Epidemiology of Glaucoma/ Clinical Trials

1 Projected Clinical Outcomes of Glaucoma Screening in African Americans

**Introduction:** Primary open-angle glaucoma affects over 2.2 million Americans, and African Americans face disproportionately higher rates of glaucoma and glaucoma-related visual impairment. Half of patients with glaucoma are unaware they have the disease, but no consensus exists on a national screening policy. Implementing a national screening policy, however, may reduce the incidence of undiagnosed glaucoma and visual impairment in African Americans and other high-risk populations.

**Methods:** Using data from the Eye Diseases Prevalence Research Group, Baltimore Eye Study, and other published sources, we developed a natural history model to project visual outcomes in African Americans screened for glaucoma under a national screening policy based on frequency-doubling technology (FDT). We projected the incidence of glaucoma and glaucoma-related low-vision and blindness, defined as visual acuity worse than 20/40 or 20/200 in the better-seeing eye, respectively. FDT’s diagnostic characteristics and the hazard ratio for glaucoma progression in treated patients were informed by meta-analyses, and the model used a Monte Carlo microsimulation framework.

**Results:** Implementation of a national glaucoma screening policy for this year’s cohort of African Americans between the age of 50 and 59 years-old with no prior diagnosis of glaucoma would reduce the lifetime prevalence of undiagnosed glaucoma from 50% to 22%, and the prevalence of glaucoma-related visual impairment from 10.8% to 10.1% (a 6.4% decrease). The prevalence of undiagnosed glaucoma would be lowest at 13% among patients between the age of 50 and 59 years-old and rise to 35% in patients over the age of 80. The program would cost $78 per screened individual, considering only the cost of FDT and confirmatory eye exams. The number needed to screen (NNS) to diagnose one person with glaucoma would be 45. The NNS to prevent one person from developing visual impairment would be 610.

**Discussion/Conclusions:** Glaucoma screening for African Americans between 50 and 59 years-old with no history of glaucoma is potentially clinically effective, though its overall impact on the development of glaucoma-related visual impairment may be small.

2 Fixed-combination Brimonidine-timolol vs. Latanoprost in Glaucoma and Ocular Hypertension Patients: A 12-week, Randomized, Comparison Study

**Introduction:** Prostaglandin analogs are commonly used as first-line therapy in glaucoma and ocular hypertension (OHT). The fixed combination of brimonidine 0.2%-timolol 0.5% reduces intraocular pressure (IOP) effectively and may be an effective primary therapy in patients intolerant to PGA. This study was designed to evaluate the IOP-lowering efficacy of fixed brimonidine-timolol compared with latanoprost in patients with glaucoma or OHT.

**Methods:** This was a prospective, randomized, multicenter, investigator-masked study. After washout of previous IOP-lowering medications, patients with IOP ≥24 mm Hg were randomized to twice-daily fixed brimonidine-timolol (n = 73) or once-daily latanoprost (n = 75, dosed in the evening, with a vehicle control in the morning to maintain masking) for 12 weeks. IOP was measured at 8 am (immediately before dosing), 10 am, and 3 pm at baseline, week 6, and week 12. The primary efficacy endpoint was the mean diurnal IOP at week 12. Safety measures included biomicroscopy.

**Results:** No significant differences occurred between treatment groups in mean diurnal IOP at baseline (brimonidine-timolol: 24.7 mm Hg, latanoprost: 25.4 mm Hg, P = .118) or week 12 (brimonidine-timolol: 17.8 mm Hg, latanoprost: 17.9 mm Hg, P = .794). The percentage of patients who achieved a mean diurnal IOP of <18 mm Hg at week 12 was 60.3% with brimonidine-timolol and 52.0% with latanoprost (P = .325). At Week 12, mean biomicroscopic scores of conjunctival hyperemia, eyelid erythema, follicles, and corneal staining were in the none-to-trace range in both groups.

**Discussion:** Fixed brimonidine-timolol was as effective as latanoprost in reducing IOP in patients with glaucoma or OHT. Both treatments provided favorable ocular surface tolerability.

**Conclusions:** Fixed brimonidine-timolol may be a viable alternative to latanoprost for treatment of patients with glaucoma or OHT.

**Reference:**
1. Sherwood MB, Craven ER, Chou C, et al. Twice-daily 0.2% brimonidine-0.5% timolol fixed-combination therapy vs. monotherapy with timolol or brimonidine in patients with glaucoma or ocular hypertension: a 12-month randomized trial. Arch Ophthalmol. 2006;124(9):1230-1238.
3 Endpoint Committee Increased Validity and Statistical Power in the Ocular Hypertension Treatment Study (OHTS)

MAE O. GORDON, Bradley S. Wilson, Patricia A. Morris, Dale K. Heuer, Eve J. Higginbotham, Richard K. Parrish II
Washington University School of Medicine, St. Louis, MO, Medical College of Wisconsin, Milwaukee, WI, Howard University, Washington, DC, University of Miami Miller School of Medicine, Miami, FL

Introduction: The Ocular Hypertension Treatment Study is among the few glaucoma trials with an Endpoint Committee to determine if the cause of an endpoint was due to POAG. Did the Endpoint Committee increase accuracy of POAG incidence, treatment differential or statistical power?

Methods: Each reproducible endpoint was reviewed independently by Endpoint Committee members to determine if the endpoint was “most probably due to POAG” or “most probably not due to POAG” based on medical/ocular history, visual fields (VF) and stereoscopic optic discs photographs. Optic disc deterioration also had to be clinically significant. We compare results using all endpoints versus POAG endpoints. Data are from OHTS phase 1 when participants were managed according to their randomization assignment.

Results: 16% of the participants developed a reproducible endpoint and 8% developed a clinically significant POAG endpoint. Treatment differential and statistical power were greater for POAG endpoints than for endpoints overall.

<table>
<thead>
<tr>
<th>Attribution of Cause of Reproducible Endpoints</th>
<th>Type of Endpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>VF N</td>
<td>Percent</td>
</tr>
<tr>
<td>POAG</td>
<td>59</td>
</tr>
<tr>
<td>Probably NOT POAG</td>
<td>73</td>
</tr>
<tr>
<td>No Change/ Not Clinically Significant</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>133</td>
</tr>
</tbody>
</table>

Discussion: The 16% percent of participants who developed a reproducible “endpoint” includes endpoints due to non-glaucomatous causes or clinically non-significant endpoints. Only 8% of the participants developed a clinically significant POAG endpoint. Treatment differential and statistical power were greater for POAG endpoints than for endpoints overall.

Conclusions: Glaucoma clinical trials might benefit from an Endpoint Committee.

4 Prevalence of and Risk Factors for Inadequate Glaucoma Eyedrop Bottle Volume

MARK A. SLABAUGH, Raghu Mudumbai, Philip Chen
University of Washington, Seattle, WA

Purpose: One barrier to patient compliance with topical glaucoma treatment is an inadequate amount of medication available between scheduled prescription refills. We examined the prevalence of and risk factors for running out of glaucoma eye drops prior to a scheduled refill.

Methods: We surveyed consecutive patients using topical glaucoma therapy in both eyes. Patients were seen in glaucoma subspecialty clinics from July 1 2010 through October 1 2010. Eligible patients were on a self-administered drop regimen with no recent changes in their therapy. Patients were asked how often they ran out of drops early. Other factors examined included insurance status, visual acuity, visual field data, medical comorbidities and the number of other prescription medications.

Results: 145 patients were eligible and chose to participate during the study period. 15 patients (10.3%) reported that they “often” (5-7 times per year), “usually” (8-11 times per year) or “always” ran out of eye drops before they were able to refill their prescriptions.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Ran out of drops</th>
<th>Did not run out of drops</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor Va in better eye (≤20/200)</td>
<td>3/15</td>
<td>3/130</td>
<td>.015</td>
</tr>
<tr>
<td>MD better eye</td>
<td>-8.98 ±7.63</td>
<td>-4.47 ± 5.79</td>
<td>.013</td>
</tr>
<tr>
<td>PSD better eye</td>
<td>6.84 ± 3.86</td>
<td>4.15 ± 3.32</td>
<td>.009</td>
</tr>
<tr>
<td>Number of glaucoma bottles</td>
<td>1.60 ± 0.73</td>
<td>2.15 ± 0.83</td>
<td>.015</td>
</tr>
<tr>
<td>Number of drops per day</td>
<td>4.73 ± 2.89</td>
<td>7.04 ± 4.08</td>
<td>.035</td>
</tr>
</tbody>
</table>

Discussion: A notable proportion of patients encounter inadequate bottle volume prior to a scheduled refill. We found that patients with worse visual acuity, and worse visual field mean deviation and pattern standard deviation in their better seeing eye were more likely to run out of drops, as were patients using fewer bottles and administering fewer drops daily. The latter may be due to less practice with drop administration.

Conclusion: Because of the frequent dosing schedule and the technical difficulty of applying eye drops, compliance with medical therapy of glaucoma is difficult. Our study indicates that the basic issue of having adequate medication available is currently a problem for about 10% of patients.
5 Outcomes of Glaucoma Reoperations in the Tube vs. Trabeculectomy (TVT) Study

HADY SAHEB, Steven Gedde, Joyce Schiffman, William Feuer
Bascom Palmer Eye Institute, Miami, FL

Purpose: To describe the outcomes of patients who underwent reoperations for glaucoma in the Tube Versus Trabeculectomy (TVT) Study.

Methods: The TVT Study enrolled patients with medically uncontrolled glaucoma who had previous cataract and/or glaucoma surgery and randomized them to surgical treatment with a tube shunt or trabeculectomy. Data were analyzed from patients who failed their assigned treatment and subsequently had additional glaucoma surgery. Outcome measures included intraocular pressure (IOP), visual acuity (VA), use of glaucoma medications, failure (IOP > 21 mm Hg or not reduced by 20%, IOP ≤ 5 mm Hg, reoperation for glaucoma, loss of light perception vision), and surgical complications.

Results: Additional glaucoma surgery was performed during the first 5 years of follow-up in 26% of patients in the TVT Study, including 9% in the tube group and 19% in the trabeculectomy group (p = 0.025). In the tube group, 4 (50%) patients underwent implantation of a second tube shunt as a glaucoma reoperation and 4 (50%) patients had a cyclodestructive procedure. In the trabeculectomy group, a tube shunt was placed in 17 (94%) patients requiring a reoperation. After 2 years, IOP (mean ± SD) was 15.0 ± 5.5 mm Hg in the tube group and 15.5 ± 8.3 mm Hg in the trabeculectomy group (p = 0.87). The number of glaucoma medications (mean ± SD) was 1.1 ± 1.4 in the tube group and 1.5 ± 1.5 in the trabeculectomy group (p = 0.66). The cumulative probability of failure during the first 2 years of follow-up was 29% in the tube group and 9% in the trabeculectomy group (p = 0.45). Surgical complications developed in 2 (25%) patients in the tube group and 8 (44%) patients in the trabeculectomy group (p = 0.42).

Discussion: Patients in the tube group underwent placement of a second tube shunt or a cyclodestructive procedure with similar frequency, while most patients in the trabeculectomy group had tube shunt surgery as a glaucoma reoperation. Similar surgical outcomes were observed between the tube and trabeculectomy groups following additional glaucoma surgery.

Conclusions: Successful control of IOP was usually achieved in patients who had glaucoma reoperations in the TVT Study.

6 Clinical Characteristics of Glaucoma Patients with High Myopia

SIMON K. LAW, Maha Sami, JoAnn Giaconi, Anne L. Coleman, Kouros Nouri-Mahdavi, Joseph Caprioli
Jules Stein Eye Institute, Los Angeles, CA

Introduction: Detection of glaucoma in eyes with high myopia is often difficult because eyes with high myopia may have glaucoma-like optic disc appearance and abnormal visual field. This study is to evaluate the clinical characteristics of glaucoma patients with high myopia.

Methods: Medical records of patients seen in our Glaucoma Clinic from 1999 to 2009 were reviewed. Patients who were <55 years of age with spherical equivalent <−5 diopters were enrolled. The diagnosis of glaucoma was defined by optic disc or visual field characteristics typical for glaucoma. Clinical characteristics were compared between eyes with glaucoma and eyes without glaucoma. Logistic modeling accounted for enrollment of two eyes of subjects.

Results: Medical records of >2000 patients were reviewed. 162 patients (291 eyes) were enrolled including 85 eyes with primary open angle glaucoma and 206 eyes without glaucoma. Refractive error did not differ significantly between the two groups. In univariate analysis, myopic eyes with glaucoma were significantly different from myopic eyes without glaucoma in terms of age (44.8±6.7 vs. 40.7±10.1 years, respectively, p=0.006), central corneal thickness (553±35 vs. 573±37 microns, p=0.001), cup/disc ratio (0.68±0.23 vs. 0.47±0.20, p=0.019), average retinal nerve fiber layer (RNFL) thickness measured by optical coherent tomography (68.25±18.32 vs. 91.64±24.22, p=0.001), superior RNFL thickness (81.28±26.37 vs. 108.69±24.22, p=0.016), inferior RNFL thickness (77.76±27.46 vs. 109.55±23.17, p=0.019). There is a strong trend of the mean deviation of visual field of myopic eyes with glaucoma to be less than the non-glaucoma myopic eyes (-6.65±8.32 vs. -2.35±4.07, p=0.054). Age and inferior RNFL remained statistically significant in multivariate analysis.

Conclusions: Eyes with high myopia and glaucoma are significantly older with thinner central corneas, greater cup/disc ratio, and thinner RNFL measurement than in non-glaucoma eyes with similar degrees of myopia.

Reference:
7 24-hour Intraocular Pressure (IOP) Reduction of Taprenepag Isopropyl (PF-04217329) Alone and in Combination with Latanoprost

**SUSAN RABER, Min Zhang, Charles S. Tressler, Ronald A. Schachar**
Pfizer Inc, San Diego, CA, Pfizer Inc, New York, NY

**Purpose:** To characterize the 24-hour IOP reduction of the EP2 agonist taprenepag isopropyl (TAP) alone and in an unfixed combination with latanoprost (LAT).

**Methods:** Randomized, single-masked, crossover study of 14 days of TAP 0.01% alone and with LAT 0.005% at 8AM in 32 ocular hypertensive or glaucoma patients (24 non-Japanese and 8 Japanese) with baseline 8 AM IOP ≥ 22 mmHg. IOP was evaluated every 2 hours with exception of 2AM at baseline and day 14 of each study period.

**Results:** After washout, 30 subjects (7 Japanese) were treated. Baseline IOP ranged from 16.7 mmHg (8PM & 4AM) to 23.3 mmHg (8AM). Statistically significant IOP reduction was observed at all time points for both treatments (p<0.0001): TAP ranged from 3.1 mmHg at 2 hours postdose (10AM) to 4.8 mmHg at 24 hours (8AM), and TAP+LAT ranged from 3.9 mmHg at 2 hours (10AM) to 6.6 mmHg at 6 hours postdose (2PM). Fluctuation (mean difference in max and min IOP reduction over 24 hours) was lower for TAP (1.7 mmHg) versus TAP+LAT (2.7 mmHg). Least square mean difference in 24-hour IOP of 1.1 mmHg (TAP+LAT 5.4 vs. TAP 4.3 mmHg) was statistically significant (p=0.0037, 2-sided). Treatment-related AEs experienced by ≥ 20% of subjects were conjunctival hyperemia, photophobia, corneal staining, and corneal thickness increase. IOP reduction and safety were comparable in Japanese and non-Japanese.

**Conclusion:** TAP significantly lowered IOP during both day and night-time hours. TAP + LAT provided additional IOP reduction over TAP alone. Magnitude of IOP reduction observed reflected the lower baseline values; greater IOP reductions have been observed with TAP and TAP+LAT in a previous clinical trial with 8AM baseline of ≥ 26 mmHg.

8 Cost Consequence Analysis of the Tube vs. Trabeculectomy Trial

**PRATAP CHALLA, Santanu K. Datta, Steven J. Gedde, William J. Feuer, Joyce C. Schiffman**
Duke University, Durham, NC, Bascom Palmer Eye Institute, Miami, FL

**Purpose:** To report a cost consequence analysis of the first 5-years of follow-up in the Tube Versus Trabeculectomy (TVT) Study

**Methods:** Cost consequence analysis

**Design:** Multicenter randomized clinical trial

**Setting:** 17 Clinical Centers

**Study Population:** Patients 18 to 85 yrs old with prior trabeculectomy, cataract extraction with IOL, or both and uncontrolled glaucoma on MTMT with intraocular pressure >18 mm Hg and <40 mm Hg

**Interventions:** 350-mm2 Baerveldt glaucoma implant or trabeculectomy with mitomycin C 0.4 mg/ml for 4 minutes

**Main Outcome Measures:** Cost of glaucoma medications and surgical interventions

**Results:** A total of 212 eyes of 212 patients were enrolled, including 107 in the tube group and 105 in the trabeculectomy group. The cost of initial surgical treatment was $3,513 and $2,691 for the tube and trabeculectomy groups, respectively. Patients in both treatment groups had very similar follow-up time until failure: 50 and 49.5 months for tube and trabeculectomy, respectively. The monthly cost of glaucoma medications (mean ± SD) was $35.87 ± 38.01 in the tube group and $20.29 ± 53.88 in the trabeculectomy group. The total cost for glaucoma reoperations was $22,819 and $64,622 in tube and trabeculectomy groups, respectively. Procedures to manage complications resulted in a total cost of $126,587 and $45,231 in tube and trabeculectomy groups, respectively. The total cost of medical and surgical treatment per patient was $2,878 and $1,839 for tube and trabeculectomy groups, respectively.

