if effective, would be an invaluable asset in treating pediatric glaucoma due to its minimally invasive nature.

This is the first study examining the effect of MP-TSCPC on pediatric glaucoma patients. The success rate for MP-TSCPC for the adult patients were comparable to those reported in previous studies. The success rate for pediatric glaucoma patients, however, was significantly lower and also appears lower than the success rate reported for traditional TSCPC in pediatric glaucoma patients.3

Conclusion
MP-TSCPC is a safe procedure in pediatric as well as adult glaucoma patients, but the rate of success was significantly lower in pediatric patients than in adult patients in our case series. Thus, MP-TSCPC should be used with caution in pediatric glaucoma before more evidence can be shown.
Table 1. Demographic and clinical characteristics of pediatric Glaucoma Patients Undergoing MP TSCPC

<table>
<thead>
<tr>
<th>Patient</th>
<th>sex</th>
<th>Age (years)</th>
<th>IOP before MPTSCPC(mmHg)</th>
<th>Diagnosis</th>
<th>IOP at 1 month(mmHg)</th>
<th>IOP at 3 months(mmHg)</th>
<th>IOP at 6 months(mmHg)</th>
<th>Success/Failure</th>
</tr>
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<tr>
<td>1</td>
<td>F</td>
<td>4</td>
<td>29</td>
<td>Sturge Weber syndrome</td>
<td>31</td>
<td>29.5</td>
<td>20</td>
<td>Failure due to Reoperation</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>1</td>
<td>25</td>
<td>Sturge Weber syndrome</td>
<td>5</td>
<td>19</td>
<td>16</td>
<td>Success</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>1.3</td>
<td>24</td>
<td>Persistent hyperplastic primary vitreous</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>Success</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>1</td>
<td>42</td>
<td>Primary congenital glaucoma</td>
<td>37</td>
<td>6</td>
<td>9</td>
<td>Success</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>4</td>
<td>38.5</td>
<td>Aphakia glaucoma</td>
<td>41</td>
<td>41</td>
<td>30</td>
<td>Failure due to Reoperation</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>1.7</td>
<td>26</td>
<td>Aphakia glaucoma</td>
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<td>22</td>
<td>Failure due to Reoperation</td>
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<tr>
<td>7</td>
<td>M</td>
<td>4</td>
<td>54</td>
<td>Congenital glaucoma</td>
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<td>25</td>
<td>27</td>
<td>Failure due to Reoperation</td>
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<td>8</td>
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<td>17</td>
<td>31</td>
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<tr>
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<td>M</td>
<td>14</td>
<td>39</td>
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<td>12.5</td>
<td>18</td>
<td>30</td>
<td>Failure due to IOP&gt;21 mmHg</td>
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</tbody>
</table>

References

**122 A Novel Flexible Microfluidic Meshwork to Reduce Fibrosis in Glaucoma Surgery**

**BEHZAD AMOOZGAR1, Lan Luan, Jun Hui Lee, Michele Bloomer, Max Kudisch, Paul Coh, Chong Xie, Ying Han**

1 University of California, San Francisco

**Purpose/Relevance**

Fibrosis and capsule formation are the main reasons for glaucoma implant failure, which is largely caused by foreign body reaction between the implants and the surrounding tissue.\(^1,2\) To address these critical issues, we present a novel implant for glaucoma device. The design consists of interconnected, cellular-dimensioned microfluidic channels which can conduct aqueous humor. Moreover, it is ultra-flexible and affords mechanical compliance similar to that of the ocular tissue so that the implant is not recognized as a foreign body. In this study, we used the rabbit model to test the amount of capsule formation around the new microfluidic meshwork and compare it with capsule formation around a conventional glaucoma surgical device.

**Methods**

The ultra-flexible microfluidic implant was made from Polydimethylsiloxane (PDMS) by using micro-fabrication techniques. The implant was engineered to dynamically maintain aqueous humor outflow at about 1 – 2 µL/min with channel dimension at 25 x 25 µm. With aqueous humor viscosity at 4 centipoise (cP), the implant was designed to reach the targeted pressure of 10 mmHg. The overall size of the implant was 10x10mm. Six eyes from 3 New Zealand albino rabbits were randomized to receive either the microfluidic new implant or a plate of Ahmed valve PF7, which were placed at subtenon space at superotemporal quadrant in a standard fashion (Fig. 1). All animal eyes were examined for signs of infection and implant erosion on days 1, 3, 7, and 14 and monthly thereafter. The eyes were exenterated at 3 months. Histology slides of the implant and the surrounding tissues were prepared and stained with hematoxylin-eosin. The histologic sections were examined using light microscopy by a pathologist who was blinded to the different groups. Thickness at the bottom of the capsule around the implant was measured for each eye. Paired student’s t-test was used to compare the difference in the thickness of fibrous capsule between the two groups.

**Results**

As shown in Fig 2, in both cross section (Fig 2A and 2B) and histological slides (Fig 2C and Fig 2D), a dense capsule formed around the plate of Ahmed PF7 but nearly no capsule formed around the brown microfluidic implant. Thickness at the bottom of fibrotic capsules around the Ahmed PF7 from the 3 rabbit eyes was 90um, 82um, and 72 µm, respectively. The thickness at the bottom of fibrotic capsules around the new microfluidic implant was 1um, 2um, and 1 µm, respectively. The difference in thickness of capsule between the two groups was significant (P<0.001). No complications were noticed in the 6 eyes, and both implants were tolerated well by all rabbits.

**Discussion**

The novel porous microfluidic implant is ultra-flexible, has cellular scale feature, and maintains bio-integration characteristics. These key components minimize foreign body reaction between the implant and eye tissue, and therefore decrease fibrosis and capsule formation. This addresses the critical issue of scar formation after glaucoma surgery.

**Conclusion**

This study supports that this new microfluidic implant can substantially reduce or even eliminate fibrotic tissue formation around implants after placed into rabbit eyes. In further research, we will incorporate the meshwork with a drainage tube to test a new glaucoma surgical device.

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*Fig.1 One eye received microfluidic implant (left upper) and the other eye received a plate of Ahmed PF7 (right upper)*
Figure 2. Animal study of prototype meshwork, in comparison with AGV. A. Cross section of AGV on the rabbit eye. Magnified view is showed in the red box. B. Cross section of the prototype meshwork on the rabbit eye. Magnified view is showed in the red box. C. HE staining of histological slide for the AGV implant. Arrow points to the base of capsule (100x) D. HE staining of histological slide for the prototype meshwork. Arrows denotes meshwork components (100x). Magnified view of meshwork (400x) is showed in the black box.

References


123  Efficacy of Transscleral Cyclophotocoagulation Using 2 Different Treatment Protocols

YUNGTAI KUNG1, Narae Ko1, Leona Ding1, Philip Chen1, Joanne Wen1
1 University of Washington

Purpose/Relevance

Transscleral cyclophotocoagulation (CPC) is often used to manage uncontrolled intraocular pressure (IOP) and refractory glaucoma, though treatment parameters vary.1,2 This study examined the long-term efficacy and safety of CPC using 2 different treatment protocols.