**Discussion:** The surgical cost of tube shunt surgery is higher than trabeculectomy and supplemental medical therapy was more expensive after tube surgery compared with trabeculectomy. Reoperations to manage complications were more costly after tube placement, and reoperations for glaucoma incurred a greater cost following trabeculectomy. The total cost of all medical and surgical treatment was higher for tube surgery compared with trabeculectomy.

**Conclusions:** Both procedures yield similar effectiveness but aggregating the costs of medical and surgical treatment, tube shunt surgery was more expensive than trabeculectomy with MMC during the first 5 years of follow-up in the TVT Study.
9 Cost Analysis of Ex-press™ vs. Trabeculectomy

HUSSAIN Y. PATEL, Lilach Drori Wagschal, Graham E. Trope, Yvonne Buys

University of Toronto, Toronto, ON, Canada

Introduction: Cost constraints have the ability to obstruct the introduction of new technology. This study aimed to compare the cost differences between Ex-PRESS and trabeculectomy.

Methods: Prospective, randomised, non-masked, comparative study. 40 patients were enrolled: 20 each in Ex-PRESS and trabeculectomy. Surgical cost difference was analysed using the vendor list price with only differences between operations analysed. 1 year post-operative cost difference was analysed for cost of follow-up visits, additional procedures and medication.

Results: Insertion of the Ex-PRESS device had a net surgical cost of CAN $1005 greater than trabeculectomy due to the cost of the Ex-PRESS device ($900) and viscoelastic ($129) minus the cost of the disposable superblade ($24) used for trabeculectomy. Interim analysis of patients with 1 year follow up data (n = 15) revealed no significant difference in mean total post-operative costs ($738 ± 627 vs. $574 ± 286, p = 0.4), cost of follow up visits ($362 ± 187 vs. $334 ± 83, p = 0.7), additional procedures ($259 ± 363 vs. $160 ± 206, p = 0.5) or medication ($104 ± 114 vs. $68 ± 56, p = 0.4) for Ex-PRESS vs trabeculectomy respectively. For our department the incremental cost of Ex-PRESS would be +/- $200,000, and for the province of Ontario +/- $1,800,000.

Discussion: The Ex-PRESS device has been developed as an alternative filtration procedure to trabeculectomy. Two previous publications have compared the efficacy and safety of Ex-PRESS to trabeculectomy.1, 2 To our knowledge, no previous reports have compared the cost difference between the 2 operations.

Conclusion: This study demonstrates that the Ex-PRESS device is associated with greater surgical costs compared to trabeculectomy. However, based on interim data there does not appear to be a significant difference in post-operative costs.

References:
10 Development of a Glaucoma Specific Utility Elicitation Instrument

STEVEN KYMES, Colleen Peters, Kathleen Beusterien, Sameer Kotak, Andreas Pleil

Washington University School of Medicine, Saint Louis, MO, Oxford Outcomes, Bethesda, MD, Pfizer, Inc., New York, NY

Introduction: The utility is a metric ranging from 0 (death) to 1 (perfect health) describing preference for a health state. A utility of 0.65 for blindness would indicate that being blind is 35% worse than being in perfect health. We developed a short interview based upon the National Eye Institute’s Visual Function Questionnaire (NEI-VFQ) to estimate utility loss from POAG progression.

Methods: We identified items from the NEI-VFQ responsive to differences in mean deviation in a cross sectional sample of 1,677 people enrolled in OHTS and 99 people with more advanced disease. Twelve items were identified and incorporated into a conjoint interview administered to 48 people with POAG. From these results we identified 5 items of greatest importance (the peripheral vision item was added separately). We then constructed an interview using standard gamble and visual analog scale which was administered to 404 community based participants to elicit utility weights for these items.

Results: The five attributes most important to people with glaucoma were reading, driving, leaving home, requiring help with activities and the ability to accomplish tasks. Loss of all of these functions and peripheral vision had a disutility of 0.27. In the Table we detail the utility loss associated with each item.

Discussion: There is measurable loss of utility associated with modest loss in visual function. However, determining how this is associated with glaucoma progression remains to be seen and will be part of our validation of the instrument.

Conclusions: We have developed a glaucoma specific utility elicitation instrument based upon the NEI-VFQ. Further validation will be necessary to determine its usefulness to health policy makers and clinicians.
11 Toward a Predictive Model for Detecting Non-adherence to Glaucoma Medications: The Automated Dosing Reminder Study (ADRS)

DOLLY S. CHANG, Harry A. Quigley, David S. Friedman, Travis C. Frazier, Michael V. Boland
Wilmer Eye Institute, Johns Hopkins University, Baltimore, MD, Madigan Army Medical Center, Tacoma, WA

Introduction: Prior work has identified risk factors for non-adherence with glaucoma medications. As part of the Automated Dosing Reminder Study (ADRS), we asked questions and collected baseline characteristics that might detect non-adherence with glaucoma therapy.

Methods: 323 patients treated with once daily prostaglandin therapy in a university-based glaucoma practice were enrolled in the study. Subject use of medication was monitored electronically for 3 months. Multivariable regression was used to assess the association between baseline criteria and adherence, adjusting for age, gender, race, and number of glaucoma medications prescribed.

Results: 19.5% of subjects used their prostaglandin drops less than 75% of the time. Younger age, non-white race, single medication therapy, no prior eye surgery, no family history of glaucoma, and using medications ≤ 1 year were factors significantly associated with poor adherence. Three questions were also significantly related to non-adherence (p ≤ 0.001): 1) Over the past month, what percentage of your drops do you think you took correctly? 2) Some days I forgot to take one of my doses of glaucoma medications. And 3) What are the names of your glaucoma medications? We constructed a predictive model including these questions and factors associated with poor adherence. The area under the receiver operating characteristic curve was 0.87, indicating good discrimination.

Discussion: Patients in the poor adherence group took fewer drops than they reported (86% by report vs. 47% as measured). Items in the questionnaire were highly specific but not sensitive. A possible strategy to identify non-adherence is to administer a 3-item questionnaire for patients who were non-white or without family history of glaucoma. If positive in 2 out of 3 questions, non-adherence can be identified with a sensitivity of 69% and a specificity of 86%.

Conclusion: Combining clinical factors and the answers to some simple questions can assist clinicians in identifying patients at risk of non-adherence.


DONALD L. BUDENZ, Joyce Schiffman, Jagadeesh Bandi
University of Miami Miller School of Medicine, Miami, FL

Introduction: The purpose of the current study was to determine the prevalence of glaucoma in an urban West Africa population.

Methods: A random cluster sampling of adults age 40 and over was conducted in the city of Tema, Ghana, West Africa. Subjects underwent a field examination consisting of visual acuity, frequency doubling perimetry, Tonopen intraocular pressure, and optic disc photography. Subjects who failed any of these tests were referred for compete examination by a study ophthalmologist with gonioscopy, standard white-on-white perimetry, and stereoscopic optic disc photographs. Masked readers assessed all optic disc photographs and visual fields. The definition of glaucoma by Foster and associates1 was applied and the type of glaucoma was determined by study investigators who examined subjects.

Results: 6806 eligible subjects were identified of which 5603 (82.3%) participated in the study. The field examination identified 1869 (33.3%) subjects who failed the screening examinations. Of these, 1538 came back to the clinic for complete examination for a participation rate at this stage of 82.2%. The number of category 1 glaucoma (definite glaucomatous optic disc and visual field abnormality) was 353 (6.3%), category 2 glaucoma (advanced optic disc damage with unproven visual field loss) was 39 (0.7%), and category 3 glaucoma (IOP ≥ 35 mmHg and VA < 20/400 with optic disc not seen and visual field test impossible OR visual acuity < 20/400 and evidence of previous glaucoma filtering surgery or medical record confirmation of glaucomatous visual morbidity) was 8 (0.14%). Combining all 3 categories, the prevalence of glaucoma was 400 out of 5603 (7.1%). Primary open angle glaucoma was identified in 96.8% of subjects with glaucoma and chronic narrow angle glaucoma accounted for the remaining 3.2%.

Conclusions: Glaucoma is extremely prevalent in urban West Africa. Strategies to identify affected patients and effectively manage the disease are needed.

Reference:
13 The Different Spectrum of Glaucomas in Various Asian American Populations

SHAN C. LIN, Michael Seider, Melike Pekmezci, Pai Peng, Chris Sales, Roland Lee
UCSF Ophthalmology, San Francisco, CA, Shin-Kong Hospital, Taipei, Taiwan

Purpose: To assess the types and distribution of glaucoma types among Asian Americans.

Methods: Clinic-based population studies were conducted in retrospective fashion to assess the distribution of different types of glaucoma among Chinese Americans, Vietnamese Americans, Japanese Americans, and Filipino Americans. All patients had full ophthalmic exam including gonioscopy, optic disc examination, and visual field testing.

Results: Asian Americans have a diverse spectrum of glaucoma types that can have very different distributions among different groups. Chinese Americans have a high proportion of narrow or closed angles (57%) among their glaucoma and suspect subjects. Vietnamese Americans have a high proportion of closed-angle and mixed-mechanism glaucoma (41%) among all their glaucoma cases. Normal tension glaucoma encompasses the majority of glaucoma (69%) among Japanese Americans. In a clinic population, Filipino Americans have a higher proportion of closed angle glaucoma (8%) among their glaucoma cases than whites (0%). Filipino Americans also had a higher normal tension glaucoma proportion (47%) than whites (27%) (p=0.02).

Discussion: Chinese and Vietnamese Americans have high proportions of closed-angle glaucoma. Japanese Americans have mostly normal tension glaucoma. Filipino Americans have a moderate proportion of closed-angle glaucoma and a large proportion of normal tension glaucoma.

Conclusions: In summary, the distribution of glaucoma types varies substantially among Asian Americans.

14 Population and High Risk Group Screening for Glaucoma: The Los Angeles Latino Eye Study

JONATHAN WINARKO, Brian Francis, Rohit Varma, Cheryl Vigen, Mei-Ying Lai, Betsy Nguyen, Stanley Azen
Doheny Eye Institute, University of Southern California, Los Angeles, CA

Introduction: To evaluate glaucoma screening tests in detecting glaucoma in a Latino population and high-risk subgroups, using preset and optimized cutoff points generated by data analysis.

Methods: The Los Angeles Latino Eye Study participants (n=6082) underwent Humphrey visual field testing (HVF), frequency doubling technology perimetry, intraocular pressure, central corneal thickness and independent assessment of cup to disc ratio (C/D). Three glaucoma groups were evaluated, based on glaucomatous: 1) optic nerve appearance, 2) visual field, or 3) optic nerve and visual field. Analyses were also conducted for high-risk subgroups (family history, diabetes, and age ≥65). Sensitivity and specificity were calculated for all parameters, and receiver operating curves were calculated for continuous variables that were independently associated with glaucoma. Classification and Regression Tree (CART) analysis was used to develop a multivariable algorithm for glaucoma screening.

Results: Preset cutpoints for screening parameters yielded a poor balance of sensitivity and specificity in the population and high-risk subgroups. HVF expert reading was the only parameter exhibiting sensitivity and specificity of 80%. CART showed that overall sensitivity (92%) and specificity (92%) could be substantially improved by use of multiple screening parameters as well as different cutpoints. The best single parameter for prediction of glaucoma was C/D using a cutpoint of <0.7 vs. ≥0.7).

Discussion: The C/D ratio was the optimal predictor of glaucoma diagnosis, but no parameter by itself produced sensitivity and specificity of levels sufficient for a practical glaucoma screening program. Nevertheless, we have shown that a combination of parameters can be used in a simple decision algorithm to determine glaucoma with high sensitivity and specificity.

Conclusions: C/D ratio is the optimal parameter for screening for glaucoma, followed by HVF reading. CART showed that overall sensitivity and specificity could be improved by use of combinations of screening parameters.

Reference:
Is There an Association between Exudative Age-Related Macular Degeneration and Open-angle Glaucoma?

Tiffany N. Szymarek, Nidhi Talwar, Melissa Nika, Caroline Schmidt, Sayoko Moroi, Bin Nan, David Reed, Joshua D. Stein

University of Michigan, Ann Arbor, MI

Introduction: The purpose of this study is to determine whether an association exists between exudative macular degeneration (AMD) and open-angle glaucoma (OAG).

Methods: Individuals were identified from a large US managed care network between 2001-2009, who were ≥ 60 years and continuously enrolled for 3 to 5 years. ICD-9CM billing codes were used to identify individuals with ≥ 1 diagnoses of exudative AMD or OAG. Logistic regression analysis was performed to assess the relationship between exudative AMD and OAG adjusting for sociodemographic factors, medical and ocular comorbidities. An additional analysis was performed on individuals with suspected glaucoma to assess whether exudative AMD was associated with the conversion from suspected glaucoma to OAG.

Results: Among 399,117 individuals who met inclusion criteria, there were 44,725 (11.2%) with OAG and 9,436 (2.4%) with exudative AMD. After adjusting for confounders, individuals with exudative AMD had a 13% increased odds of OAG (p = 0.0001, adjusted OR = 1.13, 95% CI [1.06-1.20]). Those with exudative AMD had an 18% increased odds of converting from suspected glaucoma to OAG (p = 0.02, adjusted OR = 1.18, 95% CI [1.03-1.36]).

Discussion: In this study, there appears to be an association between exudative AMD and OAG, which supports previous comorbid association of these two major eye diseases in Medicare beneficiaries.

Conclusions: Additional studies are needed to determine whether or not these two conditions share some common physiologic and/or genetic risk factors.

References:


Optic Nerve Imaging

16 Detection of Glaucoma Progression by Population and Individual Derived Variability Criteria

GADIWOLLSTEIN, Lindsey S. Folio, Jacek Kotowski, Yun Ling, Richard A. Bilonick, Hiroshi Ishikawa, Larry Kagemann, Joel S. Schuman

University of Pittsburgh School of Medicine, Pittsburgh, PA

Purpose: Ocular imaging devices provide quantitative structural assessment that might improve glaucoma progression detection. The best way to use this information to detect progression remains unknown. This study examined population-derived versus individual-derived cut-off criteria for detecting progression.

Methods: 76 healthy, glaucoma suspect and glaucomatous eyes (48 subjects) with at least 4 reliable visual fields (VF) and good quality scanning laser polarimetry (GDx-ECC) acquired at the same visits were enrolled. VF progression was defined by the guided progression analysis (GPA) and by the visual field index (VFI). GDx measurements were analyzed by the standard mode (SM) using a single measurement from each visit that was compared to the population rate of progression, and the extended mode (EM) using 3 sets of measurements from each visit that were compared to the individual variability.

Results: Mean baseline VF mean deviation was -1.34 (range: -10.85 to 2.07) dB and mean follow-up duration was 3.3 (1.6-5.1) years. The proportional rectangular Venn diagrams showed agreement among VF and GDx SM and EM for the Summary plot (retinal nerve fiber layer (RNFL) thickness slope) and TSNIT average (RNFL profile change) (Figure). Note that none of the Summary Plot progressors by SM only were associated with VF progression and the complete dissociation between eyes defined as progressing by EM and VF for TSNIT Avg.

Discussion: There is poor agreement between VF and GDx progression regardless of the use of population derived or individual variability criteria.

Conclusion: Further investigation is needed to determine the best method to assess glaucoma progression.
**Other**

**17 Corneal Hysteresis Predicts the Magnitude of Intraocular Pressure Reduction from Topical Prostaglandin-Analogue Therapy**

**Joshua R. Ehrlieh, Daniel R. Agarwal, Mitsugu Shimmyo, Nathan M. Radcliffe**

Weill Cornell Medical College, New York, NY, New York Eye and Ear Infirmary, New York Medical College, New York, NY.

**Introduction:** Corneal hysteresis (CH) is a risk factor for glaucoma progression but may be influenced by intraocular pressure (IOP) [1,2]. We sought to evaluate the association between baseline CH and the magnitude of IOP reduction among treatment naïve eyes treated with topical prostaglandin-analogues (PGA).

**Methods:** In this retrospective study, 61 consecutive patients with newly diagnosed open angle-glaucoma (OAG) who were initiated on IOP lowering therapy with a PGA from an untreated baseline were reviewed. Included patients underwent ORA measurement (Reichert, Corp., Buffalo, NY) at baseline (untreated) and during a subsequent follow-up (treated) visit. Patient records were reviewed for demographic, medical and ocular data.

**Results:** Goldmann-correlated IOP measured by ORA was reduced by 4.0 mm Hg (22.3%) from 17.9 mm Hg at baseline to 13.9 mm Hg at subsequent visit (P<0.001). Corneal hysteresis increased by 0.6 mm Hg (6.3%) from 9.5 mm Hg to 10.1 mm Hg (p = 0.002). Baseline CH (but not baseline CCT) was a significant predictor of the magnitude of IOP response, with patients in the lowest quartile of CH (mean 6.9 mm Hg) experiencing 32.1% IOP reduction while those in the highest CH quartile (mean 11.9 mm Hg) experienced 7.6% IOP reduction (P<0.001). Since baseline IOP differed between CH quartiles, a multivariate analysis adjusting for baseline IOP was performed that demonstrated that baseline CH independently predicts the magnitude of percent IOP reduction from topical therapy (β=-3.5, 95% confidence interval -6.2, -0.7, p=0.01).

**Discussion:** CH may be a valuable tool in prognosticating the anticipated response to topical PGA therapy among patients with OAG and these findings may have implications for clinical trial design.

**Conclusions:** Although CH is influenced by IOP, baseline CH is independently associated with the magnitude of IOP reduction from topical PGA therapy.

**References:**


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**18 Long-term Variability of Ocular Biomechanical Properties Measured by the Ocular Response Analyzer**

**Kawehmansouri, Mauro Leite, Linda Zangwill, Felipe Medeiros, Robert N. Weinreb**

Hamilton Glaucoma Center, University of California, San Diego, CA.

**Introduction:** To evaluate the long-term variability of corneal hysteresis (CH) and corneal resistance factor (CRF) by the Ocular Response Analyzer (ORA) and to investigate the influence of intraocular pressure (IOP), central corneal thickness (CCT), age and waveform score (WS) on this variability.

**Methods:** Seventy-six eyes (healthy, suspects, glaucomatous) from 56 patients were recruited at the University of California, San Diego. CCT, Goldmann applanation tonometry (GAT), CH and CRF were obtained from all participants in two consecutive visits at least 6 months apart. The concordance correlation coefficient (CCC) along with the 95% limits of agreement were calculated to evaluate the inter-visit agreement of GAT, CH, CRF and WS. Univariable regression analysis was performed to evaluate the influence of age, CCT, GAT fluctuation and WS fluctuation on CH fluctuation and CRF fluctuation. Subsequently, multivariable models incorporating age, CCT, GAT fluctuation and WS fluctuation as independent variables and CH and CRF fluctuation as dependent variables were built.

**Results:** The mean difference between the first and the second measures was 0.15mmHg for CH and 0.34mmHg for CRF. The inter-visit CCC was 0.75 for CH and 0.84 for CRF. Results from univariable regression models showed no significant influence of age, GAT fluctuation and CCT on CH or CRF was found on CH or CRF fluctuation (P>0.1 for all associations). WS fluctuation had a significant influence on CH fluctuation (R²=0.10; P<0.001) but not on CRF fluctuation (P=0.657). After adjusting for age, GAT fluctuation and CCT, WS fluctuation still had a significant effect on CH fluctuation (P=0.001).

**Discussion:** The ORA shows good long-term reproducibility in spite of IOP fluctuations.

**Conclusions:** Fluctuations of the waveform score significantly influenced CH measures and should be considered when evaluating results from this instrument.
19 Evaluation of the Canadian Glaucoma Guidelines

ENITAN A. SOGBESAN, Yvonne M. Buys, Paul E. Rafuse, Karim F. Damji
University of Alberta, Edmonton, AB, Canada, University of Toronto, Toronto, ON, Canada, Dalhousie University, Halifax, NS, Canada

Introduction: To evaluate awareness and acceptance of the Canadian Glaucoma Guidelines (CGGs).

Methods: An online questionnaire of the CGGs was sent to members of the Canadian Ophthalmological Society (COS). Data was collated and analyzed.

Results: 207 (26% of COS) responded. Majority were in comprehensive adult practices. 57% of respondents were community based. 47% were in practice 20+ years and 18% ≤ 5 years.

91% were aware of the existence and 74% had read the guidelines. 81% were familiar with the recommendations. 76% felt the CGGs are relevant to their practice. About a half (47%) felt the recommendations will change their practice.

Agreement for most recommendations was 60 to >80% with the exception of management of combined cataract and glaucoma where it ranged from 50 to 100%. 11% were in disagreement with one or more recommendations.

66% identified barriers to implementation of recommendations. 80% have adequate trained personnel for clinical work but only 47% for stereo photos and 40% for patient education.

For staging glaucoma severity, 71% were familiar with the CGGs. However, only 42% stage the disease, 47% set target pressures and 70% assess baseline data all the time.

Discussion: There is paucity of literature assessing the knowledge and integration of guidelines. This information is important to improve both content and dissemination of the CGGs.

Conclusions: Most of the respondents were familiar with the CGGs and agreed with the recommendations; about a half felt that they would change their practice. Some barriers and limitations to implementation were identified.

References:

20 Clinical Findings in Eyes with Long Anterior Zonule (LAZ) Trait

Daniel K. Roberts, JACOB WILENSKY
University of Illinois at Chicago, Chicago, IL

Introduction: Long anterior zonule (LAZ) trait is a condition that occurs in up to 2% of individuals over 60 years of age. It is associated with a pigmentary dispersion-like phenotype, but with shallow anterior chambers. We conducted a case control investigation of LAZ patients.

Methods: 47 LAZ patients and 47 age, sex and race matched controls were examined. Examinations included ocular and medical history, refraction, slit lamp exam, applanation tonometry, corneal pachymetry, gonioscopy and A-scan biometry.

Results: The patients were 67.1 years of age. 43 of the patients were female. 50% of the LAZ patients had Krukenberg spindles. The patients were more hyperopic (+1.85 vs. -0.01 diopters, p<.01) and had shorter eyes (23.07 vs. 23.84mm, p<.01) than the controls. Six of the LAZ patients had had laser iridotomies performed because of narrow angles because of narrow angle or positive provocative tests.

Discussion: Patients with LAZ present with some clinical findings (e.g. Krukenberg spindles) that are seen in pigmentary glaucoma, but differ from it in that they are older, predominantly female and are hyperopic.

Conclusions: LAZ has some of the same morphologic features as pigmentary glaucoma, but is quite different in other aspects, although they both may be associated with clinical glaucoma.

Reference:
**21 Comparison of Aqueous Humor Proteins from Patients with Glaucoma or Cataract**

**DARRELL WUDUNN, Susanne Ragg, Melissa Key, Sarita Tony, Madhurima Bhattacharjee, Louis Cantor, Chi-Wah Yung, Yara Catoira-Boyle, Shailaja Valluri, Linda Morgan, Joni Hoop**

Indiana University, Indianapolis, IN, Persistent Systems Limited, Pune, India

**Purpose:** To identify aqueous humor proteins that distinguish glaucoma from cataract.

**Methods:** Aqueous samples were obtained from eyes during glaucoma or cataract surgery. Liquid chromatography tandem mass spectrometry (LC-MS/MS) provides great depth of protein coverage, while protein antibody arrays were used for lower abundance proteins. Glaucoma and cataract samples were age and gender matched. For LC-MS/MS, aqueous samples were depleted of albumin and immunoglobulins. Tryptic peptides were analyzed on a linear ion-trap (LTQ) mass spectrometer. After peptide identification, peptide-level quantitative information was combined into protein summaries based on reference sequence databases. For protein antibody arrays, aqueous samples were incubated on customized glass slides spotted with antibodies to 50 proteins previously identified in aqueous humor. A mixed effects model fit with restricted maximum likelihood estimation was used to test the differential abundance of each protein.

**Results:** From 21 cataract and 20 glaucoma samples LC-MS/MS detected 82 proteins with high confidence, all of which had been previously found in aqueous humor. For most proteins, mean intensity levels between glaucoma and cataract samples differed by no more than 10%. Ten proteins were present at significantly (unadjusted) different levels (10-15%) in glaucoma samples including alpha-2 macroglobulin, which has been reported to be higher in glaucoma aqueous. However, after adjustment for multiple comparisons, no differences were significant. In protein antibody array analysis (21 glaucoma and 21 cataract samples), although no proteins were significantly different after multiple comparison correction, at least seven proteins showed potential for further study.

**Discussion:** In these preliminary studies, 132 proteins were compared. Although no proteins were significantly different between cataract and glaucoma samples after multiple comparison correction, several candidates merit further study using larger sample sizes.

**Conclusions:** Aqueous humor protein profiles from glaucoma and cataract patients are similar although subtle differences would not be detectable in these small studies.

**22 Glaucoma Drainage Device Exposure in Patients with Boston Keratoprosthesis**

**SHUCHI PATEL, Hana Takusagawa, Claes Dohlman, Cynthia Grosskreutz**

Loyola University Medical Center, Maywood, IL, Massachusetts Eye and Ear Infirmary, Boston, MA

**Introduction:** Glaucoma following a Boston Keratoprosthesis (KPro) is a known occurrence. Therefore, many KPro patients require a glaucoma drainage device (GDD). One complication of a GDD is tube exposure. We did a retrospective review to see the etiologies and outcomes.

**Method:** A retrospective chart review of patients from the last 5 years with both a KPro and a GDD having tube exposure.

**Results:** 16 patients with a total of 19 incidents of tube exposure were identified. In all cases, a BCL was in place. 7/19 (37%) resolved without surgical intervention. 5/19 (26%) had the tube revised. 4/19 (21%) had the tube explanted. 3/19 (16%) have stable erosions.

**Discussion:** It has been found that a BCL with a KPro helps prevent corneal melt. Thus, it has become a mandatory part of care for a KPro. Anecdotally, we noted more tube erosions than are normally reported for GDD, which is less than 5%. Furthermore, the erosion were typically along the edge of the BCL, therefore likely mechanical. Literature states that tube exposures require surgical revision given a low likelihood of resolution, while our review shows that many of these erosions resolve without surgery. We propose that the mechanism of erosion with KPros and BCLs is different than those with spontaneous erosions. Thus, the treatment should be tailored with less aggressive measures at first since a large percentage may resolve with a change in contact lens diameter.

**Conclusion:** Tube erosions with a KPro and BCL are likely due, at least in part, to mechanical erosion. Since the mechanism is different than that of other erosions, the treatment should be modified accordingly. Our review showed a large percentage of erosions resolving without surgery. Thus, less aggressive measures may be indicated in patients with KPros and BCLs.

**References:**

Perimetry and Functional Testing

23 Development and Testing of a Novel Head-mounted, Eye-tracking Perimeter with Virtual Reality Visor

Dariusz Wroblewski, Brian A. Francis, Alfredo Sadun, Ghazal Vakili, VIKAS CHOPRA
BioFormatix, Inc., San Diego, CA, USC-Doheny Eye Institute, Los Angeles, CA

Purpose: To report on the development and preliminary evaluation of a portable, head-mounted perimeter that incorporates novel eye-tracking with visual grasp testing.

Methods: VirtualEye is a light-weight perimeter that uses a customized, head-mounted virtual reality visor connected to a laptop computer. The device performs the equivalent of full threshold 24-2 visual field testing in two modes: (1) manual (subjective), with patient response registered with a mouse click, and (2) a newly-developed visual grasp (objective), where the on-board eye tracker senses an appropriate change in gaze as evidence of target acquisition.

Results: 9 participants with normal visual fields and 25 participants with mild to severe visual field deficits due to glaucoma and neuro-ophthalmic disorders underwent VirtualEye testing in manual and visual grasp modes, and the results were compared to same-day testing using standard Humphrey Field Analyzer (HFA II). Point-by-point comparison between the results obtained with different modalities indicated: (1) a systematic shift (of 4-6 dB) towards lower sensitivities for the VirtualEye device, (2) negligible systematic differences between measurements taken in visual grasp and manual modes, and (3) the average standard deviation of the difference distributions of about 5 dB (for three pair-wise comparisons). A brief questionnaire addressing usability issues showed a preference by participants for the head-mounted perimeter due to improved comfort and ease of use.

Discussion: Preliminary clinical results indicate that our newly-developed, portable, head-mounted perimeter with novel eye-tracking with visual grasp testing had a high level of participant acceptance, and the testing was sufficiently accurate but slightly less sensitive compared with standard perimetry.

Conclusion: With contained test environment and high level of comfort and mobility for the participants, the VirtualEye perimeter may prove to be useful for out-of-clinic and population screening applications, as well as, available for persons with poor hand-eye coordination or those with inability to perform standard office testing in a seated position.
**Pharmacology**

**24 Hyperlipidemia, Statin Use and Open-angle Glaucoma**

**PAULA ANNE NEWMAN-CASEY, Nidhi Talwar, Bin Nan, Paul R. Lichter, Julia E. Richards, Joshua D. Stein**

University of Michigan, Ann Arbor, MI, University of Michigan School of Public Health, Ann Arbor, MI

**Introduction:** The purpose of this study is to determine whether hyperlipidemia or treatment of hyperlipidemia with HMG coA-reductase inhibitors (statins) affects the risk of developing open-angle glaucoma (OAG).

**Methods:** All individuals age 60 years or older continuously enrolled for at least 2 years in a large national US managed care network from 2001-2009 were identified. ICD-9CM billing codes were used to identify individuals with hyperlipidemia. Statin use was quantified for each enrollee using outpatient pharmacy records. Cox regression analyses were performed to assess the relationship between statin use, hyperlipidemia, and the development of OAG, with adjustment for sociodemographic factors, medical and ocular comorbidities. Additional models were performed to determine whether statin use is associated with development of suspected glaucoma and the conversion from suspected to diagnosed OAG.

**Results:** Of the 682,525 enrollees who met the inclusion criteria, 524,109 (77%) had hyperlipidemia and 302,157 (44%) had taken statins for ≥1 month. After adjustment for confounding factors, the hazard of developing OAG decreased 0.4% (adjusted HR = 0.996, CI (0.994-0.998) p=0.001) for every additional month of statin consumption, and the hazard of progressing from suspected glaucoma to OAG decreased 0.5% (adjusted HR = 0.995 (0.993-0.998), p= 0.0005) for every additional month of statin exposure. There was no significant difference in the hazard of developing suspected glaucoma (adjusted HR = 0.999, CI (0.998-1.001) for each additional month of statin use.

**Discussion:** This study supports others that have shown that statins may play a role in reducing the development of OAG or the progression from suspected glaucoma to OAG.

**Conclusion:** This study offers insights into why some studies in the literature support a protective role for statins and other studies do not.

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**25 The Effect of Nasal Steroids on Intraocular Pressure in Ocular Hypertension or Controlled Glaucoma**

**YVONNE M. BUYS, Darana Yuen, YaPing Jin, Tariq Alasbali, Graham E. Trope**

University of Toronto, Toronto, ON, Canada

**Introduction:** Approximately 18-36% of the general population are steroid responders and this increases to 46-92% in POAG.1 Allergic rhinitis affects up to 30% of US adults.2 Topical nasal steroids are the most effective treatment option. Studies evaluating the effect of nasal steroids in glaucoma patients are limited.

**Methods:** Prospective randomized double-masked controlled trial to evaluate the effect of 6 weeks of nasal steroids on IOP in ocular hypertension or controlled POAG. Eligible subjects were randomized to either beclomethasone or saline nasal spray twice daily for 6 weeks. There were a total of 4 study visits; baseline and weeks 2, 4 and 6 after starting the spray. Each study visit was at the same time +/- 1 hour. The main outcome measure was IOP. The study received ethics approval and was registered (Clinicaltrials.gov identifier NCT00775489). A sample size calculation indicated that 8 patients in each arm would be required to detect a difference of 3.2 mmHg with a power of 80%.

**Results:** 19 subjects completed the study; 9 in the steroid arm and 10 in the placebo arm. There were no statistically significant differences between the groups in baseline characteristics, IOP or change in IOP from baseline at any time point. At 6 weeks the mean change in IOP from baseline was -0.44 and 0.20 mmHg in the right eye (p=0.33) and 0.72 and 0.90 in the left eye (p=0.73) in the steroid and saline groups respectively.

**Discussion:** There is only one previously published study specifically evaluating nasal steroids in a glaucoma population.3 This case-control study using claims database was statistically limited by the small number of patients taking continuous high-dose nasal steroids.