Methods

Data was retrospectively collected on patients who underwent CPC at the University of Washington Eye Institute, Seattle, WA between January 1, 2005 – April 1, 2016. Data was collected on visual acuity, pre- and post-CPC IOP, race, gender, type of glaucoma and laser parameters. The Moorfields parameters consisted of 1500 mW at 1500 msec duration for 40 spots, while the long duration parameters consisted of variable power ≤ 2000 mW and duration 2000-4000 msec for ≤ 30 spots. Complications, including hyphema, inflammation, loss of vision ≥ 2 lines, progression to no light perception and hypotony, were also recorded. Success was defined by IOP 5-22 mm Hg at final follow up (≥ 6 months from treatment).

Results

A total of 37 patients were included in this study and of these, 70% (26/37) were considered treatment successes at final follow up. When comparing treatment successes versus failures, there was no significant difference between treatment settings (Moorfields versus long-duration), total power delivered, type of glaucoma, age, race, gender or underlying medical conditions (p>0.05 for all). Treatment failures had a significantly higher incidence of post-operative month one inflammation (p=0.004). Complications were not significantly associated with either laser protocol or any of the other variables.

Discussion

The overall success rate of CPC in this study was 70%, which is consistent with rates reported in the literature.1 Success rates did not differ among patients who received the Moorfields laser protocol compared to the long duration protocol. A recent study comparing short versus long duration CPC similarly reported equal efficacy in IOP lowering between those two protocols.2

Conclusion

While CPC treatment parameters can vary widely in clinical practice, the overall success and complication rates appear to be comparable.

References

Purpose/Relevance
Selective laser trabeculoplasty has few associated risks. More serious complications are rare. Cases of post-SLT central corneal edema with eventual thinning and a hyperopic shift as large as 6.00 diopters (D) have been reported. Determining risk factors could help decrease associated morbidity, including decreased acuity, the use of topical steroids, and a need to adjust corrective lenses. The aim of this study is to find characteristics among patients with a hyperopic shift after SLT, not commonly present in those without a shift. These may then be considered risk factors that if present may sway a clinician to avoid SLT in certain patients or include this in the discussion of risks.

Methods
Retrospective consecutive chart review of patients who underwent SLT from 2004 to 2010 at one institution. Age, gender, refraction, lens status, energy used, AC or endothelial pigment, and corneal pathology, in the operative and fellow eyes, were collected. Cases done with less than 360 degrees were excluded. Main outcome: post-SLT hyperopic shift in spherical equivalent, or corneal edema or thinning. Characteristics between patients with and without hyperopic shifts were compared by percentages of occurrence.

Results
240 procedures were done on 140 patients. 32.5% had an average post-SLT hyperopic shift in the spherical equivalent of 0.72 D (range 0.13 to 2.63 D). 35.4% of all the fellow eyes had an average hyperopic shift of 0.71 D (range 0.13 to 2.88 D). Within the hyperopic shift group, the average age was 64.8 years (range 48 to 95), 71.7% female, 62.3% myopic, 5.1% had endothelial pigment and average total energy 80.5 mJ (range 39.6 to 159.1 mJ). 35.8% had abnormal corneal pathology such as punctate epithelial erosions or guttata. Of those without a hyperopic shift, the average age was 66.1 years (range 25-91), 63.8% female, 60.6% myopic, 7.4% had endothelial pigment and average total energy 89.3 mJ (range 40 to 175 mJ). 39.4% had abnormal corneal pathology.

Discussion
A third of patients experienced a hyperopic shift; however, there was not a statistically significant higher percentage of patients with a hyperopic shift in the operated eye versus the fellow eye. When comparing characteristics of the group with a hyperopic shift to those without, there were slight differences between average age (1.3 years younger), gender (7.9% higher female), lens status (14.6% higher phakia), refractive status (1.7% higher myopia), endothelial pigment (2.3% lower), total energy use (8.85 mJ lower), and abnormal corneal pathology (3.6% lower). No difference was statistically significant.

Conclusion
The incidence of corneal edema following post-SLT with subsequent hyperopic shift is low requiring larger studies to elucidate risk factors. Continued reporting of these events may aid further investigation.

References
**125 Qualitative Assessment of the Distal Outflow Pathway Using Trypan Blue Following Micro-Stenting of Schlemm Canal**

**SHAKEEL SHAREEF**  
Flaum Eye Institute

**Purpose/Relevance**

In the absence of quantitative assessment of the distal outflow pathway to guide targeted stenting of Schlemm’s Canal (SC), Trypan Blue (TB) was injected post implantation to assess extent of uptake by the episcleral vasculature (EV) and to determine whether this correlated with post-op IOP reduction.

**Methods**

Following SC implantation and viscoelastic removal, continuous irrigation was turned off while maintaining the I/A handpiece in the AC. Commercially available TB was injected to fill the AC. Continuous irrigation was then turned on to observe the rate and extent of dye uptake nasally by the EV. Operative reports of consecutive cases (n=40) with minimum 3 mo. follow up (3–12 mo.) were reviewed and categorized as (i) no outflow (Group 1; n=11); (ii) subtle/slow dye uptake (Group 2; n=5); (iii) robust/rapid uptake (Group 3; n=19); (iv) uptake noted but not rate (Group 4; n=5). For each group, % IOP lowering at last visit vs. pre-op IOP, % decrease in number of pre/post-op meds, number with ≥20% IOP decrease were recorded. Proper anatomic placement of the microstent was assessed using gonioscopy focusing on depth of insertion (superficial vs. deep), extent of cannulation (complete vs. partial); snorkel patency (patent vs. blocked) and degree of TM pigmentation (TMP).

**Results**

Group 1 [5.9%; 22/8 (63.6%); 30%]; Group 2 [22.5%; 9/2 (77.8%); 50%]; Group 3 [25.6%; 27/4 (85.2%); 68.4%]; Group 4 [11.1%; 7/0 (100%); 40%]. With exception of 1 stent that was two-thirds cannulated, all insertions were deep, completely cannulated with patent snorkel. For those with >20% IOP decrease, Group 1 (all cases +2-3 TMP); Group 2 (+1 TMP); Group 3 (>50% cases +1-3 TMP).

**Discussion**

Qualitative intra-op observation of robust TB outflow via EV (Group 3) was associated with (i) a 4-fold reduction in post-op IOP vs. its absence (Group 1); (ii) >3/4th (Group 3) achieved a decrease in IOP by ≥20% vs. all other groups with a minimum +1 TMP. Groups 1-4 showed a >60% reduction in medication burden.