**Conclusions:** OH and POAG subjects show no evidence of a steroid response following 6 weeks of twice daily beclomethasone nasal spray.

**References:**

26 The Prevention of Ocular Scarring following Glaucoma Filtering Surgery Using the Monoclonal Antibody LT1009 (Sonepcizumab™) in a Rabbit Model

ZACHARY LUKOWSKI, Jeff Min, Ashley Beattie, Craig Meyers, Monica Levine, Glenn Stoller, Gregory Schultz, Don Samuelson, Mark Sherwood

University of Florida, Gainesville, FL, LPath, Inc., San Diego, CA

Introduction: Excessive scarring leading to failure of the filtering bleb continues to be a major problem following glaucoma filtration surgery. This paper examines the anti-fibrotic effects of the anti-S1P monoclonal antibody LT1009 (Sonepcizumab™) in prolonging bleb survival in a rabbit model of glaucoma filtering surgery.

Methods: The frequency of LT1009 dosage was determined initially using an ELISA assay measuring LT1009 eye tissue retention in 6 New Zealand White (NZW) rabbits. A further 21 NZW rabbits underwent glaucoma filtering surgery. Bleb tissues were observed and compared clinically and histologically. The duration of bleb elevation was compared among LT1009, balanced saline solution (BSS) negative control, and 0.4 mg/ml mitomycin-C (MMC) positive control.

Results: The mean duration of bleb survival was 28.5 +/- 8.5 days for rabbits receiving injections of LT1009, 21.0 +/- 5.6 days for those receiving injections of BSS, and 33.8 +/- 5.6 days for rabbits receiving MMC. ANOVA statistical analysis with post-hoc testing suggests a statistically significant trend of improvement in bleb duration for LT1009 when compared to BSS controls. Non-painful, upper eyelid edema was noted following five injections of LT1009 which resolved over a 10-day period. MMC eyes developed avascular conjunctivas with areas of thinning and sparse cellularity, while the conjunctiva of LT1009 and BSS eyes remained relatively normal.

Conclusions: The monoclonal antibody LT1009 demonstrated a longer duration of bleb elevation than BSS control without adverse conjunctival effects associated with MMC. However after multiple doses LT1009 use was associated with short-term upper eyelid edema.
Glaucoma Surgery

27 Prospective Randomized Study Comparing Ex-PRESS to Trabeculectomy: Interim Results

LILACH DRORI WAGSCHAL, Graham Trope, Delan Jinopriya, Yvonne Buys
University of Toronto, Toronto, ON, Canada

Introduction: There is only 1 prospective publication comparing guarded Ex-PRESS implantation to trabeculectomy. That study reported better IOP control with the express shunt.

Methods: Prospective randomized study comparing guarded Ex-PRESS to trabeculectomy. Primary outcomes were IOP and success (IOP between 5-18 mmHg and 20% reduction from baseline without medication). Secondary outcomes included # glaucoma medications, complications, corneal thickness and endothelial cell counts.

Results: To date 38 subjects have been enrolled, 19 in each group. 25 have completed 6 months and 13 have completed 1 year follow-up. At baseline, 6 months and one year the mean IOP was 24.1±7.4 vs. 20.7±10.8 (p=0.26), 11.2±4.1 vs. 10.8±4.7 (p=0.86) and 14.5±4.4 vs. 11.9±3.4 (p=0.25) in the trabeculectomy vs Ex-PRESS groups respectively. At 6 months and one year complete success rates were 83% vs. 54% (p=0.20) and 33% and 57% (p=0.59) in trabeculectomy vs. Ex-PRESS groups respectively. There were no statistically significant differences in # glaucoma medications, pachymetry, endothelial cell count or complications.

Discussion: Only 2 previous publications have compared these techniques. One a retrospective study of 100 eyes found no difference in success but more hypotony and choroidal effusions in the trabeculectomy group. A prospective, randomized trial of 80 eyes at 1 year found significantly higher success in the Ex-PRESS group and no difference in complications.1

Conclusions: To date our interim results found no statistically significant difference between the ExPRESS and the trabeculectomy groups regarding IOP and complications.

References:
28 Reduced Proteolytic Activities and Accumulation of Proteasomal Aggregates in the Glaucomatous Trabecular Meshwork

**SARAH R. WELLIK, ANNA K. JUNK, SANJAY K. BHATTACHARYA**
Bascom Palmer Eye Institute, Miami, FL

**Introduction:** The purpose of this study is to investigate proteomic changes in the trabecular meshwork of patients with primary open angle glaucoma (POAG).

**Methods:** Trabecular meshwork (TM) specimen from 15 patients with POAG necessitating trabeculectomy were collected during surgery and flash frozen at -80°C. Control tissue (from 15 age and gender matched donors) was obtained from the scleral rim of corneal transplant donors not affected with glaucoma. Proteins were isolated using established procedures and subjected to Western Blot analysis, mass spectrometry and enzymatic activity assays.

**Results:** We found elevated calpain-1 and cathepsin D immunoreactivity levels in glaucomatous TM. Both calpain-1 and cathepsin D kinetic activities were reduced in the glaucomatous TM compared to controls. Glaucomatous TM revealed notably increased amounts of proteasomal aggregates compared to controls.

**Discussion:** Evidence in recent literature supports a role of oxidative protein damage in the etiology of POAG. Modified calpain proteases may accumulate in the trabecular meshwork of patients with glaucoma, thereby interfering with TM outflow resistance. In addition, reduced enzymatic activity of both calpain-1 and the lysosomal protease cathepsin D may be involved in the pathophysiology of POAG.

**Conclusions:** These data suggest that reduced proteolytic activities of calpain-1 and cathepsin D in the TM contribute to the pathophysiology of POAG.

**References:**

29 Excimer Laser Trabeculostomy (ELT) Clinical Update 2011

**MICHAEL S. BERLIN, LEA KLEINEBERG, ULRICH GIERS, RICHARD STODTMEISTER**
Glaucotma Institute of Beverly Hills, Los Angeles, CA, Augenklinik Detmold, Detmold, Germany, W.G. Kerckhoff-Institut, Dresden, Germany

**Purpose:** To report Excimer Laser Trabeculostomy (ELT) 3 & 5 year effects on IOP and medication requirements in phakic, pseudophakic, and combined with lenectomy patients, and to review Pneumatic Canaloplasty, a secondary effect of ELT.

**Methods:** In a nonrandomized [one site] clinical trial, 80 eyes underwent ELT. 32 eyes of 32 phakic patients (group 1) and 15 eyes of 15 pseudophakic patients (group 2), underwent ELT surgery alone. 33 eyes of 33 phakic patients underwent combined ELT with cataract surgery (group 3). A fiberoptic probe was introduced through a paracentesis to contact the TM using a non-thermal, 308 nm xenon-chloride, excimer laser on one eye per patient to excise the TM, the juxtaanalicular TM and the inner wall of Schlemm’s canal.

**Results:** After 3 years, in group 1, mean preoperative IOP was 27.72 ± (5.95) mmHg with an average of 2.44 (± 1.27) topical medications. Mean postoperative IOP was 15.89 (± 3.29) at 3 years. IOP-lowering medications were reduced to 0.21 (± 0.40). In group 2, mean preoperative IOP was 26.73 (± 6.360) mmHg with an average of 2.93 (± 1.33) topical medications. Mean postoperative IOP was 14.10 (± 3.87) at 3 years. IOP-lowering medications were reduced to 0.67 (± 0.62). In group 3, mean preoperative IOP was 26.73 (± 6.360) mmHg with an average of 2.93 (± 1.33) topical medications. Mean postoperative IOP was 13.16 (± 1.46) at 3 years. Medications were reduced to 0.45 (± 0.60). During ELT surgery, bubble expansion was observed at adjacent ELT sites.

**Discussion:** The gas created during photoablation of TM tissue by the excimer laser forms bubbles within the tissue. Bubble expansion from adjacent holes implies fluid/gas flow and patency into Schlemm’s canal. Pneumatic canaloplasty is presumed to dilate Schlemm’s canal and the adjacent collector channels resulting in a decrease of IOP adjunctive to the TM perforations.

**Conclusion:** ELT is a minimally invasive, safe and effective technique for the long-term treatment of open-angle glaucoma which lowers IOP by increasing the outflow of aqueous fluid while reducing medication requirements.

**Reference:**
**30** Hydrodynamic and Morphological Correlations to Increased Aqueous Outflow Facility after Y27632 Treatment in Bovine, Monkey and Human Eyes

**HAIYAN GONG, Chen-Yuan C. Yang, Zhaozeng Lu, Ye Liu**
Boston University School of Medicine, Boston, MA, Huashan Hospital of Fudan University, Shanghai, China

**Introduction:** We investigated anatomical correlations of increased outflow facility (C) after Y27632 treatment in bovine, monkey and human eyes.

**Methods:** Experimental eyes (7 bovine, 4 monkey, 4 human) were perfused with GPBS+50 µM Y27632 for 30 min and an additional 5 human eyes for 3 hours. Control eyes (5 bovine, 4 monkey, 4 human for 30 min each, 5 human for 3 hr) were each perfused with GPBS. All eyes were perfused with fluorescent microspheres to label outflow patterns before perfusion-fixation. Confocal images were taken along the inner wall (IW) of Schlemm’s canal (SC). Total length (TL) and tracer-decorated length (L) of the IW were measured, and the average percent effective filtration length (PEFL=L/TL) was calculated. Thickness of the trabecular meshwork (TM) with high and low flow was measured and analyzed in human eyes. Sections with SC were examined by light and electron microscopy. The TL of the IW and the length exhibiting IW and juxtacanalicular tissue (JCT) separation (SL) were measured. The average percent separation length (PLS= SL/TL) was calculated.

**Results:** After 30 min Y27632 perfusion, C increased 58% (p=0.03) in bovine, 115% (p=0.03) in monkey, but remained unchanged in human eyes (p=0.98). After 3 hrs Y27632 perfusion of human eyes, C increased significantly (p=0.039) compared to controls. After 30 min Y27632 perfusion, PEFL was significantly increased in bovine (p=0.002) and monkey (p<0.001), but unchanged in human (p=0.41) compared to controls. After 3 hrs Y27632 perfusion in human eyes, PEFL was 1.4-fold larger compared to controls (p<0.05). PSL was significantly increased compared to controls in bovine (p<0.001) and monkey (p=0.001). No discernable separation between the IW and JCT were found in all human eyes, but the thickness of TM was significantly larger in high flow regions over low flow regions (p<0.05).

**Discussion:** After Y27632 treatment, different morphological changes in the TM were found in bovine, monkey and human eyes. These different changes resulted in a similar increase in PEFL, which in turn was positively correlated with an increase in C.

**Conclusions:** PEFL may be the best anatomical parameter to correlate with increased C in three species.

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**31** Effects of Benzalkonium Chloride-, Polyquad™-, and sofZia™-preserved Topical Glaucoma Medications on Human Trabecular Meshwork Cells

**MALIK Y. KAHOOK, David A. Ammar**
University of Colorado, Aurora, CO

**Introduction:** We investigated the potential cytotoxicity in cultured human trabecular meshwork (TM) cells of various topical ophthalmic glaucoma formulations containing different preservatives.

**Methods:** We tested 0.004% travoprost preserved with either 0.015% benzalkonium chloride (BAK), sofZia™, or polyquad™(PQ); and timolol with 0.020% BAK or preservative free. Also tested was a range of BAK concentrations (0.001 - 0.020%). TM cells were treated for 25 minutes at 37°C and 5% CO2 with 100 µL of solutions diluted 1:10 to mimic the reduced penetration of topical preparations to the anterior chamber. Uptake of the fluorescent vital dye (calcien-AM) was used to determine the percentage of live cells. For test solutions diluted 1:10, BAK demonstrated a dose-dependent reduction in cell viability.

**Results:** Diluted 1:10, travoprost +BAK had statistically fewer live cells (83%) than both travoprost + sofZia (100%) and travoprost + PQ (91%; p < 0.05). Similarly, compared to preservative-free timolol, timolol + BAK showed a significant decrease in viability (61% vs. 50%).

**Discussion:** These results demonstrate that the substitution or removal of the preservative BAK from topical ophthalmic drugs results in greater viability of TM cells, the cells involved in maintaining the conventional outflow pathway in vivo.

**Conclusions:** Further studies are needed to investigate the penetration into the anterior chamber of this preservative commonly used in topical glaucoma treatments.
32 New Imaging Techniques to Study Transparent Tubules (TT) Spanning Schlemm's Canal (SC), Structures Subject to Disruption by SC Surgery

MURRAY JOHNSTONE, KEVIN CURTIS, DANIEL POSBIN, JING HUANG, MARK SLABAUGH
University of Washington, Seattle, WA

Introduction: Transparent tubes (TT) that span across SC represent likely conduits for aqueous flow. SC surgery disrupts the TT. We developed new techniques to image the TT to better study their function.

Methods: M. Nemestrina (5), 80-power dissecting microscope (DM), Healon™, Karnovsky's fixative, 130 u viscoelastic cannula, fiber optic light source, light, phase contrast, Nomarsky (DIC) & confocal microscopy. Each eye (10 total) divided into 4 quadrants, viscoelastic introduced into SC in each limbal quadrant to dilate SC followed by fixation. SC lumen was examined in each radial 500 µ segment thus surveying the entire 360° of SC in each eye. At the DM with coaxial light, cylindrical structures spanning SC were transparent, becoming visible only with oblique illumination. Further imaging of cylindrical structures was done by DM (168 sections), phase contrast (19), DIC (35 stacks with a total of 5,120 1-2 µ sections) and confocal fluorescence (4 stacks, a total of 330 1 µ sections).

Results: Eye #8 OD & OS: 77 segments were examined & 91 cylindrical structures spanning SC photographed. Ave. structures/segment: OD 1.33, OS 1.07. Structure frequency: 0 (15 segments), 1 (40 segments), 2 (16 segments), 3 (5 segments) and 4 (1 segment). Eye #8 OS; structures per quadrant: SN (8), IN (13), IT (14), ST (12). Computer generated 360° rotating 3D projections were obtained in 3 confocal stacks. The 3D projections demonstrated cylindrical structures arising from SC inner wall in a funnel shape to then cross SC with their distal lumen opening at collector channel ostia.

Conclusions: Transparent tubes spanning SC become visible with the new imaging techniques. The TT appear capable of acting as normal aqueous conduits but are subject to disruption by SC surgery.

33 Altered Stability of mRNAs Associated with Glaucoma Progression in Human Trabecular Meshwork Cells following Oxidative Stress

HIDEKI MOCHIZUKI, James D. BRANDT, Paul RUSSELL
University of California, Davis, Davis, CA

Introduction: Oxidative stress is present in glaucoma and may be an important factor in its pathogenesis. Certain cytokines are increased in human trabecular meshwork (HTM) cells after oxidative challenge. It has been reported that HuR, an RNA-binding protein, can stabilize mRNA with an AU-rich element (ARE) in the 3'-untranslated region from degradation in the cytoplasm. The purpose of this study is to determine if oxidative stress on HTM cells influences the stability of key ARE-containing mRNAs known to be associated with glaucoma progression.

Methods: Cultures of HTM cells were established from several different normal donor corneal buttons that were unsuitable for transplant. Immunohistochemistry for HuR was performed in addition to Western blots of HuR. The cells were treated with 150µM hydrogen peroxide for 2 hours in the presence of actinomycin D, which inhibits RNA synthesis, and compared with control cells. The selected mRNAs from the cells were analyzed by using relative quantitative PCR.

Results: HuR was detected in HTM cells with Western blot. Immunohistochemistry demonstrated that hydrogen peroxide treatment induces the translocation of HuR from the nucleus to the cytoplasm. Hydrogen peroxide increased IL-6 mRNA stability 1.5 to 2 fold while IL-8 mRNA was increased 1.1 to 1.3 fold. The mRNAs of SPARC and MMP-3, which do not have AREs, were stable after actinomycin D treatment and were not altered with oxidation.

Discussion: Oxidative stress stabilizes IL-6 mRNA significantly while IL-8 mRNA stability was marginally increased. Our data suggests that the decay of certain mRNAs associated with glaucoma is altered in the TM of glaucoma patients.

Conclusion: Stabilization of mRNAs may provide new insights into the pathogenesis of glaucoma and presents the potential for development of new therapies to target the HTM.
Imaging of Anterior Segment

34 An Analysis of the Change in Anterior Chamber Depth before and after Laser Peripheral Iridotomy

MONIKA SINGH, Shobit Rastogi, Douglas Lazzaro, Michael Ehrenhaus
SUNY Downstate Medical Center, Brooklyn, NY

Introduction: Angle-closure glaucoma often develops in eyes that are anatomically pre-disposed to it, i.e. narrow angles. In order to prevent an attack of acute angle closure glaucoma, a procedure, laser peripheral iridotomy (LPI) is performed. The goal of an LPI is to alleviate pupillary block and prevent angle closure.

This study analyzed the changes in the anterior chamber depth in patients with narrow angles who had undergone an LPI.

Methods: The study was conducted prospectively at the Long Island College Hospital (LICH). Patients who were scheduled to have an LPI done were consented and had Scheimpflug PentaCam photos taken before and after the LPI. Scheimpflug Pentacam images, segments 13-17, from 152-183 degrees of the anterior chamber were used for analysis. Both anterior chamber depth and volume were recorded.

A total of 53 eyes of 38 patients (ages 50-77, mean = 60) were enrolled in the study, after informed consent was obtained.

Results: The anterior chamber depth pre-LPI varied for the 53 eyes in our study from 1.13 to 4.00 mm (mean = 2.52 mm); post-LPI values ranged from 2-5.11 mm (mean = 3.13). There was a 0.6 mm increase in anterior chamber depth on average. Anterior chamber volume also showed an increase, from 96.8 mm³ to 124.6 mm³ (mean = 27.8 mm³) between pre and post LPI. Further, IOP measurements, taken as part of the standard ophthalmic exam, showed a decrease of 4 points, i.e. from 20 mm Hg to 16 mm Hg.

Discussion: Till date, patients who have undergone a laser peripheral iridotomy have gonioscopy performed at future visits to qualify the increase in anterior chamber depth. There is no standard accepted method to quantify the objective increase in anterior chamber depth.

Conclusions: The findings of our study validate the Scheimpflug Pentacam as a useful tool in monitoring patients who have undergone laser peripheral iridotomy.

35 Anterior Chamber Depth, Iridocorneal Angle Width, and Intraocular Pressure Changes after Uneventful Phacoemulsification in Narrow Versus Open-angle Eyes

GUOFU HUANG, Eduardo Gonzalez, Pai-Huei Peng, Thidarat Leeungurasatien, Roland Lee, Shan Lin
San Francisco School of Medicine, University of California, San Francisco, CA, Shi-Kong Wu Ho-Su Memorial hospital, Taipei, Taiwan, University of California, San Francisco, San Francisco, CA

Purpose: To investigate the changes in anterior chamber angle using AS-OCT and its correlation with intraocular pressure after phacoemulsification with intraocular lens implantation in narrow and open angle eyes.

Methods: In this prospective study, all subjects underwent phacoemulsification with foldable lens implantation. Images of the anterior segment were obtained using a commercially available AS-OCT device under dark conditions. Mean anterior chamber angle grading ≤ II was considered as narrow angle using the Shaffer grading system. Data were recorded preoperatively, and at 10 days, 1 month, 3 months, and 6 months after surgery. Anterior chamber depth (ACD) and angle opening distance at 500µm (AOD500) anterior to the scleral spur were used to evaluate anterior chamber configuration before and after surgery. Correlation was evaluated between angle width and percent IOP reduction using Pearson two-tailed t test.

Results: Data were collected from 63 eyes that underwent cataract surgery. Twenty nine eyes were determined to be narrow angle. Before surgery the mean AOD500 and ACD in the narrow angle (NA) group were 210.93±113.63µm and 2.25±0.29 mm, respectively. At 6 months after surgery, the mean AOD500 and ACD in the NA group were 385.71±103.91µm and 3.76±0.22 mm, respectively. Anterior chamber angle widening postoperatively was approximately 50% in the NA group and 30% in control group. The postoperative IOP was reduced significantly in both groups. The amount of IOP reduction was 2.61±1.80 mmHg (16.65%) in the NA group, 1.41±2.13 mmHg (9.61%) in the control group, which were significantly different between the groups (p=0.029). We also found weak but significant correlations between IOP decrease and angle widening (r=0.386, p=0.039) in the NA group.

Conclusions: Postoperative reduction in IOP was proportional to the increase in angle width in narrow angle eyes. Phacoemulsification with intraocular implantation may widen the angle to lessen angle crowding in cataract eyes with narrow angle configuration.
To Compare EyeCam with Gonioscopy for Evaluation of the Anterior Chamber Angle

SUNITA RADHAKRISHNAN, Haiyan Wang, Terri D. Pickering, Andrew G. Iwach

Glaucoma Research and Education Group, San Francisco, CA, Glaucoma Center of San Francisco, San Francisco, CA

Purpose: To compare EyeCamTM (Clarity Medical Systems, Pleasanton) imaging with gonioscopy for evaluation of the anterior chamber angle. The EyeCamTM provides photographic images of the angle and can be performed by a technician.

Methods: Charts of all patients who underwent EyeCam imaging at the Glaucoma Center of San Francisco were reviewed. Patients were excluded if the interval between gonioscopy and EyeCam was > 3 years, if any laser or surgery was performed in the interval between gonioscopy and EyeCam or if gonioscopy data was not available for all four quadrants. Only one eye per patient was included. Gonioscopy grading was based on anatomical structure observed with the eye in primary gaze. EyeCam images were also graded based on angle structure visible and the EyeCam grader was masked to gonioscopy findings. Kappa statistic was used to evaluate the correlation between gonioscopy and EyeCam imaging.

Results: 50 eyes (50 patients) were studied, the mean age was 57.8 ± 14.3 years and 52% were males. Thirty four eyes (68%) had POAG or were glaucoma suspects and the remaining included 4 eyes (8%) with pigment dispersion, 5 eyes (10%) with refractive error only, 3 eyes (6%) with exfoliation, 3 eyes (6%) with PACG and one eye (2%) with inflammatory glaucoma. Disregarding scleral spur-ciliary body mismatches, the agreement between EyeCam and gonioscopy by Kappa statistic was 0.74, 0.71, 0.77 and 0.74 in the inferior, superior, nasal, & temporal quadrants respectively. Sources of discrepancy between the two techniques included incorrect angulation of the EyeCam probe during image acquisition and incorrect interpretation of gonioscopy or EyeCam findings.

Conclusion: The EyeCam provided high quality documentation of the anterior chamber angle appearance. In this group of mostly open angles, EyeCam performed by a technician showed substantial agreement with gonioscopy. The EyeCam’s unique features may be valuable in the setting of telemedicine as well as for patient and physician education.
Optic Nerve Imaging

37 Enhanced Depth Imaging Optical Coherence Tomography of Deep Optic Nerve Complex Structures

SUNGCHUL PARK, Carlos Gustavo V. De Moraes, Christopher CW Teng, Celso Tello, Jeffrey M. Liebmann, Robert Ritch
New York Eye and Ear Infirmary, New York, NY, New York University School of Medicine, New York, NY

Introduction: To assess the usefulness of enhanced depth imaging spectral-domain optical coherence tomography (EDI SD-OCT) in evaluating deep structures of the optic nerve complex (ONC: optic nerve head + parapapillary structures).

Methods: EDI SD-OCT images were obtained from both eyes of 71 glaucoma patients. Deep ONC structures including lamina cribrosa (LC), parapapillary choroid and sclera, short posterior ciliary artery (SPCA) and its branches, and optic nerve meninges with subarachnoid space were investigated.

Results: LC of various cross-sectional shapes (flat, round, oblique and W-shaped) was clearly differentiated from prelaminar tissue in most eyes, but its posterior surface was variably demarcated. Posterior bowing of the LC in patients with unilateral visual field loss varied considerably (patient 1 [A,B] vs. 2 [C,D]), and so did its pore shape. Most eyes had 1 round pore for the central retinal artery and 1 or 2 irregularly shaped pores for (branches of) the central retinal vein. SPCAs and their branches including the cilioretinal artery were frequently visualized (E,F). There was a full-thickness defect of the LC in the area of acquired pit (G) and an unspecified central pit of the optic nerve in 2 eyes, respectively. Subarachnoid space and its trabeculae around the optic nerve was identified with optic nerve meninges in 11 eyes with myopia (H), and an ovoid full-thickness scleral defect was noted in 1 eye with extreme myopia.

Discussion: EDI SD-OCT provided detailed high-resolution cross-sectional images of the deep ONC structures, which can be reconstructed into 3D images.

Conclusions: EDI SD-OCT is helpful in detecting, conceptualizing and understanding basic and complicated anatomies and pathologies of the ONC.
38 In Vivo Imaging of RGC Uptake of Activatable Cell-Penetrating Probes for Imaging Apoptosis in Rodents

EDWARD M. BARNETT, Xudong Qiu, James R. Johnson, David Piwnica-Worms
Washington University in St. Louis, St. Louis, MO

Introduction: Previously, we reported the in vitro and in vivo validation of first (TcapQ) and second generation (KcapQ) activatable peptide probes developed for imaging apoptosis through effector caspase activity.1,2,3 Although the second generation probe, with its modified cell penetrating sequence, displays a lower in vitro toxicity compared with TcapQ, the effect of this alteration on cellular uptake has yet to be demonstrated. Using in vivo imaging with a confocal scanning laser ophthalmoscope, we compared the RGC uptake of these probes in rats.

Methods: Both probes consist of a cell-penetrating peptide conjugated to an effector caspase recognition sequence (DEVD) that is flanked by a fluorophore (reporter). To enable in vivo imaging using the HRA-II (Heidelberg Engineering), Alexa-Fluor 488 was utilized as the fluorophore. Since these experiments focused on uptake rather than activation, unquenched probe was used (Tcap488, Kcap488). Following intravitreal injection of probe in rats, the retina was imaged in vivo to assess RGC uptake and labeled cells were counted using Image J software.

Results: Using similar concentrations (~175 uM) the Tcap488 probe resulted in a greater than 3-fold increase in cellular uptake as compared with Kcap488 as demonstrated by cell counts from HRA-II images of rat retinas. This finding was consistent across the time points examined. The advantage of Tcap over Kcap remained even when the concentration of Kcap used was increased as much as 10-fold.

Discussion: While the second generation probe (KcapQ) demonstrated potential advantages over the first generation probe (TcapQ) in terms of sensitivity to activated effector caspases, quenching efficiency, and reduced cellular toxicity in in vitro studies, it shows reduced cellular uptake as assessed by in vivo imaging.

Conclusions: Reduced cellular toxicity of cell-penetrating probes for imaging in vivo RGC apoptosis may come at the expense of reduced cellular uptake.

References:
**40 Factors Influencing the Signal Strength with Spectral-Domain Optical Coherence Tomography**

**JAY RIDDLE, Gina Lee, Hamid Hosseini, Elena Bitrian, Naveed Nilforushan, Joseph Caprioli, Kouros Nouri-Mahdavi**

Jules Stein Eye Institute, Los Angeles, CA

**Purpose:*** To determine factors affecting signal strength (SS) with spectral-domain optical coherence tomography (SD-OCT).

**Methods:** Fifty-six eyes of 32 patients from the UCLA OCT Imaging Study were included. Eyes with open-angle glaucoma or glaucoma suspects meeting the following criteria were prospectively enrolled: reliable fields with MD >-12.0 db, age >30 years, best corrected visual acuity >20/80, spherical refractive error less than 8.0 D and astigmatism <3 D, no other retinal or neurological diseases and no prior incisional surgery other than cataract extraction. Eligible patients underwent a full eye exam including autorefractometry, biometry with IOLMaster, and disc and retinal nerve fiber layer (RNFL) OCT imaging (Optic disc Cube 200x200, Cirrus OCT) by a single technician. Linear regression analyses correcting for the correlation of the two eyes of the same subject were performed to determine factors influencing SS on OCT images.

**Results:** Signal strength ranged from 6 to 10 (mean ± SD: 8.01 ± 0.79). On univariate analyses, older age (p =0.002), higher central corneal thickness (CCT; p=0.025), higher IOP (p=0.034), longer axial length (p=0.117), and pseudophakia (p=0.145) were predictive of a lower SS. Only age (p<0.001) and axial length (p=0.012) were associated with a lower SS on multivariate analyses while CCT approached statistical significance (p=0.077). The effect of age did not change after adjusting for LogMAR visual acuity or lens status. Severity of glaucoma was not a predictive factor for a poorer SS on multivariate analyses (p=0.684 for mean deviation).

**Discussion:** Older age and longer axial length and, to a lesser extent, CCT are the major determinants for lower image quality with SD-OCT. The age influence does not seem to be related to media opacity. However, the role of media opacity needs to be further investigated.

**Conclusion:** SD-OCT image quality tends to be worse in older patients especially those with higher degrees of myopia. This finding has clinical implications since lower SS has been associated with thinner RNFL measurements.

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**41 Optic Nerve Head Vessel Caliber Changes in Glaucoma**

**RICHARD K. LEE, Dyani A. Loo, Lauren A.B. Hodgson, Tien Y. Wong, David S. Greenfield, Jonathan G. Crowston**

Bascom Palmer Eye Institute, Miami, FL, Centre for Eye Research Australia, East Melbourne, Australia, Bascom Palmer Eye Institute, Palm Beach Gardens, FL

**Purpose:** Vascular factors have been suggested to impact the risk for development and progression of glaucomatous optic nerve head (ONH) and visual field changes. The purpose of this study is to determine if glaucoma is associated with peri-papillary vascular changes compared to normal eyes.

**Methods:** Normal eyes (n=38) had no history of ocular disease except cataract, IOP ≤ 21 mmHg, had a normal ONH appearance based upon review of stereo disc photography, and normal SAP. Glaucomatous eyes (n=38) had glaucomatous ONH damage and corresponding abnormal SAP defined as an abnormal glaucoma hemifield test and pattern standard deviation (PSD) outside 95% normal limits (average PSD greater than 8.0 dB). Retinal vascular caliber was measured using a previously established protocol (Amerasinghe et al). Graders were masked to glaucoma status with the ONH removed from photos used for analysis of central retinal artery equivalent (CRAE) and the central retinal vein equivalent (CRVE) calibers.

**Results:** Average CRAE for glaucomatous eyes was 140 μM (SD=18) compared to 150 μM (SD=15) for normal eyes. Average CRVE for glaucomatous eyes was 215 μM (SD=23) compared to 225 μM (SD=20) for normal eyes. CRAE was statistically decreased for glaucomatous compared to normal eyes (t-test, p=0.0017) with decreased CRVE for glaucomatous compared to normal eyes (t-test p=0.012).

**Discussion:** Glaucomatous ONHs had an average 6.7% decrease in arterial and 4.4% decrease in venous vessel caliber compared to normal eyes. Glaucoma has been suggested to be associated with vasospasm and other vascular risk factors. In addition, decreased optic nerve head perfusion has been suggested to be a risk factor for the development and progression of glaucomatous damage. This study demonstrates that vessel caliber, which can affect perfusion pressure and rates, is decreased in ONHs of glaucomatous eyes.

**Conclusions:** Mean arteriolar caliber is significantly decreased in glaucomatous ONHs suggesting glaucoma is associated with vascular changes.

**Reference:**
42 Choroidal Thickness Measured by SDOCT Depends on Age, Axial Length, CCT and Diastolic Perfusion Pressure, but Not Degree of Glaucoma Damage

Eugenio Maul, Harry A. Quigley
Wilmer Eye Institute, Baltimore, MD

Introduction: To measure macular and peripapillary choroidal thickness and to determine parameters associated with it in glaucoma patients.

Methods: Spectral domain optical coherence tomography (SDOCT) scans were obtained to estimate average choroidal thickness in a group of normals, glaucoma suspects and glaucoma field loss patients. Average thickness was calculated from enhanced depth SDOCT images. Glaucosa was defined by disc and field criteria. The most affected eye was analyzed for comparisons across individuals, while right/left and upper half/lower half comparisons were made to compare thickness against degree of visual field damage.

Results: 74 glaucoma/suspect patients were imaged. The choroidal-scleral interface (CSI) was visualized in 86% and 96% of the macular and peripapillary scans, respectively. In multivariable linear regression analysis, the macular choroid was significantly thinner in association with 4 features: longer eyes (22 µm per mm longer [95% CI: -33, -11]), older individuals (31 µm thinner per decade older [95% CI: -44 -17]), lower diastolic ocular perfusion pressure (26 µm thinner per 10 mmHg lower [95% CI: 8, 44]), and thicker central corneas (6 µm per 10 µm thicker cornea [95% CI: -10, 0]). Peripapillary choroidal thickness was not significantly different between glaucoma and suspect patients. Thickness was not associated with damage severity as estimated by visual field mean deviation or nerve fiber layer thickness, including comparisons of right to left eye or upper to lower values.

Discussion: Age, axial length, CCT, and diastolic ocular perfusion pressure are significantly associated with choroidal thickness. Degree of visual field damage was not consistently associated with choroidal thickness.

Conclusion: Choroidal thickness is a dynamic variable, affected by blood pressure and intraocular pressure.