**Conclusion**

Proper anatomic stenting of SC alone may not ensure optimal IOP lowering. Studies utilizing intra-op TB following stenting in areas of greater TM pigmentation or initial blood reflux in SC provide an opportunity to qualitatively assess the post trabecular outflow pathway in the vicinity of presumed collector channels. TB would serve as an internal marker for robust dye outflow via the EV. If egress is poor, this may allow surgeons to reposition their implant/device of choice to a new location to maximize outflow with subsequent optimal lowering of IOP.

**References**

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126 Micropulse Cyclophotocoagulation: Initial Results in Uncontrolled Glaucoma

MATTHEW EMANUEL¹, Davinder Grover, David Godfrey, Oluwatosin Smith, Michelle Butler, Helen Kornmann, Ronald Fellman

¹ Glaucoma Associates of Texas

Purpose/Relevance
The purpose of this study is to publish the results of Micropulse Trans-Scleral Cyclophotocoagulation (MP-TSCPC), a new and increasingly popular treatment, in patients with uncontrolled glaucoma.

Methods
A retrospective chart review was performed for all patients who underwent a MP-TSCPC at the Glaucoma Associates of Texas. The eyes in this study reflect the initial learning curve for all surgeons involved.

Results
A total of 84 eyes were treated with MP-TSCPC in this study. The mean age of treated patients was 74 years and 48 (57%) were female. Preoperatively, mean intraocular pressure (IOP) was 27.7 mmHg and mean number of ocular antihypertensive medications used was 3.3. Mean post-operative IOP at months 1, 3, 6, and 12 were lowered to 16.3 mmHg (41.2% reduction), 14.6 mmHg, 13.0 mmHg, and 11.1 mmHg, respectively. Postoperative ocular antihypertensive medication use was also lowered to 1.9, 2.0, 2.0, and 2.3 medications at months 1, 3, 6, and 12, respectively. Five patients required further laser or surgical intervention for adequate IOP control. Complications included hypotony, IOP spike, hyphema, serous choroidal detachment, and persistent inflammation.

Discussion
To our knowledge, this is the largest cohort of patients undergoing Micropulse TSCPC. Our study shows that MP-TSCPC is effective at lowering intraocular pressure and decreasing the need for ocular antihypertensive medications. While there are some relatively mild complications, mostly related to low or high IOP, short term results indicated that MP-TSCPC is adequately safe and effective at lowering IOP.

Conclusion
Eyes with limited visual potential or at high risk for incisional glaucoma surgery can successfully be treated with ciliary body ablation. Micropulse transscleral CPC is a reasonable and effective alternative to traditional CPC. It should be noted that these results present short term data and both longer follow-up and further studies are necessary.

References
Purpose/Relevance
To assess the efficacy of combining the procedures of trabeculectomy with Baerveldt implant insertions in patients with primary open angle glaucoma versus other types of glaucoma.

Methods
Visual acuity and intraocular pressure were analyzed retrospectively from our 67 patients for a duration of day one post-op up to two years post-op.

Results
Our data included 67 patients of ages 15-89 at the time of surgery. 42 patients had primary open angle glaucoma (POAG) and 25 had other types of glaucoma. The other types of glaucoma studied included glaucoma caused by pigment dispersion syndrome, juvenile glaucoma, neovascular glaucoma, mixed mechanism glaucoma, traumatic glaucoma, chronic angle closure glaucoma, and uveitic glaucoma.

Preoperatively, the POAG patients had an average IOP of 23.4 mmHg and a visual acuity of 25/200. Our patients with other types of glaucoma had an IOP of 26.7 and also an average visual acuity of 15/200. The p value for the IOP between the 2 groups was 0.19, and for visual acuity, it was 0.25. Thus, no statistical significance could be demonstrated.

On the first day post-op, our primary open angle glaucoma (POAG) patients had an average IOP of 13.4 mmHg and a visual acuity of 15/200. Our patients with other types of glaucoma had an IOP of 15.5 and also an average visual acuity of 1/200. The p value for the IOP between the 2 groups was 0.51, and for visual acuity, it was 0.89. Thus, no statistical significance could be demonstrated.

One week post-op, our primary open angle glaucoma (POAG) patients had an average IOP of 12.0 mmHg and a visual acuity of 10/200. Our patients with other types of glaucoma had an IOP of 15.5 and also an average visual acuity of 7/200. The p value for the IOP between the 2 groups was 0.08, and for visual acuity, it was 0.49. Thus, no statistical significance could be demonstrated.

On the first month post-op, our primary open angle glaucoma (POAG) patients had an average IOP of 15.2 mmHg and a visual acuity of 18/200. Our patients with other types of glaucoma had an IOP of 14.5 and also an average visual acuity of 6/200. The p value for the IOP between the 2 groups was 0.64, and for visual acuity, it was 0.06. Thus, no statistical significance could be demonstrated.

After 3 months post-op, our primary open angle glaucoma (POAG) patients had an average IOP of 15.2 mmHg and a visual acuity of 22/200. Our patients with other types of glaucoma had an IOP of 13.4 and also an average visual acuity of 5/200. The p value for the IOP between the 2 groups was 0.46, and for visual acuity, it was 0.02. Thus, a statistically significant difference existed between our POAG patients and our patients with other types of glaucoma three months out of surgery.

After 6 months post-op, our primary open angle glaucoma (POAG) patients had an average IOP of 14.3 mmHg and a visual acuity of 28/200. Our patients with other types of glaucoma had an IOP of 11.6 and also an average visual acuity of 5/200. The p value for the IOP between the 2 groups was 0.12, and for visual acuity, it was 0.02. Thus, a statistically significant difference existed between our POAG patients and our patients with other types of glaucoma six months out of surgery.

One year post-op, our primary open angle glaucoma (POAG) patients had an average IOP of 13.4 mmHg and a visual acuity of 15/200. Our patients with other types of glaucoma had an IOP of 11.2 and also an average visual acuity of 6/200. The p value for the IOP between the 2 groups was 0.92, and for visual acuity, it was 0.27. Thus, no statistical significance could be demonstrated.

Two years post-op, our primary open angle glaucoma (POAG) patients had an average IOP of 13.7 mmHg and a visual acuity of 18/200. Our patients with other types of glaucoma had an IOP of 11.4 and also an average visual acuity of 1/200. The p value for the IOP between the 2 groups was 0.44, and for visual acuity, it was 0.06. Thus, no statistical significance could be demonstrated.

Discussion
Statistically, our POAG patients had a statistically significant improvement in vision at months three and six post-op versus our patients with other types of glaucoma, based on a p value less than 0.05. However, we are confident that this is a rough approximation of the actual statistical differences between our two groups. We will continue to perfect our statistical analysis and add more patients to our study.

Conclusion
The mainstays of glaucoma surgeries are trabeculectomy and Baerveldt-implants. However, there is limited data on what happens when you combine these two procedures. This data helps us correlate an improvement in outcome in our POAG patients who get this surgery, versus our patients with other types of glaucoma. We would like this affect clinical practice in that hopefully this data can encourage ophthalmologists to combine these procedures for better visual acuity outcomes in our patients with glaucoma.
References


**128 A Mathematical Model of Aqueous Humor Dynamics**

**ANHTUAN NGUYEN**, Jeffrey Kiel, Carol Toris

1 Case Western Reserve University

**Purpose/Relevance**
To depict steady state aqueous humor dynamics during physiological and non-physiological conditions utilizing a mathematical model.

**Methods**
A mathematical model was developed in LabVIEW, a visual programming language (National Instruments, Austin, TX). The model establishes the relationships between ciliary and choroidal hemodynamics, passive and active process of aqueous production, aqueous outflow facility and the aqueous outflow via the trabecular and uveoscleral pathways, and the intraocular pressure (IOP). The model is consistent with current concepts of aqueous dynamics and has been validated by a number of in vivo studies.1

**Results**
Toris et al measured parameters of aqueous humor dynamics including outflow facility, uveoscleral outflow, and aqueous flow in eyes with ocular hypertension.2 Using these parameters, the model predicts an IOP of 22.1 mmHg compared to an average IOP of 21.4 mmHg measured by Toris et al in eyes with ocular hypertension. The model also shows that as uveoscleral outflow increases at different fixed levels of outflow facility, the IOP decreases to a similar degree as seen clinically (figure 1). However, in response to an increase in uveoscleral outflow, there is a proportional decrease in trabecular outflow that blunts the fall in IOP (figure 2).

**Discussion**
The model accurately simulates aqueous humor dynamics in accordance with the Goldmann equation and clinical observations.

**Conclusion**
The model is useful to study aqueous dynamic parameters that are difficult to measure in vivo. Physiologic and non-physiologic or disease conditions of aqueous dynamics can be simulated.

**References**

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**Figure 1:** The effect on intraocular pressure (IOP) as uveoscleral (US) outflow increases at different outflow facilities (C, µL/min/mmHg). Values of outflow facility are chosen so that IOP increments in 5 mmHg steps when US outflow is 0.

**Figure 2:** The effects on intraocular pressure (IOP), total aqueous outflow (Outflow), and trabecular outflow (TrabOut) when uveoscleral outflow (US) is increased and aqueous production (Prod) is constant.
Purpose/Relevance
Goldmann applanation tonometry is the gold standard technique for clinically measuring intraocular pressure. Tonometers may develop calibration errors which can be clinically significant and lead to errors in patient management. The West Virginia University Eye Institute (WVUEI) protocol was to access tonometer calibration annually. Recent literature, however, recommends monthly calibration checks.¹ There are 3 specific aims: 1) Increase calibration checks from annually to monthly for all tonometers. 2) Decrease the percentage of tonometers out of calibration by 10%. 3) Improve employee understanding of tonometer calibration.

Methods
A multidisciplinary quality improvement team including faculty, a fellow, resident, nurse and technician was assembled. The team identified knowledge and current protocol as primary factors influencing the maintenance of tonometer calibration. A Plan, Do, Study, Act (PDSA) cycle was devised to assess the knowledge of staff via an electronic survey and the prevalence of tonometers out of calibration. A training program and a monthly calibration assessment protocol were implemented, over a 4-month period.

Results
Prior to intervention, 47.5% of 40 staff reported knowing how to check calibration, 92.5% had not checked calibration within the last month, 71.5% within the last year and only 38.5% felt this was “absolutely” part of their job. Follow up of 18 staff after an educational video revealed 72.2% of respondents completed the video and 67% felt capable of checking calibration.

At baseline, 5/38 tonometers (13.1%) were out of calibration. 100% of tonometers were checked monthly for 4 months. Additional tonometers out of calibration in each month ranged from 0-10.5% (avg 5.25%), a 60% relative reduction. No tonometers were out of calibration in the final month, a 13.1% absolute reduction. Tonometers in more frequent use did not have a higher frequency of calibration errors.

Discussion
Monthly calibration assessment decreased the number of tonometers out of calibration and is now WVUEI protocol. Staff participants improved their knowledge, but only half participated in the final survey.

Conclusion
A multidisciplinary team conducting a quality improvement initiative significantly decreased the number of Goldmann tonometers out of calibration, improving the quality of patient care.

Reference
A Survey of Patient Perceptions and Preferences for Glaucoma Treatment With Intravitreal Injections

NATHAN FISCHER1, Jon Torres, Leonard Seibold, Mina Pantcheva, Malik Kahook, Jeffrey SooHoo

1 University of Colorado

Purpose/Relevance
To investigate patient preferences regarding glaucoma treatment with intravitreal injections.

Methods
Patients who both use topical glaucoma medication and had previously received an intravitreal injection for treatment of another ocular condition were surveyed by telephone using a 10-item questionnaire delivered by a trained interviewer. Patient preferences regarding glaucoma treatment modalities, specifically a theoretical choice between topical and intravitreal treatment options, were recorded and results were compiled.

Results
Twenty-four patients completed the survey. Mean patient age was 62.1 years (range 16 to 95). Patients were on an average of 1.5 glaucoma medications per day (range 1 to 4). Seventy percent of patients (n = 17) said they would prefer topical medication if equal in efficacy to monthly intravitreal injection. In a theoretical scenario in which a monthly intravitreal injection was more effective than topical medication, 80% (n = 19) said they would then prefer injection. The percentage of patients preferring injection also increased as the theoretical dosing interval changed. Assuming equivalent efficacy, 54% of patients preferred injection if only required every 2 months, 67% if every 3 months, and 87% if injection was only required every 6 months. The main reasons cited for preferring topical medications were fear of pain, fear of the procedure, and the inconvenience of more clinic appointments to receive medication.

Discussion
Currently, treatment of glaucoma centers on lowering intraocular pressure (IOP) with topical medications, laser, or surgery. Patient compliance and physiologic barriers can limit the success of topical medications, the most common treatment modality. Patient adherence is limited by complex medication regimens, medication side effects, and other social and patient-specific factors. Therefore, alternative methods of drug delivery have been proposed, such as drug-eluting punctal plugs, surgical implants, conjunctival inserts, and intravitreal injections. In this survey, patients with prior experience with both topical glaucoma medications and intravitreal injections were open to the possibility of glaucoma treatment with intravitreal injection, although some barriers to acceptance were identified.

Conclusion
Use of topical medications for glaucoma is a significant burden for many patients. Patients are open to sustained-release methods of drug delivery, and their willingness to undergo more invasive treatments for glaucoma rises with a longer duration between treatments.

References
131 Factors Influencing the Decision to Pursue Subspecialty Practice in Glaucoma

SWARUP SWAMINATHAN1, Ashley Crane, Michael Yim, Wei Shi, William Feuer, Steve Gedde
1 Bascom Palmer Eye Institute

Purpose/Relevance

To identify factors influencing the decision to pursue glaucoma as an area of subspecialty practice.