References:

43 The Effect of Software Upgrade on Optical Coherence Tomography Measurement of Retinal Nerve Fiber Layer Thickness

Leonard K. Seibold, Naresh Mandava, Malik Y. Kahook
University of Colorado, Aurora, CO

Introduction: To determine the effect of software upgrades on retinal nerve fiber layer (RNFL) thickness measurements taken by optical coherence tomography (OCT).

Methods: 80 normal eyes (40 patients) were scanned for RNFL thickness measurements using the Spectralis (Heidelberg Engineering, Heidelberg, Germany) spectral-domain OCT instrument by a single experienced operator on the same day. Scan analysis was performed using version 4.0 software and then reanalyzed after upgrade to version 5.1.3. Student paired t testing and Pearson’s correlation coefficient were used for statistical analysis.

Results: Average and quadrant RNFL thicknesses generated using version 4.0 and 5.1.3 software on Spectralis demonstrated high correlation (r= 0.998 average, r=0.996-0.957 quadrants). Average RNFL thickness using version 4.0 software was 107.41 µm ± 13.30 compared to 107.34 µm ± 13.13 for version 5.1.3 software (p=0.488). Version 5.1.3 also generated thinner RNFL measurements in the temporal and nasal quadrants. Mean quadrant RNFL differences between version 4.0 and 5.1.3 were +0.37 µm (p=0.055) temporal, -1.15 µm (p=0.096) superior, +0.26 µm (p=0.294) nasal, and 0.00 µm (p=1.000) inferior.

Discussion: Recent studies have shown significant differences in RNFL measurements between different spectral and time domain OCT instruments1. While previous work has shown decreased artifacts in spectral-domain compared to time-domain OCT, this to our knowledge is the first study to evaluate for differences in RNFL thickness values due solely to software upgrades in the same device2.

Conclusions: There is excellent correlation in RNFL thickness measurements taken with Spectralis OCT before and after software upgrades. While the thickness values are not identical, the difference did not reach statistical significance.

References:
**Glaucoma Surgery**

### 44 Needling vs. Blebectomy: Surgical Outcomes of Ahmed Valve Encapsulated Blebs

**Ramesh S. Ayyala, ARLEY S. JARAMILLO**
Tulane School of Medicine, New Orleans, LA

**Purpose:** To evaluate the surgical outcomes of poorly functioning encapsulated filtering blebs (with poor response to topical medications) following AGV by needling with MMC vs. surgical excision.

**Methods:** Retrospective study of 158 Glaucoma pts. who underwent Ahmed valve implantation from 2007 to 2009. Inclusion criteria: Failed AGVs due to encapsulated blebs with IOP > 21 mm Hg on meds. that were managed by one or more needling with MMC or surgical excision of the capsule. Success defined as decrease in IOP by 30% or IOP less than 21 mm Hg, maintained for at least 6 months or longer (12-24 months).

Failure defined as IOP > 21 mm Hg on maximum medications.

**Results:** 26 eyes of 24 patients met inclusion criteria. 18 eyes of 16 patients were treated with needling of the bleb followed by injection of 0.05 cc MMC (0.4mg/cc). 3 patients had more than 1 needling (2-4) of the bleb.

6 patients were treated with surgical excision followed by the application of weck cell sponge soaked in MMC (0.4 mg/cc) for 40 seconds.

No complications were noticed in terms of conjunctival melt overlying the end plate, infections, corneal decompensation or other vision threatening events.

Needling resulted in 9/18 (50%) success rate at 6 months and at 18 months. Excision resulted in 5/6 (83%) success at 6 months and 4/6 (67%) at 18 months.

**Conclusion:** Needling with MMC is a reasonable first option in the treatment of encapsulated blebs (not responding to medications). Surgical excision of the encapsulated blebs with MMC application is an excellent second option, when needling fails. Longer follow up and more patients are needed to confirm these findings.

**References:**

### 45 Delayed-onset Symptomatic Hyphema following Trabecome Surgery: A Single Center Case Series

**YACHNA AHUSA, Mehrdad MALIHI, Arthur J. Sit**
Mayo Clinic, Rochester, MN

**Introduction:** Trabecome surgery reduces IOP by ablating a segment of trabecular meshwork. While blood reflux is extremely common intraoperatively, delayed-onset hyphema in the absence of further ocular surgeries or trauma has not previously been reported.

In this study, we describe a series of patients who experienced delayed-onset symptomatic hyphema after Trabecome surgery for open-angle glaucoma.

**Methods:** Cases of delayed-onset, symptomatic hyphema were identified from patients who had Trabecome surgery at Mayo Clinic by a single surgeon (AJS) between 2006 and 2010. The diagnosis of hyphema was made on the basis of slitlamp examination and gonioscopy.

**Results:** Out of 250 cases of Trabecome surgery, there were 11 cases (1 male and 10 females) of delayed-onset symptomatic hyphema (4.4%). Average age was 74.8 years (range 66-82 years). Time of onset of hyphema ranged from 2 to 31 months after surgery. The most common symptom at presentation was transient blurry vision upon awakening. The most common patient characteristic was maintaining a sleep position toward the side that had undergone Trabecome surgery. Most cases of hyphema resolved within 1-2 weeks with the exception of one patient who required trabeculectomy due to an irreversible IOP spike.

**Discussion:** Although Trabecome patients have an open blood-aqueous barrier, the proportion of patients developing late-onset symptomatic hyphemas is small. The likely mechanism is ocular compression from a sleeping position on the surgical side, followed by sudden decompression and blood reflux when the pillow was removed. Asymptomatic hyphemas may also occur but were not identified in this series.

**Conclusions:** Delayed-onset hyphema after Trabecome surgery can occur and patients should be aware of the symptoms. Patients should avoid sleeping towards the side of surgery, particularly if they experience hyphema symptoms upon awakening.
Response to Initial Selective Laser Trabeculoplasty (SLT) is Not Predictive of Response to Repeat SLT

Ben J. Harvey, Michael P. Hood, Patrick W. Risch, James M. Rouse, Mahmoud A. Khaimi, Gregory L. Skuta, Steven R. Sarkisian

Dean McGee Eye Institute, Oklahoma City, OK

Purpose: To evaluate the use of repeat selective laser trabeculoplasty (SLT) in patients with previous SLT treatment and determine if response to initial SLT is predictive of response to repeat SLT.

Methods: A retrospective chart review of 115 eyes of 86 patients with open angle glaucoma (OAG) or ocular hypertension (OHT) who underwent repeat 180 or 360 degree SLT therapy after failing an initial SLT treatment despite maximal medical management. Patients were included if they were >18 years of age, diagnosed with OAG or OHT and had undergone repeat SLT therapy. No SLT-naive trabecular meshwork was included in the repeat SLT analysis. Patients were excluded if they underwent other glaucoma procedures between SLT treatments or if they were lost to follow-up after laser therapy. IOP (mmHg) was measured prior to each laser and 30-60 minutes, 1-4 weeks, 3-6 months, 6-12 months, 12-18 months, 18-24 months, 24-36 months, and 36-48 months after laser treatment. Generalized estimating equations were used to estimate response and adverse event probabilities while accounting for the correlation among eye-level measures on the same subject.

Results: Mean baseline IOP prior to initial (SLT1) and repeat SLT (SLT2) was 22.54 ± 5.12 mmHg and 21.68 ± 3.38 mmHg, respectively. A response to SLT was defined as an IOP decrease of >20% from baseline at 3-6 months after laser. The percentage of eyes responding to SLT1 was 54% (95% CI: 42%-65%) was similar to the percentage responding to SLT2 which was 56% (95% CI: 44%-67%) (p=0.96). Responding to SLT1 was not predictive of responding to SLT2 (p=0.87). The only adverse events were early (30-120 minutes) and late (1-4 weeks) IOP spikes after laser in both groups. Early IOP spikes occurred in 14% (95% CI: 8%-23%) of SLT1 and 3% (95% CI: 1%-9%) of SLT2. Late IOP spikes occurred in 3% (95% CI: 1%-9%) of SLT1 and 9% (95% CI: 5%-17%) of SLT2. No SLT-naive trabecular meshwork was included in the repeat SLT analysis. Patients were excluded if they underwent other glaucoma procedures between SLT treatments or if they were lost to follow-up after laser therapy. IOP (mmHg) was measured prior to each laser and 30-60 minutes, 1-4 weeks, 3-6 months, 6-12 months, 12-18 months, 18-24 months, 24-36 months, and 36-48 months after laser treatment. Generalized estimating equations were used to estimate response and adverse event probabilities while accounting for the correlation among eye-level measures on the same subject.

Conclusions: Repeat SLT therapy is safe and effective in the treatment of OAG and OHT in patients who underwent prior SLT therapy. Its success rates are similar to those seen after initial SLT therapy although response to initial SLT is not predictive of response to repeat SLT.

Mid-term Results of Efficacy, Safety, and Survival Rates of PGY4 Resident Performed Trabeculectomy with MMC Alone or with the Ex-PRESS Shunt

Stella N. Arthur, Guruprasad R. Pattar, Darrell WuDunn, Mark Kaehr, Louis B. Cantor, Joni Hoop, Yara Catoira-Boyle

Indiana University, Indianapolis, IN

Introduction: To evaluate mid-term efficacy, safety, and survival rates of trabeculectomy (trab) with MMC alone or with Ex-PRESS shunt R-50 (trab-Ex) performed by PGY4 residents.

Methods: Retrospective chart review of consecutive trabs from 3/26/06 to 5/1/08 and trab-Ex from 5/1/08 to 2/1/10 performed by residents under supervision of single attending surgeon (YCB). Visual acuity (VA), intraocular pressure (IOP), number of medications, steroid use in weeks, suture lysis, incidence of choroidal effusion and hypotony were analyzed. Failure criteria were: IOP 21 mmHg or less than 20% reduction; loss of light perception; bleb revision; or further glaucoma surgery.1

Results: 29 patients underwent trab and 22 patients had trab-Ex. Follow-up (f/u) was 27.3 ±16.7 vs. 11.8±6.9 months for trab and trab-Ex respectively (p=0.0001). 22 trab patients and 17 trab-Ex patients had 12 months f/u. Age, ethnicity, previous surgery or laser, or lens status were similar in both groups. Trab and trab-Ex had similar mean±SD of: logMAR VA pre-operatively (0.31±0.3 vs. 0.32±0.5, p=0.95), and at 12 months (0.51±0.6 vs. 0.56±0.6, p=0.77); IOP pre-operatively (17.9±5.1 vs. 20.9±9.5, p=0.14), and at 12 months (10.6±5.9 vs. 11.7±7.5, p=0.61); and medications pre-operatively (3.6±0.8 vs. 3.3±0.9, p=0.27), and at 12 months (0.9±1.5 vs 1.3±1.7, p=0.45).

Suture lysis (40% vs. 38%) and steroid use in weeks (21.0±16.1 vs. 39.0±11.1, p=0.38) were similar in both groups. Trab-Ex had no effusions (0% vs. 17%) or hypotony (0% vs. 18%) compared to trab. Survival rates for trab vs. trab-Ex were 92% vs. 96% at 12 months.

Discussion: At 12 months trab had lower safety and similar efficacy and survival to trab-Ex. Our data support the efficacy of Ex-PRESS shunt.2

Conclusion: Ex-PRESS shunt appears a reasonable option for novice surgeons. Long-term prospective studies are needed to substantiate these findings.

References:
48 Glaucoma Management in Patients Undergoing Boston Type I Keratoprosthesis Implantation

JENNIFER S. HUANG, Simon K. Law, John A. Giacconi, Anne L. Coleman, Joseph Caprioli, Anthony J. Aldave
Jules Stein Eye Institute, David Geffen School of Medicine at UCLA, Los Angeles, CA

Introduction: The purpose of this study was to review glaucoma management in patients undergoing Boston type I keratoprosthesis (kpro) implantation with or without concurrent placement of a glaucoma drainage device (GDD) in a large consecutive case series.

Methods: All kpro procedures by a single surgeon with or without concurrent placement of a GDD between May 2004 and October 2010 were reviewed.

Results: 102 kpro procedures were performed in 90 eyes of 86 patients. Preoperative prevalence of glaucoma was 77% (69/90 eyes). Concurrent GDD implantation was performed in 39 of 90 eyes (42%) while 52 eyes (58%) received no glaucoma surgery at the time of kpro surgery. Mean preoperative intraocular pressure (IOP) was 22.3 mmHg and 13.7 mmHg in eyes in which a concurrent GDD was and was not placed, respectively (p<0.0001). Incidence of elevated postoperative IOP (defined as IOP > or equal to 25 mmHg at any visit) was 18.4% (7 eyes) compared to 13.5% (7 eyes) in patients with and without concurrent GDD placement, respectively (p=0.57). Of the patients without GDD placement at the time of kpro implantation, 19.2% (10 eyes) required additional medical therapy for adequate IOP control compared to 10.5% (4 eyes) in which a GDD was placed at the time of kpro surgery (p=0.38). While glaucoma surgery was required to manage elevated IOP following kpro implantation in 5.8% (3/52) of the eyes that did not undergo simultaneous GDD placement, none of the eyes in which a concurrent GDD was placed required additional glaucoma surgery (p=0.26).

Discussion: Glaucoma is the most common comorbid condition in patients undergoing kpro implantation. Preoperative IOP is the primary factor that determines whether a GDD is implanted with the kpro. Although eyes with concurrent GDD implanted with the kpro had higher pre-operative IOP, they had lower rates of additional glaucoma medications or surgeries required following kpro surgery.

Conclusion: Concurrent GDD implantation should be considered in all cases of elevated IOP undergoing Boston type I keratoprosthesis implantation.

Reference:

49 Treatment of Uveitis and Outcomes of Glaucoma Drainage Implant Surgery: A Meta-Analysis

MEENAKSHI CHAKU, Mingyue Hao, Jae K. Lee, Peter A. Netland
University of Virginia, Charlottesville, VA

Introduction: Varying success rates of glaucoma drainage implant (GDI) surgery have been reported in uveitic glaucoma patients. In this meta-analysis, our purpose was to evaluate the effect of uveitis treatment on GDI surgical outcomes.

Methods: Two groups were defined prior to analysis based on medical therapy of uveitis. Group 1 included articles with corticosteroid-treated uveitis, with no defined pre- or postoperative control of uveitis and no immunomodulatory medications. Group 2 included articles with aggressive medically-treated uveitis, with maintenance of defined pre- and postoperative levels of inflammation and use of immunomodulatory medications. Variables were analyzed using a one-sided weighted binomial test (P values < 0.05 significant).

Results: Using PubMed, 16 articles evaluating GDI surgery in uveitic glaucoma patients with comparable outcome criteria were identified. At Year 1 after GDI surgery, Group 2 (5 articles, 122 eyes) had 95.1% success (95% CI: 91.2-98.9%), which was significantly (P=0.014) higher than 81.6% success (95% CI: 74.5-88.7%) in Group 1 (11 articles, 114 eyes). Overall success of Group 2 was 86.1% (95% CI: 79.9-92.2%), which was significantly higher (P=0.014) than 74.3% (95% CI: 66.9-81.6%) in Group 1.

Discussion: Our meta-analysis demonstrated significantly greater GDI success in Group 2 compared to Group 1. Potential study limitations include the use of summary data and differences of patients across studies.

Conclusion: Surgical success was significantly higher in uveitic glaucoma patients treated with more intensive immunosuppressive therapy before and after GDI surgery. Level of control of uveitis pre- and postoperatively appears to influence GDI surgery outcomes.

References:
50 Comparison of the P50, P200 and R50 Ex-PRESS™ Glaucoma Filtration Devices

ARVINDNEELAKANTAN, David G. Godfrey, Ronald L. Fellman
Glaucoma Associates of Texas, Dallas, TX

Purpose: Ex-PRESS™ shunts are commercially available in different sizes and models based upon differences in design, and size of the internal diameter. Our purpose was to compare surgical outcomes after implantation of the R50, P50 and P200 models for control of intraocular pressure (IOP) in glaucoma patients.

Methods: A retrospective analysis of 76 Ex-PRESS shunts from Jan 2009 to June 2010 was conducted. Eyes with less than 3 months of postoperative follow-up (FU) were excluded. Surgical success was defined as: 5mm Hg ≤ IOP ≤ 18mm Hg with or without medication. Repeat glaucoma surgery or NLP vision were considered failures.

Results: 71 eyes of 67 patients met inclusion criteria. 38 of 71 eyes had the procedure combined with cataract surgery. In all three Ex-PRESS models used, the postoperative IOP and glaucoma medication use was significantly lowered from baseline at final FU (mean 9.5 ± 4.5 months). The change from baseline IOP was not significantly different in the combined group when compared to the Ex-PRESS alone group (p=0.89). Surgery was successful in 94.23% P50 eyes (N=52), 100% P200 eyes (N=11), and 87.5% R50 eyes (N=8) at final FU. The P200 Ex-PRESS shunt model significantly lowered postoperative IOP when compared to the P50 and R50 models (Fisher t-test, p < 0.05). One eye each in the P50 and P200 groups developed a postoperative choroidal effusion. There were no eyes with shallow AC’s needing reformation. One eye each in the P50 and P200 groups failed and needed further glaucoma surgery.