Methods

An anonymous survey was sent to all ophthalmologists who had completed training within the last 5 years. The survey collected information about demographics, medical education, current practice, and factors influencing final career choice. Statistical comparisons were made between responses from practicing glaucoma specialists and other ophthalmologists.

Results

The survey response rate was 32.2% (696/2161), including 149 glaucoma specialists and 472 ophthalmologists in other subspecialties. Glaucoma practitioners rated the quality of glaucoma rotations higher (p=0.025) and performed more glaucoma filtering procedures (p=0.004) during residency compared with ophthalmologists practicing in other subspecialties. Glaucoma specialists made the decision to pursue fellowship training later than other subspecialists (p=0.024). Continuity of care was rated as more important in influencing final career choice by glaucoma practitioners relative to other ophthalmologists (p=0.002).

Discussion

A variety of factors influence career decisions, and differences exist between newly practicing glaucoma specialists and ophthalmologists in other subspecialties. Experience gained during rotations in glaucoma and performing glaucoma filtering surgery may be particularly important in stimulating interest in a career in glaucoma. Continuity of care is more important to glaucoma specialists than other ophthalmologists.

Conclusion

Understanding factors that direct young ophthalmologists into different career pathways may prove useful in developing workforce planning strategies to meet future eye care needs in the United States.

Reference

Modeling Corneal Pressure by Using Scleral Pressure with Pneumatonometry

**YING HAN**, Debbie Kuo, Yvonne Ou, Jacquie Duncan
1 University of California, San Francisco

**Purpose/Relevance**
To evaluate the usefulness of scleral pneumatonometry as an alternative for corneal measurements of intraocular pressure (IOP) over a broad range of IOPs.

**Methods**
The study was a prospective, observational cohort study. It was conducted in the University of California, San Francisco, Retina Clinic between August and November 2013 in 33 adult patients (age range, 34-94 years; mean ± standard deviation, 74.1±13.4 years) receiving anti-vascular endothelial growth factor intravitreal injections, which transiently increase IOP. Corneal pachymetry and serial corneal and temporal scleral pneumatonometry (baseline, immediately after, and 10, 20, and 30 minutes after injection) were collected. One-time baseline corneal and scleral pneumatonometry readings were obtained in the noninjected eye. Correlation analysis and a Bland-Altman plot were used to evaluate reliability and agreement between scleral and corneal measurements of IOP. A linear mixed model was used to determine the relationship between measurements and to perform covariate analyses.

**Results**
Scleral and corneal pneumatonometry showed nearly 1:1 linear correlation, although scleral pneumatonometry was biased toward higher values (r = 0.94; P < 0.001). Scleral pneumatonometry averaged 9.0 mmHg higher than corneal pneumatonometry (95% limits of agreement, -1.5 to 19.5 mmHg). A linear mixed model resulted in the following equation: corneal IOP = 1.04 × scleral IOP - 10.37. Age, central corneal thickness, laterality, and glaucoma and lens status did not impact this relationship. The difference between corneal and scleral pneumotonometry was correlated between the two eyes of individual patients (r = 0.75; P < 0.001).

**Discussion**
Differences between serial scleral measurements reflect differences between serial corneal measurements. Our results support consistency of the relationship between scleral and corneal pneumotonometry across the range of physiologic and pathologic IOPs for individual patients.

**Conclusion**
Scleral pneumotonometry should be considered as an alternative to corneal pneumotonometry for following patients in whom corneal measurements are unreliable or unobtainable.

**Reference**
Comparison of Horizontal and Vertical Positioning of the iCare Rebound Tonometer

IYZA BAIG¹, Badar Patel, Laura Baker, Alice Chuang, Lauren Blieden, Theodore Baker, Robert Feldman
¹ McGovern Medical School at UTHealth

Purpose/Relevance
There are times in a clinical setting when the iCare needs to be held in a position other than the standard validated position. The purpose was to evaluate the agreement between intraocular pressure (IOP) measurements taken with the participant in a seated position holding the iCare tonometer (Tiolat, Helsinki, Finland) in the standard (vertical) position and then with the handle rotated 90 degrees (horizontal; Figure 1), and to assess the agreement between each position and pneumotonometry (Mentor, Model 30 Classic, Reichert, New York, USA).

Methods
Participants with clear, healthy corneas were recruited. Central corneal thickness (CCT) was determined by anterior segment optical coherence tomography (CASIA SS-1000, Tomey, Nagoya, Japan), and IOPs were measured with the iCare held in both positions and with a pneumotonometer (PT). Bland-Altman analysis was used to determine agreements between the 2 iCare positions and PT. Correlation between IOP readings and CCT was estimated for each method using regression analysis.

Results
107 subjects were included. Mean age was 25.5 ± 8.5 years. Overall mean IOP was 15.9 ± 4.1 mm Hg in the standard position and 16.2 ± 4.2 mm Hg in the rotated position. The mean difference in IOP readings between iCare positions was 0.33 mm Hg with limits of agreement (LOAs) = [-2.77, 3.43]. The mean difference in IOP readings between iCare positions and PT was -1.92 mm Hg with LOAs = [-8.06, 4.22] and 0.59 mm Hg with LOAs = [-7.85, 4.67] for standard and rotated positions, respectively. IOP readings increased as the CCT increased for all 3 methods (P<0.001, Figure 2). PT IOP increased 0.24 mm Hg, rotated iCare readings increased 0.69 mm Hg, and standard iCare readings increased 0.72 mm Hg per 10 µm increase of CCT, respectively. iCare underestimated IOP in thin and normal corneas and overestimated in thick corneas, compared to PT.

Discussion
The results demonstrated good agreement between the 2 iCare positions, but poor agreement with PT. The ability to use the device in another position may allow IOP measurements in cases where the standard position is not possible, such as orbital trauma or bed-ridden patients. The effect of CCT on IOP measured with iCare was approximately 3 times that of the effect of CCT on IOP taken by PT.

Conclusion
The iCare can be used in either the standard or rotated position with no effect on IOP readings. Regardless of position, IOP measurements are greatly affected by CCT, resulting in poor agreement with PT measurements.
Figure 2. Scatter plot of IOP and CCT by iCare and Pneumotonometer

References
134 The Role of Self Intraocular Pressure Phasing with the iCare 1 in the Management of Glaucoma

ELDAR ROSENFELD, Michael Waisbourd, Shimon Kurtz
1 Tel-Aviv Medical Center

Purpose/Relevance
Intraocular pressure (IOP) is the only treatable risk factor for glaucoma. Studies show that besides peak IOP, the size of pressure fluctuation is an independent risk factor for progression. 1 Although difficult, phasing of IOP is beneficial in determining peak IOP and pressure fluctuations. We retrospectively evaluated the influence of home phasing on the management of glaucoma and glaucoma suspect patients.

Methods
A retrospective study that included treated glaucoma patients with progressing disease despite reaching target IOP, ocular hypertension (OHT) and glaucoma suspects (GS) with questionable treatment need. Patients measured their IOP with the Icare, 4 times a day (morning, noon, evening and night) for at least four consecutive days. The results were compared to the prephasing IOP by the Goldmann applantation tonometer (GAT) and used in deciding about further management.

Results
79 eyes of 40 patients (23 male) were enrolled in the study. The mean age was 59.1±14.6 years. 67 eyes had diagnosed treated glaucoma (37 primary open angle, 8 pseudoexfoliation, 20 normal tension and two uveitic), 12 eyes untreated (6 OHT and 6 GS). 56 of 79 eyes completed the 4 days home phasing protocol (at least 14 of 16 of measurements). The mean IOP difference was 17.51±5.1mmHg and 15.64±4.19mmHg (prephasing by GAT and multiple day phasing by the Icare one) (p=0.007). 44 of 79 eyes (55.7%) had their treatment modified because of the phasing results. Four NTG patients had number of drops reduced because of appreciation of over treatment. 40 patients had treatment enhancement due to large IOP fluctuations (16 eyes), IOP above set target (one eye) and 23 eyes due to both together. Of these, 9 eyes were on maximum tolerated medical therapy and referred to trabeculectomy. Statistically significant difference was found when comparing prephasing IOP and peak IOP during phasing of all patients (17.51±5.12mmHg and 21.34±5.69mmHg respectively (p=<0.0001), as well as in the treatment changed group, p=0.001, and in the non-treatment modified group, p=0.01. The mean IOP difference between the prephasing IOP and maximum IOP was also found to be statistically significant between the two groups (p=0.03).

Discussion
Although time consuming, IOP phasing is beneficial in the evaluation and management of glaucoma patients. Our study shows that more than half of studied patients had uncontrolled IOP that occurred outside office hours and were bound to be missed. A modification in treatment was needed in order to lower their IOP and prevent further progression of the disease.

Conclusion
The Icare 1 is a useful in self-measurement the IOP, records peak IOP and large IOP fluctuations that were bound to be missed by conventional day time IOP and phasing measurements. The apparatus aids in decision making of treatment modifications and thereby provides for the patient the best treatment possible to control the disease.

Reference


135 The Relationship Between Anti-VEGF Treatments and the Development of Glaucoma or Ocular Hypertension in Macular Degeneration Patients

NATHAN HOULIHAN¹, Jonathan Lin, Jon Gieser, Darcie Delzell, Jeremy Wingard
¹ Wheaton Eye Clinic

Purpose/Relevance

Neovascular age-related macular degeneration (AMD) and other vascular disorders of the retina are commonly treated with intravitreal injections of anti-vascular endothelial growth factor (VEGF) agents. Transient elevated intraocular pressure is a well-known side effect of this treatment,¹ but the incidence of sustained ocular hypertension (OHT) or open angle glaucoma (OAG) has been insufficiently studied.

Methods

A unique, controlled retrospective chart review was performed, analyzing only patients who received unilateral anti-VEGF injections, but in whom both eyes were amenable to analysis for OHT or OAG development. Patients in whom OHT or OAG was suspected were referred to a glaucoma specialist within the practice (Wheaton Eye Clinic, Wheaton, IL) for opinion as to disease status. 3081 patients received at least one injection from 2005 to 2013 and were then screened. 1107 subjects met entry criteria, and charts were assessed for demographics, specific drugs used, dates of injections, lens status, length of follow-up, and development of OHT or OAG. OHT or OAG events were defined as the diagnosis of OHT or OAG by a glaucoma specialist or use of glaucoma medication for more than 30 days.

Results

43 patients (3.88%) developed OHT or OAG in only the injected eye, 21 patients (1.90%) developed OHT or OAG in both eyes, and 2 patients (0.18%) developed OHT or OAG only in the untreated eye. Of the patients with OHT or OAG in just one eye, 43/45 (95.6%) developed it in the treated eye (binomial test p-value for the comparison <0.0001). Notably, 30 patients received 25 or more injections of the anti-VEGF drug bevacizumab, and of those 30 patients, 11 (36.7%) developed OHT or OAG in the treated eye only.

Discussion

The degree to which anti-VEGF injections contribute to the emergence of OHT or OAG is not fully known. Previous studies have not shown a direct connection in pathology between neovascular AMD and OHT or OAG, and therefore the current results support the hypothesis that the administered injections have a significant impact on the development of these entities. Based on the small subset of high use bevacizumab patients, there appears to be a connection between either length of treatment or number of treatments and disease development. This relationship will bear further scrutiny in continued work.

Conclusion

Unilateral intravitreal anti-VEGF treatment in AMD patients is associated with a significantly increased incidence of OHT and OAG in the treated eye.

Reference

**Purpose/Relevance**

Eye dominance has been a neglected aspect of human lateralization. The extent of the association of handedness and eyedness has important implications for the nature of genetic theories of handedness and eyedness. The study aims to determine the association between ocular dominance and handedness in glaucoma patients.

**Methods**

Recruited glaucoma patients completed validated self-administered questionnaires to determine eye preference and handedness (Edinburg Handedness Inventory questionnaire). Ocular dominance was assessed using the Miles test and the Dolman test (hole-in-the-card). Data was analyzed using SPSS Software v20.

**Results**

Patients (n=306) mean age was 66.3±11.9 years; 60.5% were females. Eye preference questionnaire showed preference of 75.5% right-eyed, 22.9% left-eyed, and 1.6% used both eyes. Miles test showed a preference of 52.6% right-eye dominant, 30.1% left-eye dominant, and 17.3% both-eyed dominant. Dolman test showed 58.2% right-eye dominant, 38.9% left-eye dominant, and 2.9% were both-eyed dominant. Disagreement between the two ocular dominance tests occurred in 25.5% subjects. For patients whose ocular dominance could be determined by both tests, the agreement of measurements was moderate (Kappa=0.600, p=0.001). The Edinburg Handedness questionnaire found 88.2% patients were right-handed, 7.8% left-handed, and 3.9% were ambidextrous. By Miles test, 53.6% patients showed uncrossed hand-ocular dominance and 46.4% had crossed dominance. By Dolman test, patients showed 58.8% uncrossed hand-ocular dominance and 41.2% had crossed dominance. A significant association was found between hand-ocular dominance by the Miles and Dolman test (Kappa=0.095, p=0.002 and Kappa=0.102, p=0.003, respectively).

**Discussion**

A majority of glaucoma patients demonstrated right-eye preference and dominance, with a few showing no difference in preference confirmed by the Miles and Dolman tests. Disagreement was found between the Miles and Dolman test among patients that are both-eyed dominant. This may be due to the variance in hole size made by subjects hands in the Miles test compared to the 3cm hole-in-the-card (Dolman test). Better standardization may be required to further compare the two ocular dominance tests.

**Conclusion**

The study showed significant relationship between the ocular dominance and handedness, and support the lateralization of crossed and uncrossed ocular dominance and hand preference. Further studies are required to confirm these observations.