Discussion: All three Ex-PRESS shunt models were effective in lowering IOP in a safe manner, both alone and combined with cataract surgery. The P200 model lowered IOP more effectively compared to the P50 and R50 models. However the sample size for the P200 and R50 models were small, and this study has all the inherent problems associated with a retrospective study.

Conclusions: The Ex-PRESS™ glaucoma filtration device is a safe alternative to traditional trabeculectomy surgery and is as effective in combination with cataract surgery. The P200 model Ex-PRESS shunt maybe, a reasonable choice in patients with advanced glaucoma or normal tension glaucoma needing lower postoperative intraocular pressures.

51 Risk Factors Associated with Aqueous Tube Shunt Extrusion: A Retrospective Case-control Study

KUNDANDEEP S. NAGI, Robert Feldman, Nick Bell, Alice Chuang, Laura Baker, Stephen Huddleston, David Lee, Michael Koval, Ricardo Cumba
University of Texas Health Science Center at Houston, Houston, TX, University of Texas Medical School at Houston, Houston, TX

Purpose: To investigate the risk factors that may lead to aqueous tube shunt extrusion in glaucoma patients.

Methods: A retrospective 1:2 matched case-control study utilizing medical records from patients that underwent implantation of glaucoma drainage devices with patch grafts at the Robert Cizik Eye Clinic, UTHealth from 1995 to 2005. Eyes with tube erosion were identified as cases and each matched with two controls that underwent tube shunt implantation within 6 months of the case. Demographic, systemic and ocular histories, as well as implantation parameters were recorded. Statistical analysis, including two sample t-test and Fisher-Exact test, was used to compare each risk factor and a stepwise conditional logistic regression was used to identify risk factors associated with erosion.

Results: Eighteen cases and 36 controls were included in this study. Among them, 33% were male, 52% were black, with a mean age of 58 (±20) years. There were no statistically significant differences in race, age, hypertension, diabetes, number of glaucoma lowering medications, and surgery parameters. The risk of erosion was increased if an eye had neovascular (NVG) glaucoma (28% vs 6%, p=0.034), more than 3 ocular surgeries prior to implantation (56% vs 22%, p=0.030), and previous tube implantation (second shunts) (22% vs 3%, p=0.037). Conditional logistic regression confirmed two risk factors: NVG and previous tube implantation.

Discussion: This study has identified 2 risk factors: NVG and prior tube implantation. This may be related to poor tissue distensibility and wound healing. Overall, previous ocular surgery (greater than 3) also correlated with increased risk of erosion, though although the sample size is too small to analyze the specific surgeries involved.

Conclusion: Eyes with NVG and a history of previous tube implantation were associated with increased risk of tube extrusion.
52 “ECP-Plus” to Treat Refractory Glaucoma

JAMES C. TAN, Ghazal Yakili, Robert Noecker, Brian Francis

University of Southern California, Los Angeles, CA, University of Pittsburgh, Pittsburgh, PA

Purpose: To report clinical outcomes following endoscopic cyclophotocoagulation (ECP) of the posterior ciliary processes and pars plana (“ECP-plus”) via a pars plana (PP) approach for refractory glaucoma.

Methods: Retrospective analysis of clinical data from subjects followed for at least 3 months (m) after 360 degree ECP-plus following PP vitrectomy. Subjects had uncontrolled intraocular pressure (IOP) despite prior glaucoma surgery and maximally tolerated medical therapy. The primary outcome was IOP, and secondary outcomes were complications.

Results: 53 subjects’ data were analyzed. 32.1% (17/54) had primary open angle glaucoma (POAG), 26.4% (14/54) had chronic angle closure glaucoma, and the rest (41.5%) had secondary OAG. 28/53 of subjects had 12m, and 10/53 had 24m of follow up respectively. Mean preoperative IOP was 27.9±7.5mmHg (mean±SD). Postoperative IOP at 1m (11.5±8.8), 3m (8.9±5.7), 6m (9.6±4.6), 12m (10.7±5.2), 18m (8.1±5.1) and 24m (11.1±6.5) was significantly lower than before laser (all p<.001). IOP reduction <20%; hypotony (IOP≤5mmHg) on 2 consecutive follow ups after 1m; further glaucoma surgery; or loss of light perception) was 85% at 1m, 78% at 12m, and 78% at 24m. Mean number of medications fell from 3.4±1.2 pre-laser to 1.1±1.1 at 1m (p<.0001), 0.7±1.2 at 12m (p<.0001), and 0.6±1.3 (p=0.005) at 24m postoperatively. In the initial postoperative period (<3m), 2/53 had hypotony, with both having choroidal detachments; 2/53 had uveitis with fibrin. After 3m, 4/53 had hypotony, with 3/4 having choroidal. 3/53 needed further related surgery, 2/3 of whom had hypotony. 1/53 had a failed corneal graft. All initial uveitis had resolved. No subjects suffered retinal detachment or endophthalmitis.

Discussion: IOP was significantly lowered by a mean of at least 58% following ECP-plus. IOP reduction was relatively sustained over the follow up period and fewer glaucoma medications were needed. 7.5% had hypotony beyond 3m postoperatively.

Conclusion: ECP-plus is effective in lowering IOP in refractory cases of glaucoma, patients require fewer medications postoperatively, and the treatment is relatively well tolerated.

53 Second Generation Stents in Mild-Moderate Open-angle Glaucoma: Design Review and Initial Clinical Data from Prospective, Randomized Study

JASON BACHARACH
North Bay Eye Associates, Inc., Petaluma, CA

Introduction: Our purpose is to review product design and initial clinical data following implantation of second generation stents during cataract surgery vs. cataract surgery alone in mild to moderate open-angle glaucoma.

Methods: A second generation trabecular bypass stent is under clinical investigation in a prospective, randomized US IDE study. This single-piece heparin-coated titanium stent is inserted in Schlemm’s canal via ab interno implantation through a temporal corneal incision. Multiple outlet lateral lumens are designed to provide an exit route for aqueous from the anterior chamber. Preclinical in vitro work has shown increased outflow facility with this device.1 The initial study phase involved 44 subjects randomized to implantation of two stents during cataract surgery (treatment) or cataract surgery only (control). Postoperative examinations were at 1 day, 1 week and 1, 3, 6, 12, 18 and 24 months. Analyses of safety included adverse events and complications. One year IOP ≤18 mmHg without medication was the primary efficacy endpoint.

Results: Seventy-seven percent (20/26) of treatment eyes and 24% (4/17) of control eyes met the primary efficacy endpoint. Postoperative adverse events >10% were elevated IOP at any visit (11% treatment vs. 47% control), conjunctivitis (7% treatment vs. 12% control), BCVA loss ≥1 line (0% treatment vs. 12% control) and eye pain (0% treatment vs. 12% control).

Discussion: In this series, overall safety was comparable in both groups. IOP was managed to ≤18 mmHg without medication at 1 year in a higher proportion of stent subjects, suggesting an incremental benefit of stent implantation vs. cataract surgery alone.

Conclusions: These data form the basis for continued investigation in mild to moderate open-angle glaucoma requiring cataract surgery.

Reference:
54 Trabeculectomy Using Collagen Matrix Implant: A Retrospective Review on 1-Year Data

James M. Rouse, Steven R. Sarkisian
Dean McGee Eye Institute, Oklahoma City, OK

Introduction: To investigate the efficacy of the collagen matrix implant as a wound modulating agent in glaucoma filtering surgery

Methods: Retrospective, consecutive case review of 24 eyes of 19 patients with primary open angle glaucoma undergoing trabeculectomy with the ExPress mini glaucoma shunt. Collagen matrix was implanted just before the conjunctival closure. Main outcome measures included post-operative intraocular pressure (IOP) and post-operative complications. Secondary outcome measures include post-operative visual acuity and need for further glaucoma surgery or medications. Surgical success was defined as IOP greater than 5 mmHg and less than 22 mmHg with or without glaucoma medications or greater than 20% reduction from baseline if baseline is less than 22 mmHg. Failure was defined as IOP greater than 21 mmHg or less than 20% reduction from baseline in patients whose baseline is less than 21 mmHg.

Results: Surgical success, as defined above, was achieved in 86.4% of the cases reviewed at their approximate 1 year follow up visit. Three eyes required the addition of glaucoma medications in the first year of follow-up. One patient underwent 5-fluorouracil injection at 2 months. No other patient had any antifibrotic agent intra or post-operatively. Two patients had early wound leaks successfully closed in the first few weeks. No further surgical interventions were required for any patients.

Discussion: The collagen matrix is a recent advancement in wound modulation in glaucoma filtering surgery. This matrix helps to induce a regenerative wound healing process and due to its biodegradable nature can act as scaffolding to form blebs resembling natural architecture rather than the thin avascular blebs associated with antifibrotic agents. To this date, there is limited data available for filtering surgery using the collagen matrix. This case series represents the first report of the use of collagen matrix in the US with one year follow up.

Conclusions: The collagen matrix is a relatively safe and effective method for wound modulation in glaucoma filtration surgery.

55 Hypotonous Maculopathy: Outcomes after Bleb Revision

Elena Bitrian, Diem Bui, Suyeon Ahn, Joseph Caprioli
Jules Stein Eye Institute, Los Angeles, CA

Purpose: To report the long-term efficacy and safety of bleb revision for hypotonous maculopathy.

Methods: This is a non comparative retrospective case series of hypotonous maculopathy that underwent a primary bleb revision between June 1999 and June 2010 by a single surgeon. Hypotonous maculopathy was characterized by low IOP, loss in visual acuity and retinal striae. Patients with less than 3 months of follow-up or that underwent a prior bleb revision were excluded. Surgery involved resection of necrotic conjunctiva, resuture of the scleral flap with 10-0 nylon, use of pericardium patch graft in some cases and conjunctival advancement.

Results: Thirty-three eyes of 33 patients (age 66.65 ± 14.40 years) were followed for an average of 2.74 ± 3.07 years (range 3 months - 9.5 years). Forty-five percent were female and 3 (9%) presented with choroidal as well as macula striae. After bleb revision, the mean baseline intraocular pressure (IOP) increased from 3.16 ± 1.94 mmHg to 11.71 ± 5.24 mm Hg at the last follow-up (P<0.001). Visual acuity also improved from 0.30 ± 0.21 to 0.53 ± 0.23 (P<0.001). Seventy-five percent of patients were on no antiglaucoma drops at last follow-up. Four cases (12%) required a second bleb revision to resolve the hypotonous maculopathy.

Discussion: Surgical repair for hypotony maculopathy was associated not only with improvement in IOP, but also in visual acuity, both at short and long term of follow-up.

Conclusion: Bleb revision is an effective procedure with good long-term control of IOP and improvement of visual acuity in eyes with hypotonous maculopathy.

References:
56 Influence of Cup-to-Disc Ratio on Ab Interno Trabeculotomy Outcomes

STEVEN D. VOLD
Boozman-Hof Eye Clinic, P.A., Rogers, AR

Introduction: To analyze the impact of cup-to-disc ratio on the safety and efficacy of ab interno trabeculotomy using the Trabectome in glaucoma patients.

Methods: A prospective, non-randomized, observational, comparative cohort study of 1604 Trabectome patients was followed for at least 6 months. The patients were stratified into 2 groups based on their cup-to-disc ratios. Group 1 has patients with cup-to-disc ratios less than or equal to 0.8. The patients with cup-to-disc ratios greater than 0.8 are in group 2. The main outcome measures were intraocular pressure, glaucoma medications and occurrence of any secondary surgeries.

Results: At 6 months post-operatively, the IOP in group 1 patients (n=835) was reduced 28% from 24.8±8.0 mmHg to 16.4±4.2 mmHg (p<0.01), and mean number of glaucoma medications was reduced 24% from 2.71±1.33 mmHg to 1.93±1.38 mmHg (p<0.01). At 6 months post-operatively, the IOP in group 2 patients (n=769) was reduced 23% from 22.8±7.2 mmHg to 15.9±4.1 mmHg, and mean number of medications dropped 23% from 2.90±1.21 mmHg to 2.08±1.37 mmHg (p<0.01). The percentages of secondary surgeries in the groups were 12% and 16% respectively.

Discussion: Ab interno trabeculotomy has been demonstrated to be effective and safe in patients with open angle glaucoma. However, little is known about whether the severity of glaucoma might impact postoperative outcomes of Trabectome surgery. This study evaluates the hypothesis that patients with an earlier stage of glaucoma might respond more favorably than those with more advanced glaucomatous disease.

Conclusions: The drop in IOP and glaucoma medications was significant in each of the two groups. Group 1 had the highest percentage drop in IOP and glaucoma medications at 6 months postoperatively from baseline levels.

Reference:

57 Intraocular Pressure Control in Patients Undergoing Ex-PRESS Miniature Glaucoma Implant with and without Cataract Extraction

REGINEM. PAPPAS, Leslie S. Jones, Oluwatosin Smith
Pinnacle Eye Center, Melbourne, FL, Howard University, Washington, VA, Glaucoma Associates of Texas, Dallas, TX

Introduction: This study evaluated the effectiveness and rate of complications of the Ex-PRESS Mini Glaucoma Shunt in reducing IOP when performed with cataract surgery and alone.

Methods: This retrospective study was conducted at Pinnacle Eye Center, Howard University Hospital, and the University of Mississippi Medical Center. A chart review of consecutive eyes having undergone Ex-PRESS Mini Glaucoma Shunt implantation between January 2008 and December 2008 was performed. The following preoperative data were recorded: best corrected visual acuity, IOP, and number of preoperative glaucoma medications. Operative data including surgeon, technique, size of shunt, use of antimetabolites, and occurrence of complications were also recorded. Postoperative data collection included IOP measured and number of eye medications recorded at day 1, week 1 and months 1, 3, 6, 9 and 12. Success was deemed as IOP <18 mmHg. Failure was defined as eyes that required re-operation for glaucoma.

Results: A total of 180 eyes of 174 consecutive patient records were reviewed. There were 59% female (n=102) and 41% male patients (n=72). The mean age was 71 years. All surgeries were performed by a single surgeon at each center with use of Mitomycin C and placement of the shunt under a partial thickness sclera flap. Forty-eight eyes underwent combined cataract extraction with Ex-PRESS implantation and 126 eye had Ex-PRESS implantation alone. Average preoperative IOP was 23 mmHg for all eyes. The average postoperative IOP for eyes undergoing cataract and Ex-PRESS was 13 mmHg and 12 mmHg in the Ex-PRESS only group at postoperative day 1; 11 mmHg for both groups at postoperative day 7; 13 for both groups at the 6,9, and 12 month time points. There were few complications with 4 eyes experiencing worsening of cataract, 3 bleb leaks, 4 subsequent bleb revisions, 3 subsequent Baerveldt aqueous tube shunts.

Discussion: The Ex-PRESS implant was equally effective when performed with cataract surgery and alone. Few complications were noted in either group.

Conclusion: Implantation of Ex-PRESS mini shunt was effective and safe with control of IOP as long as 12 months following the procedure when performed with cataract extraction and alone.
**58 Comparison of Surgical Outcomes Between Canaloplasty and Trabeculectomy at 12 Months Follow-Up**

**RAMESH S. AYYALA, Amina L. Chaudhry, David Zurakowski**

Tulane School of Medicine, New Orleans, LA. Children’s Hospital Boston, Harvard Medical School, Boston, MA

**Purpose:** To compare surgical outcomes of patients following canaloplasty and trabeculectomy through 12 months follow-up.

**Methods:** Retrospective, non-randomized, comparative case series (in patients with OAG) involving 33 eyes in 33 patients who underwent canaloplasty and 46 eyes in 46 patients who underwent trabeculectomy with MMC with 12 months postoperative follow-up were included. All surgeries were performed by a single surgeon.

**Main Outcome Measures:** IOP, visual acuity, postoperative medications, surgical failure and complication rates.

**Results:** There were no differences in demographics or previous surgery between the groups. Excluding surgical failures and patients on postoperative medications, ANOVA indicated that IOP was significantly higher in the canaloplasty group on 1 day (P = 0.02), 1 week (P < 0.01), 1 month (P < 0.01) and 12 months (P = 0.02). No significant differences were found in the number of preoperative or postoperative medications, or visual acuity at 12 months. There was no difference in surgical failure rates between canaloplasty (n = 5, 15%) and trabeculectomy (n = 5, 11%) groups (P = 0.74). A higher percentage of patients treated with canaloplasty than trabeculectomy (36% vs. 20%) required postoperative medications, although this did not reach statistical significance (P = 0.12).