**References**

**137 Differences in Aqueous Humor Dynamics Among Chinese and Caucasian Adults**

**CAROL TORIS¹, Baojiang Chen, Junjun Xiong, Shan Fan**

¹ University of Nebraska Medical Center

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**Purpose/Relevance**

This study identifies differing patterns of aqueous humor dynamics (AHD) in healthy Chinese and Caucasian adults that may help to explain the difference in glaucoma prevalence in these ethnic groups.

**Methods**

Data from two studies were compiled and compared.¹ ² Groups were comprised of young (between 20 and 30 years old, 32 Chinese and 39 Caucasians) and old adults (50 years and older, 37 Chinese and 46 Caucasians). Measurements included parameters of aqueous humor dynamics and ocular biometrics. A generalized estimating equation method was used to assess differences in AHD between groups by adjusting for the other variables. The ordinal GEE method was used to compare the ordinal variable, Shaffer Grade between groups.

**Results**

In young Chinese compared to similarly-aged Caucasians, central cornea thickness (CCT) was greater (adjusted effect = -29.27, p < 0.0001); IOP was higher (adjusted effect = -2.33, p < 0.0001); anterior chamber volume (ACV) was smaller (adjusted effect = 28.78, p = 0.0002); outflow facility (determined by fluorophotometry) was greater (adjusted effect = -0.05, p = 0.05) and uveoscleral outflow rate (Fu) was slower (adjusted effect = 0.54, p = 0.007). In old Chinese compared to Caucasians, the anterior chamber angle was smaller (Shaffer Grade, adjusted OR = 0.30, p = 0.007); IOP was higher (adjusted effect = -2.02, p < 0.0001); ACV was smaller (adjusted effect = 33.15, p < 0.0001); and outflow facility (determined by tonography) was greater (adjusted effect = -0.05, p = 0.013). All other parameters were not different between ethnic groups.

**Discussion**

Numerous differences in AHD and ocular biometrics exist among Chinese and Caucasian adults (Table 1). In Chinese compared to Caucasians, the cornea is thicker which may contribute in part to the higher IOP measurement. The smaller anterior chamber volume and narrower anterior chamber angle supports a slower rate of drainage through the uveoscleral outflow pathway, despite faster aqueous flow. When separating young and old groups (Table 2) the ethnic difference in aqueous flow occurs only in the old and in CCT occurs only in the young group.

**Conclusion**

The smaller AC volume and narrower angle in Chinese together with higher aqueous flow and lower uveoscleral outflow may increase their risk of narrow angle glaucoma. On the other hand, the smaller outflow facility in Caucasians might increase their risk of open angle glaucoma. Such information potentially could lead to improved screening and treatment options tailored towards specific ethnic groups.

**References**

Table 1. Overall differences between healthy Caucasian and Chinese adults.

<table>
<thead>
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<th>Variable</th>
<th>Caucasian</th>
<th>Chinese</th>
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<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>Std</td>
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<tr>
<td>Anterior chamber volume (ul)</td>
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<td>Central cornea thickness (um)</td>
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<td>IOP (mmHg)</td>
<td>170</td>
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<tr>
<td>Episceral venous pressure (mmHg)</td>
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<td>Outflow facility determined by tonography</td>
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<tr>
<td>by fluorophotometry</td>
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<tr>
<td>Uveoscleral outflow (ul/min)</td>
<td>167</td>
<td>1.25</td>
<td>0.94</td>
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</table>
Table 2. Differences between healthy young and old Caucasian and Chinese adults.

<table>
<thead>
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<th>Chinese</th>
<th>P value</th>
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</thead>
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<td></td>
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<td>Anterior chamber volume (ul)</td>
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<td>Uveoscleral outflow</td>
<td>76</td>
<td>1.51</td>
<td>0.92</td>
</tr>
</tbody>
</table>

|                                              | N   | Mean | Std   | N   | Mean | Std   |         |
| Anterior chamber volume (ul)                 | 92  | 161.2| 39.4  | 73  | 129.2| 33.5  | <0.0001 |
| Central cornea thickness (um)                | 92  | 532.1| 29.7  | 73  | 531.0| 36.1  | 0.81    |
| IOP (mmHg)                                   | 92  | 14.5 | 2.7   | 73  | 16.5 | 2.1   | <0.0001 |
| Episcleral venous pressure (mmHg)            | 92  | 8.9  | 1.8   | 73  | 8.6  | 1.2   | 0.26    |
| Aqueous flow (ul/min)                        | 92  | 2.42 | 0.70  | 73  | 2.68 | 0.78  | 0.023   |
| Outflow facility determined by tonography (ul/min/mmHg) | 45  | 0.20 | 0.11  | 73  | 0.24 | 0.07  | 0.042   |
| Outflow facility determined by fluorophotometry (ul/min/mmHg) | 91  | 0.29 | 0.18  | 64  | 0.32 | 0.25  | 0.37    |
| Uveoscleral outflow                          | 91  | 1.03 | 0.91  | 73  | 0.74 | 0.99  | 0.05    |
Clinical Effectiveness of Currently Available Low-Vision Devices in Glaucoma Patients with Moderate to Severe Vision Loss

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1 Ivey Eye Institute

Purpose/Relevance
To study the effectiveness of currently available low vision devices in glaucoma patients with moderate to severe vision loss.

Methods
Sixteen patients were enrolled into the study. Patients with a best-corrected visual acuity between 20/70 and 20/400 in the better eye and a diagnosis of stable primary or secondary open angle glaucoma were randomized to a low-vision treatment group or non-intervention control group. A telephone interview was used before and after the 4-week testing period to assess functional vision. Patients placed in the treatment group received a low vision examination and the use of various currently available low-vision aids. Patients placed in the control group received a low vision examination only. The Veterans Affairs Low Vision Visual Functioning Questionnaire-48 was used to assess functional visual criteria. Changes in patients’ reading ability and overall visual ability were chosen as the primary outcomes. Other visual functioning domains (mobility, visual information processing and visual motor skills) were considered as secondary outcomes.

Results
Ten patients in the treatment group showed a significant improvement in reading ability and overall visual ability compared to the control group. The difference in mean score for reading ability was 2.52 logits (2.02; p < 0.05) and overall visual ability was 0.78 logits (0.64; p < 0.05). However, no significant improvement was noted in the other visual functioning domains involving mobility and visual motor skills.

Discussion
Please see conclusion.

Conclusion
Currently available low vision devices primarily enhance central vision with limited benefits to functional activities relying on peripheral vision. This is an important finding when recommending visual aids to glaucoma patients referred for low vision assessments. Furthermore, this identifies the types of devices that need to be developed for those with peripheral visual field defects.

Reference
**Purpose/Relevance**
To determine if ptosis repair may aid in visual field loss in patients with advanced glaucoma.

**Methods**
Retrospective charts review of patients with advanced glaucoma who underwent ptosis repair.

**Results**
There was a total of 23 patients with visual field testing 20° or less. 21 of the 23 patients reported subjective improvement in visual field loss. 19 of the 23 demonstrated improvement on formal visual field testing with the Humphrey 24-2 SITA STANDARD. The average improvement in visual field loss was 5°.

**Discussion**
Patients with glaucoma not only report decrease in visual acuity but also decrease in contrast sensitivity. Patients with glaucoma were found to be more likely to be at fault in motor vehicle accidents. They were also found to be at risk for unsafe driving. This study demonstrates that repair of ptosis can help improve the quality of life of the patient with severe visual field loss from glaucoma.

**Conclusion**
Ptosis repair may be beneficial in patients with significant visual field loss, both subjectively and objectively.

**References**
Further Elucidation of the Mechanism of Action of Trabodenoson Using Validated 3D-Human Trabecular Meshwork Constructs

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Purpose/Relevance
Glaucoma is characterized by elevated intraocular pressures (IOP) resulting in the loss of retinal ganglion cells. Adenosine A1 receptor stimulation has been shown to lower IOP by increasing total outflow via the conventional trabecular meshwork (TM) pathway through a matrix metalloproteinase (MMP)-mediated mechanism.1 Trabodenoson (TRABO) is an adenosine mimetic that selectively binds the A1 receptor, increases outflow through the conventional TM pathway,2 and lowers IOP in glaucoma patients.3 The purpose of the current study was to elucidate further TRABO’s mechanism of action in a validated 3D-human trabecular meshwork (3D-HTM™) ex-vivo tissue model.

Methods
The 3D-HTM constructs were cultured in 10% FBS-IMEM, using primary cells from 4 individual donor eyes and standard validated protocols, over a three week period. Upon confluence, the constructs were serum-starved (1% FBS-IMEM) for 6 days prior to initiation of treatment: vehicle, 1 μM and 10 μM TRABO. Supernatants and tissue lysates were collected on days 2 and 8 post-initiation of treatment and analyzed as follows: Total MMP-2 and TIMP-2 levels in supernatant by immunoassay; MMP-2 activity in supernatant by zymography; active MMP-14, collagen IV and fibronectin levels in tissue lysates by western blot analysis.

Results
Supernatant analysis revealed a significant increase in MMP-2 activity on days 2 and 8 following initiation of 1 and 10 μM TRABO treatments. The total levels of secreted MMP-2 and TIMP-2 did not change significantly on either day post-treatment. Western blot analysis of the lysates revealed a significant increase in active MMP-14 levels on both days with 1 μM TRABO; day 8 with 10 μM TRABO treatment. Significant decreases in fibronectin (day 2 and 8) and collagen IV (day 8) by 1 μM TRABO were observed, whereas 10 μM TRABO significantly decreased collagen IV (day 2 and 8) and fibronectin (day 8).

Discussion
TRABO is an adenosine mimetic that selectively binds the A1 receptor and increases aqueous humor outflow through the conventional TM pathway.2 From these results, TRABO treatment increased not only MMP-2 activity, but also active MMP-14 levels, which is responsible for the activation of MMP-2 in the presence of TIMP-2. Active MMP-2 can digest extracellular matrix proteins to decrease outflow resistance.

Conclusion
TRABO increases MMP-2 activity and levels of active MMP-14, the primary MMP responsible for activating MMP-2, in human TM tissue constructs leading to decreased fibronectin and collagen IV levels.

References
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Contractile Capacity of the Distal Aqueous Drainage System

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Purpose/Relevance
Outflow resistance in the aqueous drainage tract distal to trabecular meshwork (TM) is potentially an important determinant of intraocular pressure (IOP). It may also influence the success of treatments or surgeries directing aqueous into the distal system. Mechanisms controlling distal outflow resistance are unclear. We hypothesize that aqueous vessel wall contractility influences the caliber of the distal tract and outflow resistance.

Methods
We determined if cells with a smooth muscle identity populate aqueous vessel walls. 2-photon imaging was performed of live mouse eyes and postmortem. Transgenic reporter mice expressing a fluorescent endothelial-specific marker (Prox1) and wild-type control mice were studied as models of the corresponding human system.

Results
We imaged deep in the sclera to identify distal aqueous vessels. Aqueous vessels appeared as signal voids amongst the scleral collagen fibers. Vessels were tracked from episcleral veins to their origins in Schlemm’s canal. Cells were resolved. Endothelium bordered the lumen of aqueous vessels. External to endothelium were cells with actin in a contracted state and expressing smooth muscle markers (eg., alpha smooth muscle actin) in a profile similar to that of arterial walls and ciliary muscle. Pharmacological actin disruption with latrunculin-B caused luminal enlargement of the distal vessels.

Discussion
Our findings support an organization of aqueous vessel walls that is like that of blood vessels. A central lumen is lined by endothelium surrounded by cells bearing smooth muscle and contractile features.

Conclusion
The organization and cellular identity of the distal aqueous drainage tract reflects a capacity to contract. We speculate that this supports dynamic alteration of aqueous vessel caliber and outflow resistance analogous to the role of vascular tone in regulating blood flow.

References
Ab Interno Trabeculectomy Increases Outflow Facility in a Human Anterior Segment Perfusion Model

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Purpose/Relevance
To determine the change in outflow facility (C) in human anterior segments after ab interno trabeculectomy (Trabectome).

Methods
Human anterior segments were isolated from eyes of donors with no reported history of ocular disease. The tissues were connected to a perfusion system and flow rates were measured for 20 minutes each at pressures of 10, 20, 30, and 40 mm Hg. Individual C values were calculated by dividing the flow rate by its corresponding pressure, and then by averaging the four individual C measurements. The anterior segments were removed from the chamber and Trabectome was performed on 90-100 degrees of trabecular meshwork of one of each pair of donor eyes. The control fellow eye was treated similarly except for the Trabectome procedure. Outflow facility values were compared at the standardized perfusion pressures and between Trabectome eyes and control eyes.

Results
Compared to baseline, C increased by 0.19 µL/min/mm Hg (p = .006) in Trabectome (ab interno trabeculectomy) eyes (79% increase) versus a decrease of 0.07 µL/min/mm Hg (p = .832) in the sham eyes (10% decrease).

Discussion
The Trabectome procedure effectively increased C in human eyes ex vivo. This study reaffirms the hypothesis that Trabectome lowers the intraocular pressure by increasing outflow facility through the ablation of the trabecular meshwork. An ongoing prospective study involves the measurement of parameters of aqueous humor dynamics in patients before and after a Trabectome procedure to assess the short and long-term effects of Trabectome on aqueous humor dynamics.

Conclusion
Trabectome has been shown to decrease intraocular pressure clinically; however, the short-term and long-term outcomes are variable. Our study shows that ex vivo trabectome increases outflow facility. An ongoing prospective study on patients will determine how other aqueous humor parameters have an effect on clinical outcomes.

Reference