**Conclusions:** Canaloplasty and trabeculectomy both achieved significant reduction in IOP at 12 months, although trabeculectomy is more likely to result in IOP closer to 10 mm Hg with fewer patients requiring postoperative medications.

**References:**


**60 Potential Clinical Applications in Glaucoma Surgery**

**MOLLY M. WALSH, Pedro Gonzalez, Kelly Searle**
Duke University, Durham, NC

**Purpose:** Many trabeculectomy procedures ultimately fail due to fibroblast proliferation which can ensue postoperatively. Recent studies in other surgical subspecialties have shown potential for the adjunctive use of resveratrol to inhibit scarring after various surgical interventions. Our hypothesis is that the anti-scarring properties of resveratrol may potentially be used to decrease scarring after trabeculectomy.

**Methods:** 14 New Zealand white rabbits underwent trabeculectomy on their right eye. 7 of the rabbits were placed on resveratrol (5 mg/kg) in their drinking water. This treatment was initiated one week prior to the surgery and was continued daily until one month after the trabeculectomy. IOPs (intraocular pressures) were recorded weekly using a Tonopen device. Immunohistochemistry was then used to determine differences in collagen and fibroblast expression in both eyes.

**Results:** The average IOP difference in the control group at 1 month after trabeculectomy was an increase of 2.14 mmHg. However, the average difference observed in the resveratrol group was a decrease of 1.71 mmHg.

**Discussion:** Therefore, the difference between the treated and untreated groups was 3.85 mmHg which was statistically significant (p value of 0.014).

**Conclusions:** This study suggests that there may be a potential beneficial role for adjunctive therapy with resveratrol for patients undergoing trabeculectomy.

**References:**

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**61 Simultaneous Placement of Two Glaucoma Drainage Devices for Uncontrolled Glaucoma**

**ANNA C. MOMONT, Joshua D. Stein, Jennifer S. Weizer**
University of Michigan, Ann Arbor, MI

**Introduction:** It has been suggested that glaucoma drainage devices (GDDs) which have a larger explant surface area provide better long-term intraocular pressure (IOP) control while the presence of a flow restrictor or “valve” reduces the risk of postoperative hypotony while achieving immediate IOP lowering. The purpose of this study is to report baseline characteristics and surgical outcomes of placement of simultaneous GDDs in eyes with considerably elevated IOP despite maximal medical therapy.

**Methods:** Retrospective case series. The medical records were reviewed of consecutive patients who underwent simultaneous placement of a Baerveldt 350 and Ahmed S3 GDDs in the same eye at the University of Michigan Kellogg Eye Center from 2006 to 2009. Baseline characteristics, preoperative and postoperative IOP, number of glaucoma medications, visual acuity, and complications were recorded.

**Results:** Fourteen eyes of 14 patients (mean follow-up, 14.9 ± 15.4 months) underwent simultaneous placement of two GDDs in the same eye. The mean baseline cup to disc ratio was recorded at 0.94 ± 0.06 horizontally and 0.92 ± 0.08 vertically. The mean baseline IOP of 38.8 ± 5.7 mm Hg was significantly reduced at all times points following placement of the GDDs, and the mean IOP at last follow-up was 13.9 ± 5.8 mm Hg (p ≤ 0.0001). Mean number of glaucoma medications was significantly lower at last follow-up than preoperatively (1.5 ± 0.9 vs. 3.1 ± 0.9; p = 0.0007). There was no difference in mean logMAR visual acuity from preoperative to last follow-up (1.05 vs. 1.07; p = 0.95).

**Discussion:** Simultaneous placement of a Baerveldt 350 and Ahmed S3 GDD effectively lowers IOP in the immediate post-operative period and long-term without significant intra-operative or postoperative complications.

**Conclusions:** This surgical approach may be useful in glaucomatous eyes with advanced disease and considerably elevated preoperative IOPs.

**Reference:**
62 Resident Experience Comparing Standard Trabeculectomy with the Ex-PRESS Glaucoma Device for Treatment of Glaucoma

JUNER COLINA-LUQUEZ, Erika Wandel, Augustine Hong, Thomas Patrianakos

University of Chicago, Chicago, IL, John H Stroger Jr. Hospital of Cook County, Chicago, IL

Introduction: To compare resident results when performing a standard trabeculectomy with antifibrotics (TrabMMC) with the Ex-PRESS glaucoma shunt (R-50), (Alcon Labs, Inc., Fort Worth, TX) with antifibrotics (ExMMC).

Methods: 60 eyes with open angle glaucoma who received either TrabMMC (30 eyes) or an ExMMC (30 eyes) were retrospectively reviewed. Residents were primary surgeons on all cases. Success was defined as intraocular pressure (IOP) ≥ 5 mmHg and ≤ 20 mmHg. Comparison of pre and post operative IOP, number of medications between groups, and complications were analyzed.

Results: The mean age was 62 and 57 years in the TrabMMC and ExMMC groups, respectively. Mean follow-up was 12±7 months for TrabMMC and 10±6 months for ExMMC. The preoperative IOP was 26±8 mmHg and 29±10 mmHg for the TrabMMC and ExMMC group, respectively (P = 0.04, unpaired t-test). Postoperative IOP for the TrabMMC was 13, 13, 14 mmHg and for the ExMMC group, 10, 12 and 12 mmHg at 1, 3 and 6 months, respectively (P = 0.25, unpaired t-test). Success at 6 months was 87% for TrabMMC and 90% for ExMMC. Mean number of ocular hypotensive medications decreased from 4 to 1 in both the TrabMMC and ExMMC group (P<0.001, paired t-test). Success at 6 months was 87% for TrabMMC and 90% for ExMMC. Mean number of ocular hypotensive medications decreased from 4 to 1 in both the TrabMMC and ExMMC group (P<0.0001, paired t-test). There were 5 total cases of hypotony/choroidal, 2 in the TrabMMC group and 3 in the ExMMC group, and 3 cases of bleb failure, 2 in the TrabMMC group and 1 in the ExMMC group.

Discussion: ExMMC standardizes one of the steps of a trabeculectomy that many residents struggle with and may lead to better results.

Conclusions: At 6 months, there was no statistically significant difference in success rates, number of medications pre and post operatively and number of complications between the TrabMMC and ExMMC group performed by residents.

References:

63 Clinical Outcomes of Trabectome® Surgery in Open Angle Glaucoma

ZACHARY VEST, David G. Godfrey, Ronald L. Fellman, Arvind Neelakantan

UT Southwestern Medical Center, Dallas, TX, Glaucoma Associates of Texas, Dallas, TX

Purpose: To examine outcomes of Trabectome surgeries performed at our institution. Our goal was to compare our initial experience with published outcomes and also to examine if patients presenting with a higher initial intraocular pressure (IOP) were more likely to require further interventions.

Methods: A retrospective review of Trabectome cases from Sept 2007 to Dec 2009 was conducted allowing for a minimum follow-up (FU) of 6 months. Second eyes, cases of closed angle glaucoma and eyes with < 6 months FU were excluded, unless they failed earlier. The main outcome studied was IOP. Trabectome and Phacotrabectome eyes were analyzed as separate groups. A secondary analysis compared eyes with an initial IOP of <30 mmHg to IOP ≥30 mmHg. Surgical success was defined as IOP ≤21 mm Hg with or without medication or 20% decrease in IOP. Repeat glaucoma surgery or NLP vision were considered failures.

Results: 78 of 93 eyes met inclusion criteria. Trabectome™ (n=53) group: Mean preoperative IOP was 23.2 mmHg on 2.9 medications. Mean IOP at final FU (mean 16 months) was 19.7 mmHg on 2.9 medications. 58.5% eyes (31/53) achieved IOP success. 35.8% eyes failed at a mean of 9.3 months. Phacotrabectome group (n=25): Mean preoperative IOP was 20.8 mmHg on 2.8 medications. Mean IOP at final FU (mean 20.4 months) was 15.8 mmHg on 2.4 medications. 80% eyes (20/25) achieved IOP success. 8% eyes failed at a mean of 7.4 months. Secondary analysis based on initial IOP, showed that eyes with IOP ≥30 mmHg (n=10) had a higher failure rate (60% v. 22%) and on average failed earlier (5.5 v. 9.8 months) than those with IOP <30 mm Hg.

Discussion: The lower success rate in this study could possibly be explained by the learning curve innate to a new procedure. 26% of the Trabectome only eyes and 7% of the Phacotrabectome eyes required further glaucoma surgery. Eyes with an initial IOP of ≥30mmHg are unlikely to do well with this procedure alone.

Conclusion: Trabectome is a safe small-incision method for improving IOP control and is more effective in combination with cataract surgery. This technique offers a reasonable alternative in some patients, sparing conjunctiva for future filtering surgery.
64 Scanning Electron Microscopic Evaluation of Morphologic Changes after Continuous vs. Multipulse Yellow Laser Trabeculoplasty

JEREMY B. WINGARD, Kimberly V. Miller, Michael J. Pokabla, Korriinn Strunk, Jennifer L. Gray, Rocio Bentivegna, Robert J. Noecker

目的: 评估连续黄色激光 trabeculoplasty (YLT) 对比多种能量设置的 multipulse yellow laser trabeculoplasty (MYLT) 的形态学变化。

方法: 通过视网膜激光应用 (ALT) 使用的 argon laser, Uveal meshwork 和 trabecular meshwork (TM) 出现类似形态学变化。这与已发表的文献类似。

结果: 定向烧伤和凝固性损伤在 trabecular meshwork (TM) 中被识别。使用 argon laser 激光的多脉冲技术, 澳大利亚激光 trabeculoplasty (MYLT) 可能是一种破坏性较小的激光 trabeculoplasty 选择。

讨论: MYLT 可能是一种破坏性较小的选择。

参考文献:

65 The Effect of Intracameral Triesence (Triamcinolone Acetonide injectable suspension) on Ocular Inflammation after Trabeculectomy, Tube Shunt Implantation or Combined Trabeculectomy with Cataract Surgery

SHELLY R. GUPTA, Marlene R. Moster, Kathryn B. Freidi, Parul Ichhpujani, Jonathan S. Myers, Michael J. Pro

目的: 评估 Intracameral Triesence 在 trabeculectomy、tube shunt 或 combined phaco/trabeculectomy 后对 ocular inflammation 的影响。

方法: 在2009年4月到2010年12月期间, 33名连续合格患者接受了 Intracameral Triesence 的随机临床试验。

结果: 虽然 Intracameral Triesence 在所有观察点上都显示出与对照组相似的成功和并发症率, 但存在一定程度的炎症和角膜损伤。

讨论: Intracameral Triesence 可以用于 trabeculectomy、tube shunt 或 combined phaco/trabeculectomy。

参考文献:
66 The Effect of Selective Laser Trabeculoplasty on Intraocular Pressure after Trabeculectomy

MICHAEL P. HOOD, Benj. Harvey, Patrick W. Risch, James M. Rouse, Gregory L. Skuta, Steven R. Sarkisian, Mahmoud A. Khaimi
Dean McGee Eye Institute, Oklahoma City, OK

Purpose: To evaluate the use of selective laser trabeculoplasty (SLT) in eyes with prior trabeculectomy.

Methods: A retrospective chart review of 77 eyes of 73 patients with open angle glaucoma (OAG) undergoing SLT after previous trabeculectomy with antifibrotics. Patients were included if they were > 18 years of age, had been diagnosed with OAG, had a history of prior trabeculectomy and had undergone SLT therapy to 180 or 360 degrees of their trabecular meshwork. Intraocular pressure (IOP) was measured prior to each laser and at 30-60 minutes, 1-4 weeks, 3-6 months, 6-12 months, 12-18 months, 18-24 months, 24-36 months, and 36-48 months after laser. Generalized estimating equations were used to estimate response and adverse event probabilities while accounting for the correlation among eye-level measures on the same subject.

Results: Mean baseline IOP prior to SLT was 19.87 ± 4.39 mmHg. A response to SLT was defined as a decrease in IOP from baseline of greater than or equal to 20% at 3-6 months after laser. The response rate at 3-6 months (n=58 eyes) was 36% (95% CI: 24% to 51%). Of responding eyes at 3-6 months, 12 month data was available for 9 eyes. 44% of these eyes (95% CI: 17-76%) maintained response rate to the SLT. The only adverse events were early and late IOP spikes > 5 mmHg which was seen in 9% (95% CI: 4-18%) and 9% (95% CI: 3-20%) of eyes respectively. These IOP spikes were transient in nature.

Conclusion: SLT remains safe and effective for the treatment of open angle glaucoma in eyes previously treated with trabeculectomy (36% response rate). It remains an IOP-lowering option in select eyes that have undergone prior incisional glaucoma surgery.

67 Natural History of Glaucoma Drainage Implants and Corneal Transplants

DAVID CHU, Michael Banitt, Anne Ko, William Feuer, Joyce Schiffman, Richard K. Lee
Bascom Palmer Eye Institute, Miami, FL, New York Eye and Ear Infirmary, New York City, NY

Purpose: Failure of trabeculectomy glaucoma surgery is often followed by glaucoma drainage implant (GDI) surgery to control intraocular pressure (IOP). Secondary glaucoma after penetrating keratoplasty (PKP) and corneal decompensation after GDI placement are post-surgical complications with significant morbidity. The purpose of this study is to report the clinical course of post-trabeculectomy eyes requiring aqueous shunt implant surgery and subsequent corneal transplantation.

Methods: A retrospective review of post-trabeculectomy eyes which underwent GDI and subsequent PKP was performed. Eyes with corneal edema prior to GDI surgery, and those with GDI-corneal touch were excluded. Factors evaluated included: cornea and glaucoma diagnoses, visual acuity, intraocular pressure, corneal graft survival, surgical timing, post-operative complications, and need for additional surgery.

Results: Twenty-four eyes with glaucoma were studied (54% with an initial diagnosis of primary open angle glaucoma, 21% with pseudoexfoliation glaucoma). The average time between trabeculectomy failure to first GDI was 44.5 (±41.1) months. The average time between last GDI to first PKP was 36.8 (±27.4) months. No significant association with number of GDIs, number of prior intraocular surgeries, or GDI quadrant was observed. Corneal decompensation occurred at IOPs between 0 and 23 mmHg, suggesting endothelial dysfunction due to GDI, not damage from markedly elevated IOP. Within the first 5 years after first PKP, 20% of GDI failed and 73% of corneal grafts failed.

Conclusion: Corneal decompensation after GDI occurs even with controlled IOP. The number of glaucoma surgeries was not significantly associated with GDI to PKP time. Corneal grafts did well in the first two years after PKP, but had a significant number of failures in subsequent years, even with relatively good IOP control.
Visual Acuity Recovery after Slit Lamp Revision of Trabeculectomy

Emily Cook, Alfred Solish
Southern California Glaucoma Consultants, Pasadena, CA

Introduction: Visual acuity (VA) recovery after trabeculectomy requires approximately 2 months. Slit lamp revision (SLR) doesn’t create new astigmatism, considered a major cause of slow recovery of VA following trabeculectomy, so recovery after an SLR should be more rapid.

Methods: The charts of 47 patients and 48 eyes which underwent SLR were reviewed for VA and intraocular pressure (IOP) at 1 week, 3 weeks, 6 weeks, and 6 months.

Results: At 6 months, 33 of 48 eyes (68%) had equal or better VA than at time of procedure.

Of the 15 with lower VA, 12 had regained their VA in the first 6 weeks postoperatively but had later decreased. Their average starting IOP was 23 mmHg (range 3-50), with an average 3.25 lines lost (range 1-8), and average drop in IOP of 8.25 mmHg (range -28-48).

Of those 33 eyes which did not lose VA, the average start IOP was 16.3 mmHg (range 5-28), with an average 1.39 lines improvement in acuity (range 0-5), and the average drop in IOP was 2.95 mmHg (range -10-18). The average time taken to recover acuity was 12 weeks (range 1-25 week).

Of the 13 patients (27%) who started with an IOP greater than 21 mmHg, 8 (61%) had lower VA at 6 months than at the date of procedure. Their average loss in VA was 1.84 lines (range -8-4) and average change in IOP was 13.5 mmHg (range 6-48).

Discussion: The reason for loss of VA after SLR can be hypothesized to be from many sources similar to trabeculectomy, from hypotony maculopathy to cataract progression. While not statistically significant, recovery of visual acuity averaged longer than the reported 2 months of recovery after trabeculectomy. Pre-procedure IOP over 21 mmHg seemed to increase the chances of VA loss. VA loss was also associated with larger drops in IOP.

Conclusions: From the data presented here, it appears that the clinician must be aware that return of full pre-procedure VA cannot be assumed. Recovery time should not be presumed more rapid than trabeculectomy.

References: