



AMERICAN ACADEMY
OF OPHTHALMOLOGY®



Glaucoma 2022

Second to None Glaucoma
Care From the Second City

Subspecialty Day | AAO 2022

Chicago | Sept 30

Glaucoma 2022

Second-to-None Glaucoma Care From the Second City

Under Pressure®

Program Directors

Kelly W Muir MD and Teresa C Chen MD

In conjunction with the American Glaucoma Society



McCormick Place
Chicago, Illinois
Friday, Sept. 30, 2022

Presented by:
The American Academy of Ophthalmology

Supported by an unrestricted educational grant from
Aerie Pharmaceuticals, Inc. and Santen, Inc.



AMERICAN ACADEMY
OF OPHTHALMOLOGY®
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<i>Program Director</i>	2011	Leon W Herndon MD	1995	Reay H Brown MD
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		Anne Louise Coleman MD PhD		Jody R Piltz MD
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Brian A Francis MD	2003	Kuldev Singh MD MPH		Staff
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2016 Joel S Schuman MD		Robert D Fechtner MD		Mark Ong, <i>Designer</i>
Jody R Piltz-Seymour MD	1999	Robert N Weinreb MD		Jim Frew, <i>Cover Design</i>
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2014 David S Friedman MD MPH PhD		Robert N Weinreb MD		
James D Brandt MD				

Glaucoma Subspecialty Day 2022 Program Planning Group

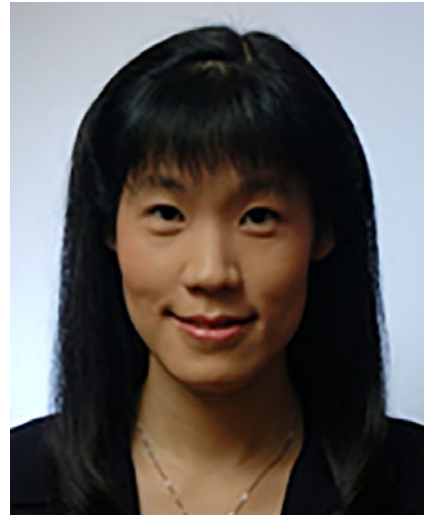
On behalf of the American Academy of Ophthalmology and the American Glaucoma Society (AGS), it is our pleasure to welcome you to Chicago and Glaucoma 2022: Second-to-None Glaucoma Care From the Second City.



Kelly W Muir MD

Program Director

None

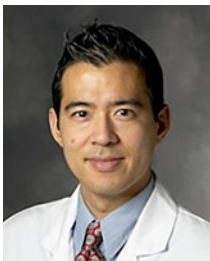


Teresa C Chen MD

Program Director

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Program Planning Group



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Aerie Pharmaceuticals, Inc.: C
Alcon Laboratories, Inc.: C
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Ocular Therapeutix: C
Omeros Corp.: C
Optomed: C | Santen, Inc.: C
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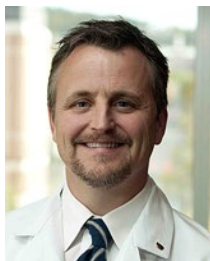
Babak Eliassi-Rad MD

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Endo Optiks, Inc.: C
Glaukos Corp.: S
Nova Med: P,US
Olleyes: SO



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Heidelberg Engineering: C,S
Topcon Medical Systems, Inc.: C,S



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AbbVie: C,L
Alcon Laboratories, Inc.: C,L
Bausch + Lomb: C,L
Beaver-Visitec International, Inc.: C
Glaukos Corp.: C,S
Iridex: C,L
New World Medical, Inc.: L,C
Ocular Therapeutix: C,SO
Santen, Inc.: C
Sight Sciences, Inc.: C,SO,L
Thea: C

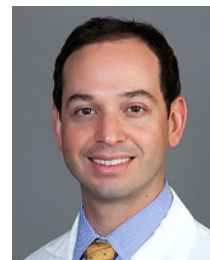


Ramya N Swamy MD MPH
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No photo available

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Luis E Vazquez MD PhD
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Manjool M Shah MD
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Glaukos Corp.: C
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None

Glaucoma 2022 Contents

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CME Credit

The Academy's CME Mission Statement

The purpose of the American Academy of Ophthalmology's Continuing Medical Education (CME) program is to present ophthalmologists with the highest quality lifelong learning opportunities that promote improvement and change in physician practices, performance, or competence, thus enabling such physicians to maintain or improve the competence and professional performance needed to provide the best possible eye care for their patients.

Glaucoma Subspecialty Day Meeting 2022 Learning Objectives

Upon completion of this activity, participants should be able to:

- Demonstrate familiarity with controversial management issues and current gaps in evidence-based glaucoma care
- Evaluate the current status of glaucoma imaging and image interpretation, as well as their role in diagnosing and managing glaucoma
- Demonstrate familiarity with current issues in medical and surgical therapy for glaucoma and how these therapies affect other eye disease
- Recognize factors that complicate care of the glaucoma patient

Glaucoma Subspecialty Day Meeting 2022 Target Audience

This activity has been designed to meet the educational needs of general ophthalmologists, glaucoma specialists and other ophthalmologic subspecialists, and allied health personnel who are involved in the management of glaucoma patients.

Teaching at a Live Activity

Teaching instruction courses or delivering a scientific paper or poster is not an *AMA PRA Category 1 Credit*[™] activity and should not be included when calculating your total *AMA PRA Category 1 Credits*[™]. Presenters may claim *AMA PRA Category 1 Credits*[™] through the American Medical Association. To obtain an application form, please contact the AMA at www.ama-assn.org.

Scientific Integrity and Disclosure of Conflicts of Interest

The American Academy of Ophthalmology is committed to ensuring that all CME information is based on the application of research findings and the implementation of evidence-based medicine. The Academy seeks to promote balance, objectivity, and absence of commercial bias in its content. All persons in a position to control the content of this activity must disclose any and all financial interests. The Academy has mechanisms in place to resolve all conflicts of interest prior to an educational activity being delivered to the learners.

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The American Academy of Ophthalmology considers presenting authors, not coauthors, to be in control of the educational content. It is Academy policy and traditional scientific publishing and professional courtesy to acknowledge all people contributing to the research, regardless of CME control of the live presentation of that content. This acknowledgment is made in a similar way in other Academy CME activities. Though coauthors are acknowledged, they do not have control of the CME content, and their disclosures are not published or resolved.

Subspecialty Day 2022 CME Credit

The American Academy of Ophthalmology is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide CME for physicians.

Friday Subspecialty Day Activity: Glaucoma, Pediatric Ophthalmology, Refractive Surgery, Retina (Day 1), and Uveitis

The Academy designates this Other (blended live and enduring material) activity for a maximum of *12 AMA PRA Category 1 Credits*[™]. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Saturday Subspecialty Day Activity: Cornea, Oculofacial Plastic Surgery, and Retina (Day 2)

The Academy designates this Other (blended live and enduring material) activity for a maximum of *12 AMA PRA Category 1 Credits*[™]. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Physicians registered as In Person and Virtual are eligible to claim the above CME credit.

Attendance Verification for CME Reporting

Before processing your requests for CME credit, the Academy must verify your attendance at AAO 2022 and/or Subspecialty Day. Badges are no longer mailed before the meeting. Picking up your badge onsite will verify your attendance.

Attendance Verification for CME Reporting

Before processing your requests for CME credit, the Academy must verify your attendance at AAO 2022 and/or Subspecialty Day. Badges are no longer mailed before the meeting. Picking up your badge onsite will verify your attendance.

How to Claim CME

Attendees can [claim credits online](#). For AAO 2022, you can claim CME credit multiple times, up to the 50-credit maximum, through Aug. 1, 2023. You can claim some in 2022 and some in 2023, or all in the same year. For 2022 Subspecialty Day, you can claim CME credit multiple times, up to the 12-credit maximum per day, through Aug. 1, 2023. You can claim some in 2022 and some in 2023, or all in the same year.

You do not need to track which sessions you attend, just the total number of hours you spend in sessions for each claim.

Academy Members

CME transcripts that include AAOE Half-Day Coding Sessions, Subspecialty Day and/or AAO 2022 credits will be available to Academy members through the Academy's [CME Central web page](#).

The Academy transcript cannot list individual course attendance. It will list only the overall credits claimed for educational activities at AAOE Half-Day Coding Sessions, Subspecialty Day and/or AAO 2022.

Nonmembers

The Academy provides nonmembers with verification of credits earned and reported for a single Academy-sponsored CME activity.

Proof of Attendance

You will be able to obtain a CME credit reporting/ proof-of attendance letter for reimbursement or hospital privileges, or for nonmembers who need it to report CME credit:

Academy Members

When you claim CME credits and complete the evaluation, you will be able to print a certificate/proof of attendance letter from your transcript page. Your certificate will also be emailed to you.

Nonmembers

When you claim CME credits and complete the evaluation, a new browser window will open with a PDF of your certificate. Please disable your pop-up blocker. Your certificate will also be emailed to you.

CME Questions

Send your questions about CME credit reporting to cme@aao.org. For Continuing Certification questions, contact the American Board of Ophthalmology at MOC@abpo.org.

The American Glaucoma Society (AGS) Subspecialty Day Lecture

Nature, Nurture, Neighborhood, Network, and Glaucoma

Anne Louise Coleman MD PhD

FRIDAY, SEPT. 30, 2022

11:36 AM - 12:06 PM



Anne Louise Coleman MD PhD

Dr. Coleman is the chair and executive medical director of the Department of Ophthalmology in the David Geffen School of Medicine, director of the UCLA Stein Eye Institute, affiliation chair of the Doheny Eye Institute, and professor of Epidemiology in the UCLA Jonathan and Karin Fielding School of Public Health.

Dr. Coleman received her medical degree from the Medical College of Virginia, completed her residency training at the University of Illinois in Chicago, and finished her fellowship training in glaucoma at the Wilmer Eye Institute, Johns Hopkins University.

She received her doctorate in epidemiology from UCLA and is a graduate of the Anderson School of Management Executive Program in Management. Dr. Coleman's research focuses on the diagnosis, treatment, risk factors, gene-environment interactions, and societal impact of glaucoma, cataracts, AMD, and amblyopia. She has also examined the lifestyle limitations imposed on patients with these chronic eye diseases. She is a past member of the Scientific Advisory Panel for Research to Prevent Blindness and is currently an associate editor of glaucoma for the *American Journal of Ophthalmology*. She has more than 240 peer-reviewed publications and has helped lead monumental studies in ophthalmology, including the Ocular Hypertension Treatment Study. Dr. Coleman is also a respected

and innovative surgeon, pioneering the use of the Ahmed glaucoma valve—the world's leading glaucoma drainage device—and publishing the first peer-reviewed article describing its safety and efficacy.

Dr. Coleman has been actively involved in national outreach programs in ophthalmology. She was elected to the National Academy of Science, Engineering, and Medicine in 2016, was a member of the National Academy of Medicine (formerly Institute of Medicine) Committee on Public Health Approaches to Reduce Vision Impairment and Promote Eye Health, and was chair of the National Eye Institute National Eye Health Educational Program. She is former president of the American Academy of Ophthalmology (the Academy), the American Ophthalmological Society, Women in Ophthalmology, and the Los Angeles Society of Ophthalmology. She is recipient of the Academy's Life Achievement Award and Secretariat Award and gave the prestigious LXXII Edward Jackson Memorial Lecture at the Academy's annual meeting in 2015. She is the only Academy president to have also given the Jackson Memorial Lecture and be honored as a member of the National Academy of Medicine. She is a former member of the St. John of Jerusalem Eye Hospital Group Board of Trustees, the Helen Keller International Board of Trustees, and the U.S. Food and Drug Administration Ophthalmic Devices Panel.

Faculty



Iqbal K Ahmed MD
Mississauga, Canada



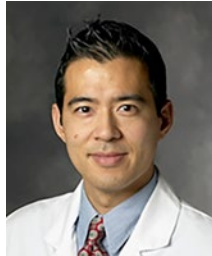
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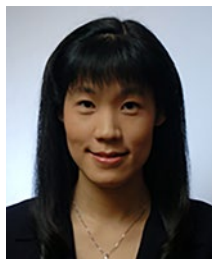
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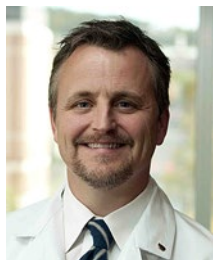
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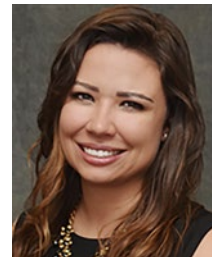
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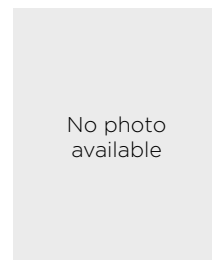
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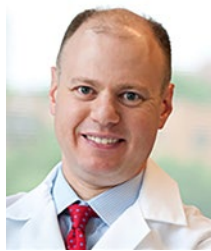
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Manjool M Shah MD
Ann Arbor, MI



Prem S Subramanian MD PhD
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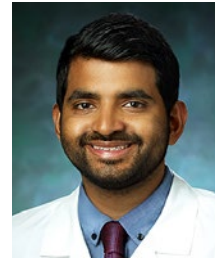
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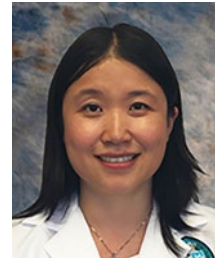
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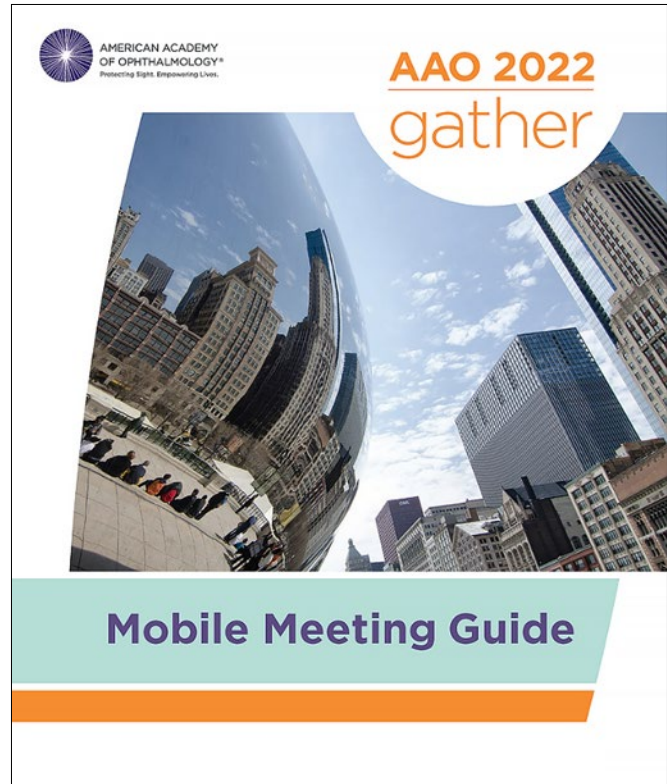


Ze Zhang MD
New Orleans, LA

Ask a Question and Respond to Polls Live During the Meeting Using the Mobile Meeting Guide

To submit an answer to a poll or ask the moderator a question during the meeting, follow the directions below.

- Access at www.aao.org/mobile
- Select “Polls/Q&A”
- Select “Current Session”
- Select “Interact with this session (live)” to open a new window
- Choose “Answer Poll” or “Ask a Question”



Glaucoma Subspecialty Day 2022

Second-to-None Glaucoma Care From the Second City

FRIDAY, SEPT. 30, 2022

8:00 AM	Welcome and Introductions	Kelly Walton Muir MD
8:02 AM	American Glaucoma Society Introduction	Christopher A Girkin MD
8:04 AM	AGS Cares	Christopher A Girkin MD
8:09 AM	Announcements	Teresa C Chen MD

Section I: Imaging/Diagnostics/Visual Fields

Moderators: Christopher A Girkin MD and Luis E Vazquez MD

Virtual Moderator Morning Sessions: Shivani S Kamat MD

8:11 AM	Detection of Glaucoma in Challenging Suspects and Myopic Eyes	Claude F Burgoyne MD	1
8:18 AM	New Humphrey Visual Field Testing Strategies	Pradeep Y Ramulu MD PhD	3
8:25 AM	Case Discussion	Atalie Carina Thompson MD MPH	4
8:32 AM	OCT Progression Analyses	Donald L Budenz MD MPH	5
8:39 AM	Humphrey Visual Field Progression Analyses	Angelo P Tanna MD	6
8:46 AM	Case Discussion	Kouros Nouri-Mahdavi MD	8
8:53 AM	Incorporation of OCT Angiography in Glaucoma Management	Robert N Weinreb MD	9
9:00 AM	Case Discussion	Osamah J Saeedi MD	10

Section II: MIGS Case-Based Section

Moderators: Manjool M Shah MD and Ramya N Swamy MD

9:07 AM	Introduction to Today's MIGS Landscape	Thomas W Samuelson MD	11
9:14 AM	Stenting the Schlemm Canal: Patient Selection and Pearls	Brian E Flowers MD	13
9:21 AM	Goniotomy, Trabeculotomy, and Viscodilation: Patient Selection and Pearls	Ze Zhang MD	15
9:28 AM	Subconjunctival Surgery: Patient Selection and Pearls	Vikas Chopra MD	16
9:35 AM	Updates to MIGS Coding: How Has My Practice Changed?	Cathleen M McCabe MD	18
9:42 AM	The Future of MIGS: What's in the Pipeline?	Iqbal K Ahmed MD	19
9:49 AM	Case Discussion		
10:04 AM	In These Unprecedented Times . . .	Nina A Goyal MD	20
10:09 AM	REFRESHMENT BREAK		

Section III: Medication and Lasers

Moderators: Babak Eliassi-Rad MD and Ramya N Swamy MD

10:39 AM	Medications: What Is Available and How Can I Get It to My Patients?	Joshua D Stein MD MS	22
10:49 AM	Micronutrients and Glaucoma: An Evidence-Based Update	Gustavo De Moraes MD	23
10:59 AM	Pregnancy and Glaucoma Management	Janet B Serle MD	24
11:09 AM	Laser Trabeculoplasty: How My Practice Has Evolved	Jonathan S Myers MD	25
11:19 AM	Management of the Patient With Narrow Angle: MythBusters	David S Friedman MD MPH PhD	26
11:29 AM	Discussion		

The American Glaucoma Society Subspecialty Day Lecture

11:34 AM	Introduction of the Lecturer	Christopher A Girkin MD	
11:36 AM	Nature, Nurture, Neighborhood, Network, and Glaucoma	Anne Louise Coleman MD PhD	27
12:06 PM	Presentation of the Award	Christopher A Girkin MD	
12:07 PM	LUNCH		

Section IV: Neuro-Ophthalmology and Glaucoma

Moderators: Robert J Noecker MD and Manjool M Shah MD

Virtual Moderator Afternoon Sessions: Rebecca Freedman Neustein MD

1:27 PM	Updates on Thyroid Eye Disease	Prem S Subramanian MD PhD	28
1:34 PM	Updates on the Management of MS and Associated Optic Neuropathies	Amanda D Henderson MD	29
1:41 PM	Glaucoma in the Neuro-Ophthalmology Practice	Julie Falardeau MD	31
1:48 PM	Double Trouble: Diplopia Creation and Management in Glaucoma and Anterior Segment Surgery	Ahmara G Ross MD	33
1:55 PM	Visual Fields and OCTs in Diagnosing Glaucomatous vs. Nonglaucomatous Disease	Khizer R Khaderi MD	35
2:02 PM	When to Image a Glaucoma Patient	Andrew G Lee MD	36
2:09 PM	Discussion		

Section V: Hot Topics in Glaucoma

Moderators: Teresa C Chen MD and Luis E Vazquez MD

2:24 PM	Artificial Intelligence: Improvements in Detecting Glaucoma	Jithin Yohannan MD	37
2:31 PM	Drug-Eluting Contact Lenses	Courtney L Ondeck MD	38
2:38 PM	Disparities in Ophthalmology Affecting Clinicians and Patients	Lama A Al-Aswad MD MPH	40
2:45 PM	IRIS® Registry: Outcomes in Glaucoma	Catherine Q Sun MD	41
2:52 PM	LiGHT Trial: Latest Findings	Gus Gazzard FRCOphth MA MBBChir MD	43
2:59 PM	Advances in Remote Monitoring and Telemedicine in Glaucoma	Susan Liang MD	44
3:06 PM	The OHTS: What's New in Genetics?	John Fingert MD PhD	45
3:13 PM	Patient-Reported Outcome Tools: The New AAO/AGS Questionnaire	George L Spaeth MD FACS	47
3:20 PM	Discussion		
3:27 PM	REFRESHMENT BREAK		

Section VI: Surgery Videos

Moderators: Robert T Chang MD and Lily T Im MD

3:57 PM	The Art of the Trab	Kuldev Singh MD MPH	49
4:07 PM	Tube Switches and Tricks	Mary Qiu MD	50
4:17 PM	MIGS Complications	Sarah Van Tassel MD	51
4:27 PM	Endoscopic Cyclophotocoagulation Laser Techniques	Brian A Francis MD	52
4:37 PM	Discussion		
4:58 PM	Closing Remarks	Kelly Walton Muir MD Teresa C Chen MD	
5:00 PM	ADJOURN		

Detection of Glaucoma in Challenging Suspects and Myopic Eyes

Claude F Burgoyne MD

I. Synopsis

This presentation focuses on the detection of early glaucoma with OCT, including discussion of OCT optic nerve head (ONH)/retinal nerve fiber layer (RNFL) parameters and reports from different OCT platforms, interpretation of OCT ONH/RNFL scans, use and interpretation of macular OCT for detection of glaucoma, comparison of ONH biomicroscopy and OCT ONH/RNFL analysis, utility of OCT in high myopia, and discrimination of glaucomatous structural damage from myopic anomalies and/or degeneration.

II. Presenter's Disclosures

- A. I receive unrestricted research support from and am an unpaid consultant to Heidelberg Engineering.
 - 1. Occasional travel support, no honorarium, no patents, and no personal income related to this consultancy
 - 2. I am Principal Investigator of the Glaucoma/Myopia OCT Phenotyping Consortium, a 13-site, investigator-initiated study to improve the OCT detection of early glaucoma in non-highly myopic eyes and of myopic structural abnormality and myopic structural glaucoma in highly myopic eyes. Heidelberg Engineering is an industry partner in this endeavor.
- B. I have been NIH funded to build OCT strategies for phenotyping the ONH peripapillary retinal and macular tissues of healthy and glaucomatous non-human primate and human eyes.

III. Definitions

- A. This presentation will focus on the ONH peri-neural canal and macular tissues.
- B. We define the ONH to include the tissues that are contained within and immediately adjacent to the neural canal, which extends from the Bruch membrane opening (BMO) through the posterior scleral canal opening.
- C. We refer to the tissue immediately adjacent to the neural canal as the peri-neural canal retina, choroid, and sclera. For OCT imaging we do not use the term "peripapillary" because the "papilla" is a clinical term that has no anatomic definition and therefore cannot be identified using OCT-detected anatomy (hereafter "OCT anatomy").

IV. Topographically Correspondent ONH/Peri-Neural Canal/Macular Structural Parameterization¹⁻⁴

Why the integration of OCT anatomy into the clinical examination of the optic nerve head tissues is necessary

- A. Clinician estimated cup-to-disc ratio is inconsistent⁵ and poorly detects regions of rim tissue that are borderline or abnormal by OCT.⁶
- B. Acquired vs. post hoc regionalization relative to the foveal BMO axis on some platforms^{1,5,6}
- C. Review of published strategies in non-highly myopic eyes¹⁻³

V. Current Best Performing Strategies in Highly Myopic Eyes Based on Published Studies

- A. Peri-neural canal RNFL thickness
- B. Macular retinal ganglion cell layer and inner plexiform layer alone and combined
- C. Peri-neural canal RNFL thickness and macula used in combination⁴

VI. What is coming for high myopia?

- A. The Glaucoma/Myopia OCT Phenotyping Consortium

Cross-sectional assessment of OCT-detected structural normality and abnormality within the ONH, peri-neural canal and macular tissues of highly myopic eyes with and without glaucoma and early non-highly myopic glaucoma eyes:

 1. "Structural normality" defined within multiple, large, ethnically diverse, non-highly myopic, "normative" data bases
 2. "Early glaucomatous structural abnormality" defined by comparing "non-highly myopic early glaucoma" eyes to (1), above
 3. "Myopic structural abnormality" defined by comparing "highly myopic without glaucoma eyes" to (1) above
 4. "Myopic structural glaucoma" defined by comparing "highly myopic with glaucoma" eyes to (3) above
- B. New/ongoing longitudinal studies in high myopia⁷

- C. Incorporation of automated image analysis/machine learning/deep learning/artificial intelligence⁸⁻¹⁰
1. Can be used to improve anatomic segmentation for parameterization
 2. Alternatively uses anatomic and signal information without biases associated with segmentation and parameterization

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New Humphrey Visual Field Testing Strategies

Pradeep Ramulu MD PhD

Introduction

Visual field testing remains a central method for diagnosing glaucoma and judging disease worsening. The ability to optimize detection and progression depends on the test algorithm used, the pattern of test locations, how tests are spaced over time, and how results are interpreted and integrated into practice. Here, we will review these concepts, focusing on testing acquired on a typical tabletop perimeter.

Observations

Test algorithms have evolved to complete testing in less time, potentially reducing burden to the patient and improving clinical flow. In particular, newer algorithms such as SITA Faster offer the opportunity to reduce test time. But does this reduction in test time sacrifice quality? Some studies have demonstrated more errors that risk less reliable test results with SITA Faster as compared to older test algorithms such as SITA Standard. For example, SITA Faster tests have more false positives, more seed point errors, and worse gaze tracking measures. At the same time, studies have shown very little extra variability in test results using the SITA Faster algorithm as compared to the SITA Standard algorithm. Thus, one should be aware of the potential for errors using SITA Faster, but this should not be an impediment to using this test algorithm in clinical practice.

A variety of test patterns have been used for visual field testing, including patterns that focus on the central 24 or central 10 degrees. While testing of the central 10 degrees will pick up some visual field defects even when they are absent in testing of the central 24 degrees, the opposite is also true. Recent research has suggested that more cases of glaucoma are picked up when testing the central 24 degrees as compared to the central 10 degrees. Some new test patterns (ie, the 24-2c) test the central 24 degrees but have extra test locations in the central 10 degrees. While the extra time required in these tests is minimal, the benefits derived are still uncertain and need to be established with additional research.

Another component of proper visual field testing is to perform the correct number of visual field tests, and to perform them in the correct temporal pattern to maximize detection of disease worsening and minimize false positives. Work has shown that temporal clustering of tests—for example, performing three visual fields at baseline and another three 2 years later—detects more disease progression with fewer false positives than performing the same number of tests evenly spaced over a 2-year period. Taking this idea further, recent research has shown that multiple visual fields can even be done on the same day with good reliability. These approaches require extra testing than one might normally perform and creates a higher patient burden, and so are best reserved for patients at higher risk of disease worsening. Artificial intelligence and other newer algorithms are likely to help us judge the eyes and patients that would most benefit from these forms of more intensive monitoring.

When deciding which visual field tests to count on in the judgment of disease progression, a common approach is to exclude tests with poor reliability measures. However, reliability measures themselves are quite unreliable. In other words, tests with good reliability measures can yield an erroneous result, and tests with poor reliability measures can, in many instances, yield meaningful information. It is important to use as much information as possible and to consider the patient's entire clinical situation, not just the visual fields, when deciding whether to alter therapy based on visual field testing results.

Case Discussion

A Troubling Lid Artifact

Atalie C Thompson MD and Sanjay Asrani MD

CASE PRESENTATION

History

A 52-year-old African American male with history of mixed-mechanism glaucoma, moderate in the right and mild in the left eye, status post laser peripheral iridotomy in both eyes, presented with a complaint of blurry vision in the right eye. Patient had a history of poor adherence to scheduled follow-up visits and noncompliance with IOP-lowering medications over the preceding 7 years. Medical history was notable for hypertension, hyperlipidemia, GERD, and asthma. His IOP had fluctuated between 14 and 18 mmHg on latanoprost and pilocarpine q.h.s. OU. Patient had previously been 20/20 in both eyes 1 year prior, but he reported a decline in vision in the right eye with a gray spot over the upper half of the right eye for the past month.

Presenter asks panel if there is anything unexpected about this chief complaint.

Ocular Exam

- Visual acuity: 20/40 OD and 20/20 OS
- Central corneal thickness: 466 OD and 468 OS
- Optic nerve exam: Notable for cup-to-disc 0.7 OD and 0.65 OS with trace temporal pallor OD
- Prior OCTs had demonstrated relatively stable (2013 to 2015) glaucomatous superotemporal and inferotemporal retinal nerve fiber layer (RNFL) thinning in both eyes.

Presenter will ask panel for interpretation of OCT RNFL, OCT macular map, and 24-2 Humphrey Visual Field (HVF) testing. The most recent (2016) OCT RNFL was concerning for progressive temporal and global RNFL loss in the right eye. The most recent 24-2 HVF was concerning for arcuate progression in the right eye and a nonspecific superior loss in the left eye (attributed to a lid artifact). However, the most recent OCT macula showed progressive loss of the papillomacular bundle in the right eye.

Presenter will ask for a differential diagnosis and next step.

Clinical Course, Final Diagnosis, and Outcome

In light of the macular OCT change, the visual field interpretation was changed to a very early bitemporal hemianopia. Neuro-ophthalmology was consulted, but after reviewing fields, they did not deem an urgent appointment necessary and scheduled the patient for evaluation in 3-4 months. With urging, a neuro-ophthalmic exam was scheduled sooner and was notable for increasing temporal pallor of the optic nerve in the right eye and a more obvious hemianopic visual field loss. MRI of the orbits with and without contrast was obtained. Coronal T2WI with contrast demonstrated an enhancing $2.7 \times 2.4 \times 2.8$ -cm sellar mass with suprasellar extension consistent with pituitary tumor.

The patient was referred to neurosurgery. Bitemporal hemianopia and central acuity improved following transnasal transseptal excision of the pituitary tumor.

Case take-home points will highlight the importance of listening to your patients, remembering patients can have more than one diagnosis, utility of reviewing the HVF and OCT side by side, and emphasizing the critical role that the OCT macular map can provide for atypical diagnoses.

OCT Progression Analyses

Donald L Budenz MD

Introduction

OCT is able to precisely measure anatomic structures that have been shown to change as part of the pathophysiology process in glaucoma progression. These include retinal nerve fiber (RNFL), optic nerve, and ganglion cell layer parameters. Because OCT is able to measure these structures reproducibly, following these parameters over time offers the clinician the ability to diagnose glaucoma worsening. However, there are limitations to progression analysis based on the reproducibility and the floor effect of the measurements. Additional limitations include artifacts in OCT measurements, which will not be addressed in this presentation due to time constraints.

Reproducibility

Test-retest variability is a feature of every medical test that is particularly important in progression analysis. The lower the test-retest variability (or better the reproducibility), the smaller the difference between examinations upon which we are able to judge progression. For example, if the average RNFL thickness declines from 90 μm to 85 μm between exam 1 and 2 but the test-retest variability of average RNFL thickness for that instrument is 7 μm , we must conclude that the decrease is insignificant since the change is within the error level of the instrument. However, if the test-retest variability is 3 μm , we have more confidence that the 5- μm change between exams is real since the change exceeds the test-retest variability. Another thing to consider is that the smaller the “piece of the pie” that we are measuring, the higher the variability. For example, with Cirrus OCT, the variability of the average RNFL thickness is 4-5 μm , that of the RNFL quadrants is 7-8 μm , and that of clock hours is 10-12 μm . These numbers are incorporated into the GPA software of Cirrus and are used to determine statistically significant change on the graphs, tables, and TSNIT plots (see below).¹⁻³

Floor Effect

The RNFL is composed of 60%-70% axons and 30%-40% glial tissue. The glial cells are preserved in severe glaucoma, and so the thickness of the RNFL never goes to zero, even in a patient who has lost all of their axons from glaucoma or other optic neuropathy.⁴ This phenomenon, called the “floor effect,” must be considered in glaucoma progression analysis. It turns out that the algorithms for calculating RNFL thickness are different between manufactures’ OCT platforms, so the floor differs between instruments.⁵ The clinical implication of this is that RNFL cannot be used to diagnose glaucoma progression once a particular OCT parameter has reached its floor. We might be lulled into thinking that a patient with severe glaucoma is stable if we are only looking at RNFL parameters, which don’t change after a certain point. In advanced glaucoma, once the RNFL floor has been reached, standard automated perimetry and ganglion cell parameters may be more helpful.

Guided Progression Analysis (GPA)

GPA software, available in the Cirrus OCT instrument, displays OCT measurements over time and incorporates known test-retest variability to determine whether change is statistically significant. There are graphs that show average RNFL, superior and inferior RNFL, and average cup:disc over time. The tables merge data from the first 2 baseline OCT scans and compare subsequent scans to the merged baseline. When statistically significant change is detected, the parameter is highlighted in yellow, indicating possible progression, and then red if progression is confirmed. Once confirmed, it is possible to reset the baselines to diagnose progression going forward. To reduce the effect of test-retest variability on the ability to detect progression, we recommend 2 exams at each time point, particularly at the baseline visit, which helps reduce false-positive results in the progression analysis.

TSNIT Graphs

“TSNIT” refers to the graph of the peripapillary RNFL thickness circle (temporal, superior, nasal, inferior, temporal). Superimposing sequential plots over time can highlight areas of change. Knowing the test-retest variability in each area helps the software detect areas of statistically significant change, which is denoted in red.

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Humphrey Visual Field Progression Analyses

Angelo P Tanna MD

Accurate and timely detection of visual field progression is important in the management of glaucoma because treatment decisions, including the decision to advance to incisional surgery, are often based on evidence of functional progression. Detection of visual field progression, however, is complicated by the variability and fluctuation in the measurement of threshold sensitivity.

Subjective assessment of serial visual field tests is a commonly used method for detecting progression in clinical practice; however, it is difficult to know the anticipated magnitude of fluctuation in eyes with glaucoma.¹ Observations with repeat visual field testing over a short time in a large cohort of glaucoma subjects demonstrates the magnitude of fluctuation varies as a function of (1) baseline defect depth (the more damaged a particular location is in the visual field, the greater the observed magnitude of fluctuation), (2) the overall level of visual field damage (the more severe the damage, the larger the amount of fluctuation), and (3) the location in the visual field (more eccentric locations are associated with larger magnitudes of fluctuation).²

Event-Based Analysis

Event-based visual field analysis determines whether visual field progression has occurred or not; however, it does not provide information about the rate of visual field change. In the United States, the most commonly used software platform for event-based analysis is Guided Progression Analysis (GPA) on the Humphrey Field Analyzer.

GPA uses the same methodology for classifying visual field series as having progressed or not as was used in the Early Manifest Glaucoma Trial (EMGT).¹ Briefly, pattern deviation glaucoma change probability maps (GCPMs) were developed using empirical data obtained from glaucoma patients. The mean pattern deviation value from the first 2 baseline visual fields at each visual field location is used for comparison against each subsequent visual field test. If on subsequent testing the pattern deviation value at a particular location has deteriorated outside the 95% confidence interval of the GCPM, that location is considered to have progressed.

The location(s) of the progressed points are flagged on the GPA printout with open, half-black, or solid black triangles, based on whether progression from the baseline values had occurred on 1, 2, or 3 consecutive follow-up visual field tests, respectively (see Figure 1). If the same ≥ 3 locations (not necessarily contiguous or in the same hemifield) have progressed on 2 or 3 consecutive visual field tests, the GPA printout indicates that there is “Possible Progression” or “Likely Progression,” respectively.

Trend-Based Analyses

Monitoring the trend of the mean deviation (MD) over time is often used in clinical research. The MD, weighted average of the severity of visual field loss compared to age-adjusted normative data, is susceptible to the influence of media opacity—most importantly, cataract. In the era of earlier cataract surgery, it is less common for patients to have severe cataract that severely impacts the MD, making linear regression of the MD over time more useful today than when it was first developed.

The visual field index (VFI) is a newer method of describing the overall severity of damage in the entire visual field. Unlike the MD, however, it relies on both pattern deviation and total deviation data to mitigate the effect of cataract. When the overall degree of damage to the visual field is severe (ie, MD < -16 dB), the VFI becomes less reliable. Otherwise, linear regression analysis of the VFI trend over time is an excellent way to gauge the rate of visual field deterioration.

Comparison of Trend- vs. Event-Based Analyses

In one study, the level of agreement between glaucoma expert consensus and the results of GPA was good.³ In routine clinical practice, visual fields are typically obtained annually. In such cases, event-based methods may be able to reliably detect progression sooner than trend-based methods. With frequent testing, however, point-wise trend-based methods are more sensitive.⁴ Global trend-based methods, at fixed specificity, appear to have sensitivity similar to that of GPA.⁵ Event-based methods for progression detection for visual field tests obtained with the size V stimulus and the 10-2 testing algorithm are needed. Such software has been developed for the analysis of 10-2 visual fields; however, it is not yet commercially available.⁶ SITA for the Size V stimulus is under commercial development.

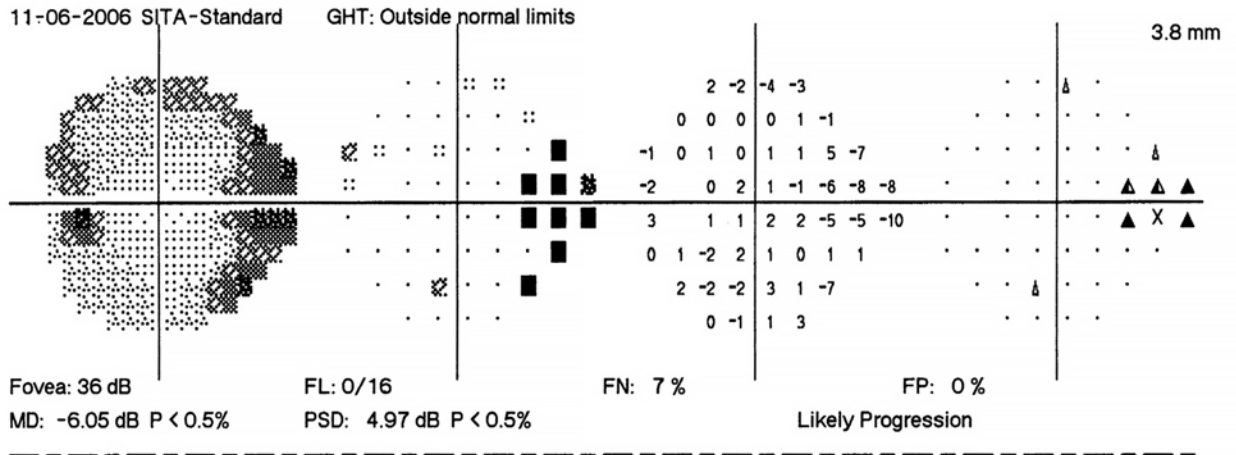


Figure 1. Part of a GPA printout for the left eye of a patient with primary open angle glaucoma. The results of this visual field test, the most recent, is compared with the mean of the first 2 baseline visual fields obtained that were judged to have been reliable and representative of the patient’s visual function (after having scaled the learning curve). The triangles on the far right represent locations of the visual field that are significantly worse (outside the 95% confidence interval of the pattern deviation glaucoma change probability maps) than baseline on the current test (open triangles), on the current test and the prior test (half-black triangles), or on the current test and 2 consecutive prior tests (black triangles). The presence of 3 or more black triangles triggers the “Likely Progression” message. These are the same criteria used to define visual field progression in the Early Manifest Glaucoma Trial. Locations that were so severely abnormal at baseline that the anticipated range of fluctuation precludes the detection of progression are marked with an “X.”

Baseline Exams: 02-06-1998 02-12-1999

- :: < 5%
- ✖ < 2%
- ⚫ < 1%
- < 0.5%
- ⚠ P < 5% Deterioration
- ▲ P < 5% (2 consecutive)
- ▲ P < 5% (3+ consecutive)
- X Out of Range

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Case Discussion

Kouros Nouri-Mahdavi MD

Challenging glaucoma cases in which OCT and/or VF progression is inconclusive or uncertain will be made. A brief pertinent history and exam findings are presented, and the results of the diagnostic studies are shown. The panel is prompted to discuss the OCT/HVF findings. The presenter will ask questions about interpretation, caveats, and management of the case given the diagnostic and clinical findings.

Incorporation of OCT Angiography in Glaucoma Management

Robert N Weinreb MD and Sasan Moghimi MD

For glaucoma evaluation, OCT angiography (OCT-A) provides quantitative assessment of vessel density (VD) in the peripapillary retina, the superficial and deep layers of the macula, and the choroid. The measurements have good short-term and long-term repeatability and reproducibility.¹ The reproducibility is lower than OCT in both healthy and glaucoma eyes.

OCT-A can detect early glaucoma.

- OCT-A and OCT measurements show similar efficiency to detect early glaucoma. However, one-third of the early glaucoma eyes show greater % loss of VD than ganglion cell complex (GCC) thickness.
- VD loss is faster than GCC thinning in half of suspect eyes. Moreover, 20% of suspect eyes had only significant loss of VD, and also faster VD loss than GCC thinning.²

OCT-A can detect progression in advanced glaucoma.

- In eyes with advanced glaucoma, there is a stronger relationship between VD and VF than between retinal nerve fiber layer (RNFL) thickness and VF. The rate of macula VD loss increases as glaucoma worsens. In contrast, there is no correlation between the rate of GCC thinning and VF severity.³
- In advanced glaucoma, particularly when VF MD is worse than -14 dB, parafoveal VD is promising tool; macula VD does not have a detectable measurement floor, whereas the RNFL typically reaches a floor at a visual sensitivity loss of -10 to -12 dB.⁴

OCT-A can help assess risk of glaucoma progression.

- Lower baseline macula and optic nerve head VD is associated with a faster rate of OCT RNFL thinning in mild to moderate glaucoma. Macula superficial, but not deep, VD is associated with future VF progression.^{2,5}
- Choroidal VD dropout (corresponding to perfusion defects on indocyanine green angiography) also has been suggested as a biomarker for VF deterioration or RNFL thinning, especially in eyes with disc hemorrhage. Moreover, it has been associated with faster central VF progression and GCC thinning (Micheletti, et al. *Br J Ophthalmol*. In press 2022).

Recommendations

- Peripapillary VD metrics perform better than macula VD in early glaucoma. Evaluation of superficial macular VD using larger scans (6×6 mm) has higher performance in detection of early glaucoma and also advanced glaucoma than smaller scans (3×3).
- Evaluation of peripapillary VD and choroidal drop-out is recommended to detect patients at high risk for glaucoma progression.
- Eyes with advanced glaucoma benefit from OCT-A imaging. Testing two times per year may provide good information for detecting progression in these patients (unpublished data).
- Up to 25% of OCT-A scans (using the SSADA algorithm) have artifacts and have poor quality, in comparison with than 3% of OCT scans.^{2,6} A systematic scan review is needed to ensure appropriate interpretation of OCT-A images. Given the high prevalence of poor-quality OCT-A images, the images should be reacquired whenever an apparent and correctable artifact is present on a captured image.

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Introduction to Today's MIGS Landscape

Thomas W Samuelson MD

I. The Glaucoma Surgical Glaucoma Landscape Before Minimally Invasive Glaucoma Surgery (MIGS)

There would be no MIGS if not for the safety limitations of traditional glaucoma surgery. While the efficacy of traditional surgery was never in doubt, safer glaucoma surgery was an unmet need for decades.

II. Early MIGS

Advances did not come fast or easy in the development of safer glaucoma surgeries, and there were several swings and misses:

A. Trabecular trephination: Abandoned

Not titratable and subjected patients to significant risk of full-thickness procedure and hypotony as well as failure due to internal occlusion or external fibrosis

B. Laser sclerostomy: Abandoned

Not titratable and subjected patients to significant risk of full-thickness procedure and hypotony as well as failure due to internal occlusion or external fibrosis

C. Ab-externo indwelling canal stenting "EyePass": Abandoned, but laid important groundwork for emerging canal stenting devices

D. Nonpenetrating deep sclerectomy (NPDS)

1. Widely perceived to be safer option than trabeculectomy
2. More popular and widely adopted in Europe than in the U.S.

E. Viscocanalostomy ab externo

1. Coupled with NPDS and suture tensioning of Schlemm canal, viscocanalostomy slowly gained popularity in Europe and in the U.S.
2. But with arrival of ab interno approaches, the popularity of ab externo approach waned.

F. Supraciliary stenting

1. After gaining FDA approval, CyPass was withdrawn by manufacturer due to cumulative endothelial cell loss that became evident after 3 years in pivotal trial.
2. Subsequent stents in this space under development

III. Ab Interno Canal Surgery

A. Indwelling devices/trabecular microbypass stents

1. iStent (Glaukos) and Hydrus (Alcon) are FDA approved for use coincident with phacoemulsification.
2. Each aspire to gain approval for stand-alone use; studies are under way.

B. Incisional goniotomy

1. A variety of surgical tools are available to perform ab interno goniotomy.
2. May be combined with phaco or as a stand-alone option

C. Canaloplasty ab interno

A variety of devices are available for ab interno delivery of viscoelastic material (OVD) into Schlemm canal.

IV. MIGS Comes of Age

Despite initial skepticism, MIGS has now become mainstream among both comprehensive ophthalmologists and glaucoma specialists.

V. Lens-Based Decision Making

Many believe that phacoemulsification is among the most important tools to help manage glaucoma. The timing of cataract surgery is often a pivotal moment in the life of a glaucoma patient, providing the IOP-lowering effect of modern cataract surgery as well as the opportunity to combine with a safe adjunct glaucoma procedure.

VI. Stand-alone MIGS

While the majority of MIGS procedures are performed coincident with phacoemulsification, many patients are becoming pseudophakic at a younger age. Accordingly, a growing number of patients will develop glaucoma long after their cataract surgery. There will likely be a sizeable market for stand-alone MIGS procedures for this population.

VII. MIGS Limitations and the Role of Traditional Surgery

In my opinion, trabeculectomy and aqueous drainage devices will remain important options for many patients who either present with advanced disease or progress despite MIGS surgery. It is important for consultative glaucoma surgeons to remain skilled at transcleral filtration procedures despite their limitations because the aging population will still require highly efficacious procedures when disease severity warrants more aggressive surgical intervention.

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Stenting the Schlemm Canal: Patient Selection and Pearls

Brian E Flowers MD

I. Background

“Microinvasive glaucoma surgery (MIGS)” is a term coined to describe what are typically ab interno glaucoma procedures, utilizing physiologic pathways, that emphasize safety over efficacy. The original iStent, approved by the FDA in 2012, is widely considered the first in this class of procedures. The following decade has witnessed an explosion in MIGS procedures.

II. Landscape

There are currently 2 implantable MIGS devices intended to stent the Schlemm canal: iStent inject W (Glaukos) and Hydrus Microstent (Alcon).

A. iStent inject W

1. This is the third iteration of the iStent, preceded by the original iStent and the first iStent inject. The iStent inject W (wide flange) has the same orifice but a larger flange than the original iStent inject (360 μm vs. 230 μm).
2. A newer version, the iStent infinite, has been used in clinical trials for several years now. It has a slightly different injector system, is loaded with 3 iStent inject Ws, and allows for an infinite number of deployments. It is expected to be approved in 2022.

B. Hydrus Microstent

The Hydrus is an 8-mm nitinol Schlemm canal implant that spans 3 clock hours of the angle. It was approved by the FDA in 2018.

III. Indications

Both the iStent and Hydrus are approved by the FDA for use in combination with cataract surgery. Clinical trials of both devices have been conducted in stand-alone fashion and await approval by the FDA.

IV. Efficacy

A. iStent inject

1. The primary endpoint in the IDE trial was the percentage of patients achieving a 20% reduction in IOP at 2 years from an unmedicated baseline.
2. This was achieved in 75.8% and 61.9% (Delta = 13.9%) of patients in the phaco/iStent group vs. phaco alone. Diurnal reduction in IOP was 7.0 mmHg vs. 5.4 mmHg (Delta = 1.6 mmHg).

B. Hydrus

1. The primary endpoint in the IDE trial was the percentage of patients achieving a 20% reduc-

tion in IOP at 2 years from an unmedicated baseline.

2. This was achieved in 77.2% and 57.8% (Delta = 19.4%) of patients in the phaco/Hydrus group vs. phaco alone. Diurnal reduction in IOP was 7.6 mmHg vs. 5.3 mmHg (Delta 2.3 mmHg).
3. A post hoc analysis of the 5-year data from the IDE trial showed that implantation of the Hydrus improved visual field outcomes vs. phaco alone. This is a first for any MIGS procedure.

V. Efficacy: Stand-alone

A. iStent infinite

1. Utilizing 3 wide flange stents and a novel injector system, the iStent infinite was studied in refractory glaucoma patients. The “average” patient was on 3.1 medications at baseline and had a history of 2 failed glaucoma surgeries.
2. 76% of subjects achieved a 20% reduction in IOP, and more than 50% achieved a 30% reduction in IOP from baseline on equal or fewer meds. A surprising result, indeed.

B. Hydrus Microstent

The Hydrus has also been studied in a refractory glaucoma population. The results have not yet been made available.

VI. Patient Selection

Safety is the “calling card” of trabecular meshwork (TM)-based MIGS. Glaucoma is stratified into mild, moderate, and severe based upon degree of visual field loss, not IOP or target IOP. We are conditioned to think of these procedures as being for mild and moderate glaucoma based upon labeling. However, these procedures should not be restricted to mild/moderate glaucoma, but considered in any situation when safety is prioritized over efficacy. This is especially true in combination surgery as the risks of intraocular surgery have been assumed.

An example would be a monocular advanced glaucoma patient with borderline IOP on multiple medications. After discussion with the patient to determine alignment of goals, one would expect most patients to prioritize safety in that situation. The bar is higher for a stand-alone procedure, and thus the balance shifts more toward efficacy. Fortunately, the evidence supports reasonable efficacy for these procedures as stand-alone.

VII. Pearls

- A. Maintain humility: There is a temptation for those who engage in complex intraocular surgery to approach these procedures with an amount of glibness. This often leads to problems or suboptimal results.
- B. Consider positioning: All TM-based MIGS procedures require an en face view of the target tissue, achieved by proper orientation of the patient and microscope. Under-rotation is the most common problem.
- C. iStent
 1. The goal is to place stents at least 2 clock hours apart in areas where there is clearly outflow (pigment).
 2. Orient inserter 90 degrees to target tissue to avoid disengaging stent upon retraction of the inserter. The surgeon should consider adjusting their seating position to ensure proper orientation.
- D. Hydrus
 1. The goal is to place the implant in the Schlemm canal in areas where there is outflow (pigment).
 2. The most common challenge is the “diving Hydrus” heading inferiorly into the ciliary body.
 3. Make a separate incision. This allows a “flatter” approach angle.
 4. Engage the entire orifice while maintaining an upward bias before advancing the implant.
 5. If the implant does “dive,” reattempt 1 clock hour ahead of initial insertion.

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2. Samuelson TW, Chang DF, Marquis R, et al. A Schlemm canal microstent for intraocular pressure reduction in primary open-angle glaucoma and cataract: the HORIZON study. *Ophthalmology* 2019; 126(1):29-37.
3. Samuelson TW, Sarkisian SR Jr, Lubeck DM, et al; iStent inject Study Group. Prospective, randomized, controlled pivotal trial of an ab interno implanted trabecular micro-bypass in primary open-angle glaucoma and cataract: two-year results. *Ophthalmology* 2019; 126(6):811-821.
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6. Samuelson TW, Katz LJ, Wells JM, Duh YJ, Giamporcaro JE; US iStent Study Group. Randomized evaluation of the trabecular micro-bypass stent with phacoemulsification in patients with glaucoma and cataract. *Ophthalmology* 2011; 118(3):459-467.

Goniotomy, Trabeculotomy, and Viscodilation: Patient Selection and Pearls

Ze Zhang MD

- I. Introduction of Goniotomy vs. Trabeculotomy vs. Viscodilation
 - A. Excisional vs. incisional, sectoral vs. 360-degrees
 1. Kahook Dual Blade
 2. Trabectome/TrabEx
 3. Gonioscopy-assisted transluminal trabeculotomy
 4. OMNI
 5. Ab interno canaloplasty
 - B. Efficacy and safety
 1. Versatile and titratable: with or without cataract surgery, treat sectoral or 360 degrees, with or without viscodilation
 2. Reliable IOP and medical reduction
 3. Safety profile well supported
 4. No implant required
- II. Patient Selection
 - A. Primary open-angle glaucoma
 - B. Secondary open-angle glaucoma such as pigmentary and pseudoexfoliation
 - C. Juvenile open-angle glaucoma
 - D. Steroid-response glaucoma
 - E. Uveitic glaucoma: well controlled
 - F. Combined with goniosynechialysis
 - G. Congenital glaucoma
- III. Pearls for Success
 - A. Preoperative planning and considerations
 1. Gonioscopy: Visualize the angle landmarks.
 2. Blood thinner use: Can patients stop the medications?
 3. Patient's ability to remain still: Consider a block or general anesthesia if unable to remain still.
 4. Expectations for postoperative recovery and results
 - a. Hyphema precautions
 - b. Activity restrictions
 - B. Intraoperative considerations and pearls
 1. Patient positioning
 2. Visualization: Use cohesive viscoelastic such as Healon or Healon GV.
 3. Trypan blue or reflux of blood
 4. Avoid limbal vessels during wound construction.
 5. Nuances to each procedure: angle, hand relaxation, instruments
 - C. Postoperative care
 1. Hyphema management
 2. Steroid taper
 3. Cholinergic use
 4. Activity restrictions
 5. Consider continuing at least 1 drop until steroid taper is completed.
- IV. Patient Cases and Outcomes
 - A. Goniotomy case
 - B. Trabeculotomy case
 - C. Viscodilation case

Selected Readings

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2. Minckler D, Baerveldt G, Ramirez MA, et al. Clinical results with the Trabectome, a novel surgical device for treatment of open-angle glaucoma. *Trans Am Ophthalmol Soc.* 2005; 104:40-50.
3. Dorairaj S, Tam MD, Balasubramani GK. Twelve-month outcomes of excisional goniotomy using the Kahook Dual Blade® in eyes with angle-closure glaucoma. *Clin Ophthalmol.* 2019; 13:1779-1785.
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Subconjunctival Surgery: Patient Selection and Pearls

Vikas Chopra MD

- I. Non-bleb MIGS vs. Bleb-Forming Subconjunctival MIGS
 - A. Non-bleb MIGS generally used for mild to moderate glaucoma
 1. Often combined with cataract surgery
 2. Typically results in modest IOP reduction
 3. Addresses compliance issues by lessening medication burden
 4. Targets outflow pathways different than traditional glaucoma surgery
 - a. Boosting trabecular outflow by bypassing trabecular meshwork and directly involving Schlemm canal
 - b. Lowering ciliary body aqueous production
 - c. Increasing uveoscleral outflow through suprachoroidal routes
 - d. Adjunctive antimetabolites (mitomycin C [MMC], 5-fluorouracil) not needed
 - B. Bleb-forming subconjunctival MIGS can target moderate to severe or refractory glaucoma.
 1. Stand-alone procedure *or* in combination with cataract surgery
 2. Typically results in robust IOP reduction
 3. Lessens number of glaucoma medications needed
 4. Targets outflow pathways similar to traditional glaucoma surgery
 - a. Creating a link between anterior chamber and subconjunctival space to improve aqueous humor draining and forming a bleb
 - b. Adjunctive antimetabolites (MMC) during surgery essential for success
- II. Goals of Bleb-Forming Subconjunctival MIGS
 - A. Match or approach efficacy of traditional glaucoma surgeries (trabs or tubes)
 - B. Provide a more reproducible intraoperative surgical procedure
 - C. Provide a more predictable postoperative course
 1. Lower risk of vision-threatening adverse events
 2. Decrease post-surgery interventions
 3. Reduce number of postoperative visits
- III. Main Surgical Procedures With Devices Available for Bleb-Forming Subconjunctival MIGS
 - A. Xen45 gel stent (Allergan, Inc.; FDA approved)
 - B. PreserFlo MicroShunt (Santen, Inc.; CE Mark 2012; FDA approval pending)
- IV. Xen45 Gel Stent
 - A. Device characteristics
 1. 6-mm-long tube of a collagen-derived gelatin crosslinked with glutaraldehyde to prevent degradation in the tissue given the lack of a foreign body reaction and excellent biocompatibility with ocular tissues
 2. Device's proximal tip is inserted through the iridocorneal angle and rests 1 mm within the anterior chamber, with 1-2 mm within scleral track with distal tip sitting under the conjunctiva and Tenon capsule, about 3-4 mm beyond the limbus, enabling aqueous humor to pass through the lumen to produce a posterior bleb after implantation.
 - B. Different surgical approaches possible
 1. Ab interno
 2. Ab externo open conjunctiva
 3. Ab externo closed conjunctiva
 - C. Antimetabolites (MMC) generally used intraoperatively
 1. Variable concentrations
 2. MMC 0.2-0.5 mg/mL × 0.2-0.3 cc (40-120 µg)
 3. Via subconj/subtenon subconjunctival sponges or injection
 - D. Results
 1. Very effective IOP lowering, with marked reduction in IOP medications and low incidence of vision-threatening adverse events
 2. Variable results from different studies due to differences in patient population, preop meds, and severity of disease, but generally >30% IOP reduction

3. Chen et al: Review and meta-analysis of 56 studies with 4410 eyes¹
 - a. Overall average IOP reduction 35% vs. baseline; Xen stand-alone MD = -7.80 mmHg (95% CI, -7.38 to -8.21; $P < .001$)
 - i. Less IOP reduction (20%) in patients with lower baseline IOPs (<22 mmHg)
 - ii. Greater IOP reduction (>50%) in eyes with high baseline IOPs (>32 mmHg)
 - b. Significant reduction in number of glaucoma meds; Xen stand-alone MD = -1.97 (95% CI, -1.75 to -2.19; $P < .001$)
 - c. Overall success range between 21% and 70% success rate at 1-2 years
 - d. Very low risk of serious adverse events (<1%)

V. PreserFlow MicroShunt

A. Device characteristics

1. 8.5-mm-long glaucoma filtration surgical device (novel synthetic thermoplastic elastomeric biomaterial called SIBS, polystyreneblock-isobutylene-block-styrene) with a 350- μ m outer diameter and a 70- μ m lumen and a beveled tip
2. A 1-mm fin positioned 4.5 mm from the tip allows fixation and prevents peritubular leakage.
3. Biocompatible with eye without inducing fibroblasts or angiogenesis

B. Singular surgical approach

1. Ab externo open conjunctiva
2. Device's proximal tip rests in the anterior chamber, parallel to the iris, while the distal tip sits under the conjunctiva and Tenon capsule, about 6 mm beyond the limbus, enabling aqueous humor to pass through the lumen to produce a posterior bleb after implantation.

C. Antimetabolites (MMC) generally used intraoperatively

1. Variable concentrations
2. MMC 0.2-0.5 mg/mL \times 0.2-0.3 cc (40-120 μ g)
3. Via subconj/subtenon subconjunctival application or injection

D. Results

1. Very effective IOP lowering, with marked reduction in IOP medications and low incidence of vision-threatening adverse events. Variable results from different studies due to differences in patient population, preop meds, and severity of disease, but generally >30% IOP reduction
2. Beckers, et al: Prospective, single-arm, multicenter clinical trial at 6 European sites³
 - a. In 81 eyes, mean IOP \pm SD, 21.7 \pm 3.4 mmHg at baseline decreased to 14.5 \pm 4.6 mmHg at Year 1, and 14.1 \pm 3.2 mmHg at Year 2.
 - b. 74% overall success at 1 and 2 years
 - c. 73% of patients were medication free at 2 years (regardless of preop IOP).
 - d. Larger IOP reduction (and less need for glaucoma meds) with adjunctive MMC 0.4 mg/mL vs. MMC 0.2 mg/mL
 - e. Frequent but nonserious adverse events in all groups, but more in higher MMC group (0.4 mg/mL) than in lower MMC group (0.4 mg/mL)
 - i. Transient hypotony (16.3%)
 - ii. Keratitis (11.6%)
 - iii. Seidel positive wound leak (7.0%)
 - f. Low incidence of serious adverse events (10% eyes), among them surgical interventions, including bleb revisions and additional glaucoma surgery

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1. Chen X-Z, Liang Z-Q, Yang K-Y, et al. The outcomes of XEN gel stent implantation: a systematic review and meta-analysis. *Front Med.* 2022; 9:804847.
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In These Unprecedented Times . . .

2022 Glaucoma Subspecialty Day

Nina A Goyal MD

Action Requested: Support Ophthalmology's Advocacy Efforts

Please respond to your Academy colleagues and be part of the community that contributes to OPHTHPAC®, the Surgical Scope Fund, and your State Eye PAC. Be part of the community that ensures ophthalmology has a strong voice in advocating for patients.

Where and How to Invest

During AAO 2022 in Chicago, invest in OPHTHPAC and Surgical Scope Fund at either of our two convention center booths (in the Grand Concourse and Lakeside Center) or [online](#). You may also invest via phone by texting **MDEYE** to **41444** for OPHTHPAC and texting **SCOPE** to **51555** for the Surgical Scope Fund.

We also encourage you to support our congressional champions by making a personal investment to their re-election campaign via [OPHTHPAC Direct](#), a unique and award-winning program that lets *you decide* who receives your political support.

Surgical Scope Fund contributions are completely confidential and may be made with corporate checks or credit cards. PAC contributions may be subject to reporting requirements.

Why Invest?

Academy Surgical Scope Fund contributions are used to support the infrastructure necessary in state legislative/regulatory battles and for public education. OPHTHPAC investments are necessary at the federal level to help elect officials who will support the interests of our profession and our patients. Similarly, state Eye PAC contributions help elect officials who will support the interests of our patients at the state level. Contributions to EACH of these three funds are necessary and help us protect sight and empower lives.

Protecting quality patient eye care and high surgical standards is a “must” for everybody. Our mission of “protecting sight and empowering lives” requires robust funding of both OPHTHPAC and the Surgical Scope Fund. Each of us has a responsibility to ensure that these funds are strong so that ophthalmology continues to thrive and patients receive optimal care.

OPHTHPAC for Federal Advocacy

OPHTHPAC is the Academy's award-winning nonpartisan political action committee, representing ophthalmology on Capitol Hill. OPHTHPAC works to build invaluable relationships with our federal lawmakers to garner their support on issues such as:

- Improving the Medicare payment system, so ophthalmologists are fairly compensated for their services

- Securing payment equity for postoperative visits, which will increase global surgical payments
- Stopping optometry from obtaining surgical laser privileges in the veterans' health-care system
- Reducing prior authorization and step therapy burdens

Academy member support of OPHTHPAC makes all this possible. Your support provides OPHTHPAC with the resources needed to engage and educate Congress on our issues, helping advance ophthalmology's federal priorities. Your support also ensures that we have a voice in helping shape the policies and regulations governing the care we provide. Academy member support of OPHTHPAC is the driving factor behind our advocacy push, and in this critical election year, we ask that you get engaged to help strengthen our efforts.

At the Academy's annual Mid-Year Forum, the Academy and the American Glaucoma Society (AGS) ensure a strong presence of glaucoma specialists to support ophthalmology's priorities. As part of this year's meeting, the AGS supported participation of fellowship trainees via the Academy's Advocacy Ambassador Program. During Congressional Advocacy Day, they visited members of Congress and their key health-care staff—either in person or virtually—to discuss ophthalmology priorities. The AGS remains a crucial partner with the Academy in its ongoing federal and state advocacy initiatives.

Surgical Scope Fund for State Advocacy

The Surgical Scope Fund (SSF) provides grants to state ophthalmology societies in support of their efforts to protect patient safety from dangerous optometric surgery proposals. Since its inception, the Surgery by Surgeons campaign and the SSF, in partnership with state ophthalmology societies, have helped 43 state/territorial ophthalmology societies reject optometric scope-of-practice expansions into surgery.

If you have already made a SSF contribution, please go to safesurgerycoalition.org to see the impact of your gift.

Dollars from the SSF are critical to build complete cutting-edge political campaigns, including media (TV, radio, and social media), educating and building relationships with legislators, and educating the voting public to contact their legislators. This helps to preserve high surgical standards by defeating optometry's surgical initiatives.

Each of these endeavors is very expensive, and no one state has the critical resources to battle big optometry on their own. Ophthalmologists must join together and donate to the SSF to fight for patient safety.

The Academy's Secretariat for State Affairs thanks the AGS, which has joined state ophthalmology societies in the past in contributing to the SSF, and looks forward to its 2022 contributions. These ophthalmic organizations complete the necessary SSF support structure for the protection of our patients' sight.

Surgical Scope Fund	OPHTHPAC®	State Eye PAC
To protect patient safety by defeating optometric surgical scope-of-practice initiatives that threaten quality surgical care	Support for candidates for U.S. Congress	Support for candidates for state House, Senate, and governor
Political grassroots activities, government relations, PR and media campaigns No funds may be used for campaign contributions or PACs.	Campaign contributions, legislative education	Campaign contributions, legislative education
Contributions: Unlimited Individual, practice, corporate, and organization	Contributions: Personal contributions are limited to \$5,000. Corporate contributions are confidential.	Contribution limits vary based on state regulations.
Contributions are 100% confidential.	Personal contributions of \$199 or less and all corporate contributions are confidential. Personal contributions of \$200 and above are on the public record.	Contributions are on the public record depending upon state statutes.

State Eye PAC

The presence of a strong State Eye PAC providing financial support for campaign contributions and legislative education to elect ophthalmology-friendly candidates to the state legislature is critical as scope-of-practice battles and many regulatory issues are fought on the state level.

Support Your Colleagues Who Are Working on Your Behalf

Two Academy committees made up of your ophthalmology colleagues are working hard on your behalf. The OPHTHPAC Committee continues to identify Congressional Advocates in each state to maintain close relationships with federal legislators to advance ophthalmology and patient causes. The Surgical Scope Fund Committee is raising funds used to protect Surgery by Surgeons during scope battles at the state level.

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Medications: What Is Available, and How Can I Get It to My Patients?

Joshua D Stein MD MS

I. Glaucoma Medication Classes

- A. Prostaglandin analogues
- B. Beta-blockers
- C. Alpha agonists
- D. Carbonic anhydrase inhibitors
- E. ROCK inhibitors
- F. Latanoprostene bunod
- G. Parasympathomimetics
- H. Combination agents
- I. Oral carbonic anhydrase inhibitors
- J. Hyperosmotics

II. Addressing Barriers to Glaucoma Medication Use

- A. Preservative-free agents
- B. Compounded agents
- C. Sustained-release agents (intracameral implants)

III. Ways to Help Patients Afford Glaucoma Medications

- A. Medication comparison pocket cards
- B. Prior authorizations
- C. GoodRx, EyeCare America discount cards
- D. Coupons and no copay cards from pharmaceutical companies
- E. Financial aid via BrightFocus¹

IV. Ways to Improve Medication Adherence

V. Medication Shortages

VI. Alternatives to Glaucoma Medications

- A. Laser trabeculoplasty
- B. Microinvasive glaucoma surgery

Selected Reading

1. BrightFocus Foundation. Financial aid for glaucoma medications: fact sheet. brightfocus.org/glaucoma/article/financial-aid-glaucoma-medications. Aug. 24, 2021.

Micronutrients and Glaucoma: An Evidence-Based Update

Gustavo De Moraes MD

The following points will be covered in this presentation:

- Recent studies on the relationship between micronutrients and glaucoma
- Clinical trials investigating neuroprotective effects of micronutrients for glaucoma progression
- Lessons learned and what to be considered in future trials looking at neuroprotection

Pregnancy and Glaucoma Management

Janet B Serle MD

- I. IOP During Pregnancy
- II. Medication Management During Pregnancy
 - A. Selection
 - B. Systemic absorption
 - C. FDA categories
 - D. Potential effects on fetus, after delivery, while nursing
- III. Laser Procedures During Pregnancy
- IV. Surgical Management During Pregnancy

Selected Readings

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Table 1. FDA Drug Risk Classification in Pregnancy

Risk Category	Glaucoma Classes	
A	No risk, based on clinical studies in pregnant women	
B	Safety suggested in animal studies, and human studies are insufficient. Or Animal studies show risk, and human studies show safety.	Selective alpha-adrenergic agonist (brimonidine, apraclonidine) Nonselective alpha and beta agonist (epinephrine, dipivefrin)
C	Human studies are insufficient, and animal studies show risk. Or No animal studies, and human studies show safety.	Beta-blockers: IUGR with oral administration Topical and oral CAI: teratogenic in animals at elevated doses Miotics: adverse animal fetal effects PGAs: adverse animal fetal effects
D	Human studies show fetal risks; drug is necessary.	
E	Fetal risks; risk/benefits do not justify use.	
Unassigned	No recommendations; no information	Netarsudil Latanoprostene bunod

Abbreviations: IUGR, intrauterine growth retardation; CAI, carbonic anhydrase inhibitors; PGA, prostaglandin analog.

Laser Trabeculoplasty: How My Practice Has Evolved

Jonathan S Myers MD

- I. There is good data that laser is at least as safe and effective as eye drops for the treatment of open-angle glaucoma.
 - A. Glaucoma Laser Trial (GLT)
 - B. LiGHT Trial: less rapid visual field progression with selective laser trabeculoplasty (SLT) vs. medications
 - C. Multiple latanoprost vs. SLT trials
- II. Most patients choose eye drops before laser, but most glaucoma specialists wouldn't. Why?
- III. Educational programs help patients accept laser (63% vs. 35%; Tran, et al).
- IV. Steps That Help Me Help My Patients Choose SLT
 - A. Discuss SLT early and often.
 - B. Mention that SLT helps the natural drainage channel of the eye work better.
 - C. Take a page from premium IOL and femto cataract surgery:
 1. "Good news: You are a candidate for laser treatment instead of daily eye drops."
 2. "I recommend that you have SLT; it's what I'd choose for myself."
 - D. Provide educational brochures highlighting laser advantages.
 1. Better IOP control
 2. Less glaucoma progression
 3. Cost savings
 4. Convenience
 5. Repeatability
 6. Avoid subsequent incisional surgery? LiGHT trial
- V. There are many times that a patient may give you an opportunity to discuss laser.
 - A. Any negative comments about medications should prompt mention of SLT.
 1. Cost comments
 2. Side effect comments
 3. "I forgot my drops last night" comments
 - B. Any time that you discuss concerns about IOP, mention that SLT may help.
 - C. Any time that there is a discussion of changing or adding medications, mention that SLT may improve IOP while reducing medications.
- VI. Question: Who goes to an orthoped with a sore knee expecting to be told that they will need to apply cream twice a day for the rest of their life?
Answer: No one.
- VII. Doctors and the historical dearth of options created the expectation that glaucoma is treated with eye-drops.
 - A. Current medical science supports SLT as a better treatment for many patients.
 - B. Doctors need to address the current gap between societal beliefs and current best practices.
 - C. Just because our patients' conceptions are out of date does not mean that our treatment choices should be out of date.

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Management of the Patient with Narrow Angle: MythBusters

David S Friedman MD MPH PhD

- I. Defining Angle Closure
 - A. Acute attack
 - B. Primary angle-closure suspect
 - C. Primary angle closure
 - D. Primary angle-closure glaucoma (PACG)
- II. Myth 1: Angle closure suspects need to be treated now!
 - A. Low incidence rates even without an iridotomy
 - 1. Greenland Eskimos' low rates
 - 2. Population-based studies show very few of those with angle closure have glaucoma.
 - B. Few develop PACG.
 - C. Fellow eyes of acute angle-closure patients have low incidence of disease after iridotomy.
- III. Myth 2: "Plateau iris" and residual angle closure after iridotomy need to be treated.
 - A. Definitions
 - B. Ultrasound biomicroscopy definitions and studies
 - C. Lack of uniformity in defining the condition
 - D. Evidence limited on effectiveness of laser iridoplasty
 - 1. Prior publications do not show a benefit.
 - 2. Cochrane review states no known benefit.
- IV. Myth 3: Acute angle-closure patients with good IOP after an acute attack should be monitored.
 - A. Clinical trials support removal of the lens after acute attacks.
 - B. Monitoring is an option, but outcomes tend to be better with cataract surgery.
- V. Myth 4: Clear lens extraction is indicated in all angle closure.
 - A. EAGLE trial showed benefit in those with high IOP and angle closure or with PACG and IOP \geq 21 mmHg.
 - B. Other indications are extrapolations; little evidence.
 - C. Most angle closure does fine.

Updates on Thyroid Eye Disease

Prem S Subramanian MD PhD

Introduction

Thyroid eye disease (TED) presents with orbital and periocular changes that include proptosis, conjunctival injection and chemosis, eyelid retraction, swelling and redness, and/or restricted ocular motility. It occurs typically in the context of systemic hyperthyroidism (Graves disease), with 40% of affected patients experiencing symptoms simultaneously with the systemic symptoms and 40% developing eye changes within 12-18 months after the systemic disease is evident. However, about 20% of patients will develop their ophthalmic changes before systemic hyperthyroidism occurs. In addition, some patients may never have thyroid dysfunction, and a subset of patients with Hashimoto thyroiditis (which results in a hypothyroid state) will also develop thyroid eye disease.

Pathophysiology

TED occurs at the cellular level by coactivation of the thyroid-stimulating hormone receptor (TSHR) and insulin-like growth factor 1 receptor (IGF-1R) by autoantibodies. Receptor stimulation on orbital fibroblasts and adipocytes leads to deposition of hyaluronic acid and osmotic movement of water into the orbit, increasing the orbital volume. Additionally, cytokine secretion results in margination of circulating fibrocytes, macrophages, and other immune-mediating cells that amplify the cytokine response and produce a local inflammatory process that worsens the orbital edema and congestion.

Classifications and Natural History of Disease

The majority of patients with TED will have mild disease, characterized by inflammatory signs and irritative symptoms in the acute stage. Eyelid changes also may occur. When proptosis or inconstant diplopia are present, then disease is classified as moderate, while constant diplopia and/or more advanced proptosis leading to worse corneal exposure leads to severe disease. Sight-threatening disease is evident with optic nerve compression at the orbital apex or with severe lagophthalmos that prevents eyelid closure and causes corneal drying, opacification, and/or ulceration.

The acute phase of disease lasts about 18-24 months in most patients and will remit spontaneously with respect to the inflammatory signs. Structural changes such as eyelid retraction, proptosis, and extraocular muscle dysfunction are more likely to remain, although some improvement may be seen when edema and not fibrosis is predominant. Recent advances in the elucidation of the cellular processes that persist in the subsequent chronic (previously called “inactive”) phase of TED suggest that there is active turnover of extracellular matrix and maintenance of the abnormal orbital status by processes that are not dormant. This biological state may help us understand how TED can be reactivated in some patients, either spontaneously or after oculoplastic or strabismus surgery done in the chronic phase.

Treatment of TED

Comanagement with an endocrinologist and/or internist should occur to ensure optimal control of any systemic dysthyroid state. While a direct relationship between a dysregulated thyroid state and severity of TED has not been proven, worsening of thyroid hormone control may be an indicator of increasing autoimmune activity and thus predict worsening TED.

TED has been considered a surgical disease, with correction of proptosis, eyelid retraction, and/or diplopia after the acute phase has ended. Medical therapies such as corticosteroids have been used to reduce the inflammatory signs of disease and as a temporizing measure before urgent surgery in sight-threatening cases of compressive optic neuropathy (CON). Both corticosteroids (especially when given in a pulsed IV course) and external beam radiotherapy have demonstrated efficacy in reducing orbital pain and conjunctival injection/chemosis in acute TED. Combined use of these agents may also be helpful in delaying or even avoiding surgery in patients with CON. The efficacy of steroids, radiation therapy, or combined treatment on proptosis, diplopia, and eyelid changes is less certain. Treatment is not recommended in the chronic phase of the disease since there is no expectation of treatment benefit once inflammation has resolved.

Biologic agents that target parts of the immunologic and inflammatory cascade of the acute phase (rituximab, tocilizumab, adalimumab) have also shown efficacy in patients with sight-threatening disease who were refractory to corticosteroid or even surgical therapy. Prospective studies using these agents are either in progress or have been completed (rituximab) and demonstrated mixed results that may have, in part, been related to differences in disease activity (acute vs. chronic) in the study populations.

Teprotumumab, which blocks activation of the IGF-1R, is a more specifically targeted therapy for TED and was FDA approved for TED in January 2020. In 2 study populations of patients with moderate to severe TED of ≤ 9 months duration (Phase 2 and 3 trials), patients who received drug were much more likely than placebo-treated patients to have reduction of proptosis of their study eye (83% vs. 10%). Improvement of inflammatory signs and symptoms as well as diplopia was also significantly greater in treated patients. Subsequent case reports and case series have suggested that teprotumumab may be effective in treating chronic TED and TED with CON, and prospective studies are being conducted to evaluate these issues. Unanswered questions include the duration of efficacy of a single course of therapy, response to shorter or longer treatment courses, and the reversibility of side effects, including hearing loss, that may be more common than noted in the initial clinical trials.

Updates on the Management of MS and Associated Optic Neuropathies

Amanda D Henderson MD

I. Presentation of Optic Neuritis

A. Typical

1. Symptoms
 - a. Acute/subacute onset of vision loss
 - b. Pain with eye movements
 - c. Unilateral involvement
2. Examination findings
 - a. Decreased visual acuity and color vision
 - b. Normal-appearing optic disc
 - c. Central/cecocentral visual field defect

B. Atypical

1. Symptoms
 - a. May not have pain with eye movements
 - b. May have bilateral involvement
2. Examination findings: May have optic disc edema

II. Diagnostic Evaluation

- A. MRI brain/orbits with and without contrast
- B. ± MRI c/t: spine with and without contrast
- C. Serum testing
- D. ± Lumbar puncture

III. Treatment in the Acute Setting

A. Steroids, IV vs. PO

1. The Optic Neuritis Treatment Trial showed that high-dose IV steroid treatment expedited visual recovery but did not change ultimate visual outcome.¹ Low representation of patients with neuromyelitis optica spectrum disorder (NMOSD) or myelin oligodendrocyte glycoprotein antibody-associated disease (MOGAD).²
2. More recent studies have demonstrated similar outcomes, tolerance, and relapse rates for equivalent doses of PO and IV steroid.³⁻⁵
3. Patients with atypical optic neuritis (ie, secondary to NMOSD, MOGAD) may need steroid treatment for improved outcomes.

- B. Plasmapheresis: Early use of plasmapheresis (PLEX) may improve visual outcomes in patients with optic neuritis secondary to seropositive NMOSD.⁶

IV. Treatment in the Chronic Setting

- A. Disease-modifying therapy for MS⁷: Many options are now available, and choice may be tailored to individual cases.
- B. Immunosuppressive/immunomodulatory therapy for NMOSD, MOGAD
 1. Seropositive NMOSD
 - a. Long-term immunosuppressive treatment required
 - b. MS disease-modifying therapies may cause worsening in NMOSD.⁸⁻¹¹
 2. MOGAD
 - a. Optimum treatment not determined
 - b. Intravenous immunoglobulin appears to work well.^{12,13}

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Glaucoma in the Neuro-Ophthalmology Practice

Julie Falardeau MD

Introduction

Optic nerve cupping is widely recognized as a feature of glaucoma. However, multiple congenital or acquired entities not associated with elevated IOP or glaucomatous optic nerve disease may result in pathologic optic nerve excavation. Furthermore, congenital optic disc anomalies and acquired nonglaucomatous optic neuropathies can also present with visual field defects that are typical of glaucoma. Differentiating glaucomatous from nonglaucomatous optic neuropathy can be challenging, even for experienced clinicians. A detailed history, thorough assessment of visual function (visual acuity, afferent pupillary function, color vision and visual field testing), close observation of disc appearance and vasculature, and ancillary testing such as OCT of the retinal nerve fiber layer and ganglion cell layer–inner plexiform layer will aid in the diagnosis of glaucomatous vs. nonglaucomatous optic neuropathy.

When It's Not Glaucoma

Optic disc mimickers

Neuro-ophthalmological conditions that can present with increased cupping include traumatic optic neuropathy, demyelinating optic neuritis, toxic optic neuropathy (methanol toxicity), hypoxic ischemic encephalopathy, arteritic ischemic optic neuropathy, and compressive and hereditary optic neuropathies.

The optic disc in nonglaucomatous etiologies classically has focal or diffuse pallor of the neuroretinal rim. Other findings commonly seen include loss of central visual acuity, poor color vision, relative afferent pupillary defects in unilateral or asymmetric damage, central/cecocentral scotoma, or visual field defects respecting the vertical meridian. Conjunctival injection, chemosis, proptosis, ocular motility disorder with or without ptosis should raise strong concerns for a nonglaucomatous condition.

Among the various forms of hereditary optic neuropathy, autosomal dominant optic atrophy is the most common optic disc mimicker. Characterized by an insidious onset, this condition is often detected incidentally during routine evaluation. The majority of patients have bilateral central or cecocentral scotoma, and the optic disc examination typically demonstrates temporal pallor, sectoral excavation of the optic disc, and increased cupping.

Visual field mimickers

Congenital optic disc disorders, ischemic optic neuropathy, and branch retinal vein occlusion can produce visual field defects similar to those seen in glaucoma. Optic disc drusen are the most common congenital cause of visual field mimicker. While B-scan ultrasonography, fundus autofluorescence, and fluorescein angiogram can be greatly helpful in the assessment of optic disc drusen, enhanced depth imaging OCT (EDI-OCT) can reliably be used to diagnose buried optic disc drusen and is becoming a top choice among neuro-ophthalmologists.

Superior segmental optic nerve hypoplasia (also known as “topless disc syndrome”) is another congenital anomaly characterized by the relatively superior entrance of the central retinal

artery, pallor of the superior optic disc, a superior peripapillary halo, and thinning of the superior nerve fiber layer with corresponding inferior arcuate or altitudinal visual field defect. Patients often have normal visual acuity, and the condition is nonprogressive.

When It Is Glaucoma

Occasionally, patients present to the neuro-ophthalmology clinic to rule out a nonglaucomatous optic neuropathy and leave the office with a diagnosis of glaucoma. Two scenarios quickly come to mind.

Scenario #1: The patient with paracentral scotoma

In patients with normal-tension glaucoma, visual field defects are often deeper, more localized, closer to fixation, and predominantly in the superior paracentral hemifield. Studies have demonstrated that systemic risk factors such as hypotension, migraine, Raynaud phenomenon, and sleep apnea were significantly higher in patients with an initial parafoveal scotoma compared to an initial nasal step. Other potential risk factors include female gender and disc hemorrhage. Some clinicians are concerned by the central location of the visual field defect despite the presence of a glaucomatous optic disc appearance and need reassurance that they are not missing an alternative etiology. In my experience, neuroimaging study and macular evaluation have already been obtained prior to the neuro-ophthalmic evaluation.

Scenario #2: The patient with presumed severe glaucoma but MRI reporting T2 hyperintensity along the course of optic nerve

Some patients with a working diagnosis of severe glaucoma may undergo MRI of the orbits to look for alternative etiologies (for example if very asymmetric), or they undergo an MRI for a completely different issue. Ophthalmologists may then be facing a report describing T2 hyperintensity along the course of the optic nerve without associated optic nerve enhancement and without any other abnormalities. The radiologist will suggest possible prior ischemia or possible prior optic neuritis, or will simply mention “suggesting optic neuropathy or “suggesting optic atrophy.” This scenario almost always leads to a neuro-ophthalmology referral.

Studies have demonstrated significant differences in the optic nerve volume on MRI in the severe glaucoma group compared with the mild and control groups. Furthermore, advanced disease is often associated with loss of volume involving the entire length of the optic nerve. This loss of volume can be associated with abnormal signal on T2-weighted images (T2 hyperintensity), but no contrast enhancement should be noted in glaucomatous optic neuropathy.

The patient's history, assessment of afferent function with visual acuity, color vision, and visual field, and careful evaluation of the optic disc remain essential before concluding that such an MRI finding is in fact due to advanced glaucomatous optic neuropathy.

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Double Trouble: Diplopia Creation and Management in Glaucoma and Anterior Segment Surgery

Ahmara Gibbons Ross MD

Diplopia and Visual Field Loss

Sensory fusion is the ability to appreciate 2 similar objects or images, one with each eye, and interpret them as 1. The interpretation of these 2 similar images as 1 image is the hallmark of retinal correspondence. The concept of motor fusion is the ability to align the eyes so that sensory fusion can be maintained. Recall that one such stimulus for these fusional eye movements is retinal disparity outside Panum’s fusional area. If retinal disparity is too great, binocular fusion cannot occur; the retinal images fall on dissimilar retinal positions and results in physiologic diplopia.¹

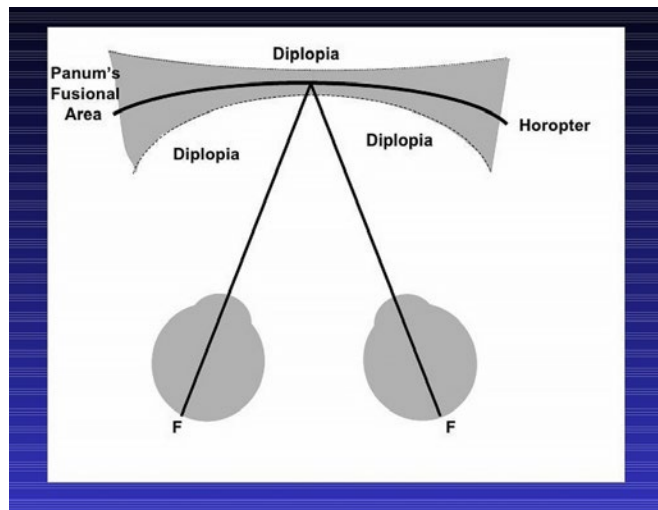


Figure 1. Panum’s fusional area. The area in gray represents a place where fusional amplitude is obtained, and it also highlights where images that fall outside of this area in the right or left eye can result in diplopia due to lack of retinal correspondence.

The best example of the type of diplopia that can present as a result of visual field defect is the hemifield slide phenomenon. This occurs when bitemporal or binasal visual field defects result in 2 images from the right and left eye, respectively, that cannot be easily fused and therefore disassociate from one another, causing diplopia that is nonparetic. The most common presentation of this phenomenon is in patients with bitemporal defects. This can occur and has presented in patients with binasal hemianopia, most commonly from optic nerve pathologies, including glaucoma.² Additionally, severely compromised visual fields from advanced glaucoma can limit the area of retinal correspondence needed for stereopsis and binocular vision, making diplopia from glaucoma difficult to treat.

While the most common complaint of diplopia associated with glaucoma has occurred in patients who have undergone incisional glaucoma with drainage devices, it is worth discussing the complexity of patients who present with diplopia from advanced glaucomatous field loss.³⁻⁵

Three Case Presentations

1. 68-year-old female with bilateral severe stage glaucoma presenting with nonparetic diplopia
2. 52-year-old female with moderate glaucoma presenting with binocular vertical diplopia status post trabeculectomy
3. 57-year-old female presenting with binocular and torsional diplopia status post glaucoma drainage device placement

Table 1. Common Glaucoma Surgeries and Risk of Diplopia

Glaucoma Treatment	Risk of Diplopia	Type of Diplopia
Medication alone	16%	Convergence insufficiency, adult-onset distance esotropia, and small-angle hypertropia
Glaucoma drainage device (Baerveldt 350 mm ²)	34%	Hyper-exo > hyper > hyper-eso > exo
Trabeculectomy	18%	Hypertropia

Teaching Points

Patients presenting with glaucoma should routinely be asked about intermittent or chronic symptoms of double vision, particularly in the context of severe visual field impairment. Treatment of diplopia in patients with severe visual field defects is difficult and will likely require combined care with strabismus experts, neuro-ophthalmologists, and medical and surgical glaucoma specialists.

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Visual Fields and OCTS—Diagnosing Glaucomatous vs. Non-Glaucomatous Disease

Khizer R Khaderi MD

In this talk, we will review advancements in utilizing traditional diagnostic equipment, including the application of artificial intelligence, to identify patterns of vision loss in both glaucomatous and non-glaucomatous disease. From this presentation, the goals include:

- Understanding the different patterns in visual field and/or OCT testing for assessing glaucomatous vs non-glaucomatous disease.
- Identifying new techniques for discerning glaucomatous vs non-glaucomatous etiologies

When to Image a Glaucoma Patient

Andrew G Lee MD

- I. Image a Special Kind of Glaucoma Called “Not Glaucoma”
Dad’s rule of ducks: “If it quacks like a duck, looks like a duck, and flies like a duck, it is a duck.”
- II. Historical Features Suggesting “Not Glaucoma”
 - A. Rapid progression
 - B. Pain
 - C. Other neurological symptoms or signs
 - D. Proptosis
 - E. Pupil abnormalities
- III. Exam Findings Suggesting “Not Glaucoma”
 - A. Hemianopic field loss
 - B. Bitemporal or homonymous
 - C. Visual acuity loss
 - D. Unilateral
 - E. Band cupping
 - F. Rim pallor
 - G. Proptosis
- IV. Ocular Imaging Suggesting “Not Glaucoma”
 - A. Hemianopic ganglion cell loss
 - B. Papillomacular bundle drop out
 - C. Band atrophy
- V. Summary
Image glaucoma when it is not a duck.

Artificial Intelligence: Improvements in Detecting Glaucoma

Detecting Glaucoma Worsening

Jithin Yohannan MD

I. AI in Detecting Visual Field (VF) Worsening

- A. Discuss results that show machine learning models can correct for poor reliability and improve the ability to detect worsening (Villasana. *Transl Vis Sci Technol*. In press.)
- B. Discuss results of study that shows deep learning model trained on a consensus of 4 of 6 algorithms is better than clinicians in routine clinical practice (Sabharwal. *Ophthalmology*. In submission.)
- C. Discuss results of work that shows AI can forecast future VF course with modest to high accuracy (Herbert. *Ophthalmology*. In submission.)

II. AI in Detecting Structural Worsening

- A. Discuss results of study that utilized fundus photos from the Ocular Hypertension Treatment Study to detect glaucoma development (Fan, et al. *JAMA Ophthalmol*. 2022.)
- B. Discuss dearth of studies that use AI to detect worsening on OCT

III. The Future of AI in Glaucoma

- A. Validating AI models and implementing into clinical workflows
- B. Developing AI to detect worsening of higher-dimensional structural data (ie, OCT 3-D cube scans)
- C. Harnessing AI in clinical trials of glaucoma therapeutics

Drug-Eluting Contact Lenses

Review of a Promising Option for Glaucoma Drug Delivery

Courtney L Ondeck MD, David S Friedman MD PhD MPH, and Joseph B Ciolino MD

I. Background

In the United States, approximately 3 million people are thought to have glaucoma.¹ There is an unmet need for a safe, effective method of sustained drug delivery to reliably improve patient compliance.

- Eye drops, typical first-line treatment for glaucoma, can have multiple side effects.
- Nonadherence to treatment can contribute to glaucomatous disease progression and vision loss.²

II. Real-World Examples

A. Ketotifen drug-eluting contact lens

- The first commercially available drug-eluting contact lens, recently approved by the FDA
- 1-day Acuvue lens loaded with 0.019 mg of ketotifen

B. Latanoprost drug-eluting contact lens (L-CL)

- Lens design: A thin drug-polymer film completely encapsulated within the periphery of a hydrogel (see Figure 1)³
- In vitro studies suggest that the latanoprost lens can deliver drug for at least 4 weeks. And in rabbits, the L-CL provided sustained drug release for 1 month as shown in aqueous humor drug concentrations.³
- In glaucomatous monkeys, the L-CL lowered IOP more than commercial latanoprost drops. A high and a low formulation of the contact lens were compared to the latanoprost eye drop, and the high-dose contact lens produced a significantly greater IOP reduction than the low-dose contact lens (see Figure 2).⁴ This contrasts with topical latanoprost, in which increasing the drug concentration or dosing frequency of the medication resulted in either no change or decrease in efficacy.⁵⁻⁶

This suggests that the sustained-release latanoprost lens does not follow the prostaglandin U-shaped dose response curve. A similar dose-dependent phenomenon was noted with the bimatoprost SR in the canine model.⁷

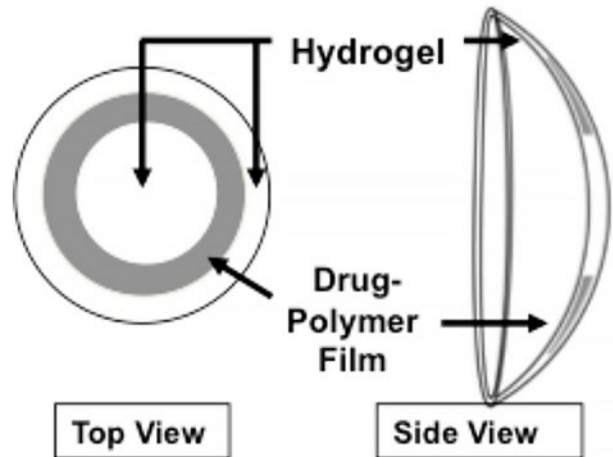


Figure 1. Schematic of drug-eluting contact lens.

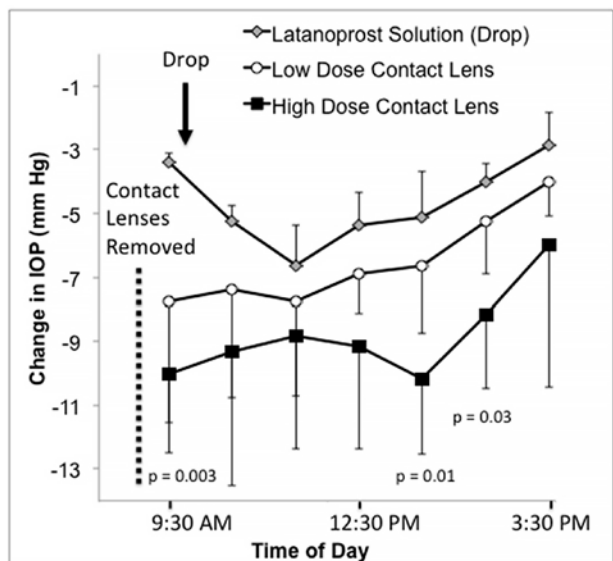


Figure 2. The IOP change from baseline over 7 hours on the last day of treatment in glaucomatous monkey eyes. Latanoprost drop data represent the change in IOP before and after the fifth consecutive morning dose of 0.005% latanoprost solution. The contact lens data represent the change in IOP after removing the lenses after 7 days of continuous wear.⁴

III. Phase 1 Clinical Trial/Safety and Efficacy Study of L-CL

- A. An open label, single center clinical trial in 1 eye of 5 participants with ocular hypertension or primary open-angle glaucoma treated with latanoprost monotherapy
- B. IOP will be measured while using latanoprost drops and then a 4-week washout period will occur, when the latanoprost will be discontinued.
- C. Following the washout period, the L-CL will be worn for 1 week with intensive monitoring.
- D. Safety, efficacy, and feasibility will be assessed.

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Disparities in Ophthalmology Affecting Clinicians and Patients

Lama A Al-Aswad MD MPH

- I. Definitions
- II. Populations and Burden of Eye Disease
- III. Addressing Health Disparities in Patient Care
- IV. Clinicians and Impact on Care Delivery
- V. Addressing Health Disparities in Clinicians
- VI. The Impact on the Overall Health System
- VII. Conclusions

IRIS[®] Registry: Outcomes in Glaucoma

Catherine Q Sun MD

- I. Background and Purpose of the IRIS[®] Registry (Intelligent Research in Sight)¹
 - A. Launched in March 2014
 - B. Submits data for quality reporting to the Centers for Medicare & Medicaid Services (CMS)
 - C. Improves patient outcomes through quality improvement
 - D. Provides deidentified data for research
- II. Current State of the IRIS Registry
 - A. 15,651 ophthalmologists and eligible clinicians in practice with them participating as of 1/2022
 - B. 71.90 million patients in the registry as of 1/2022
 - C. 46 articles published using the registry as of 1/2022
 - D. The Academy partnered with Verana Health in 2017 to manage data.
- III. Glaucoma Studies Using Data From the IRIS Registry
 - A. Disparities in glaucoma care
 1. Differences in practice patterns between academic and nonacademic settings (2016-2019)²
 2. Differences in the use of minimally invasive glaucoma surgery (MIGS) for cataract and open-angle glaucoma OAG (2013-2018)³
 - B. Selective laser trabeculoplasty (SLT)
 1. Factors associated with favorable SLT response (2013-2018)⁴
 2. Factors associated with SLT response duration⁵
 - C. MIGS
 1. Trends and usage patterns for MIGS increased during 2013-2018⁶
 2. Demographic and clinical characteristics associated with MIGS in the United States from 2013 to 2017³
 3. Glaucoma type influences glaucoma procedures.⁷
 - D. Tubes and trabeculectomy
 1. Comparing 1-year results from the Tube Versus Trabeculectomy (TVT) RCT to a cohort of patients who received tube shunt or trabeculectomy in the IRIS[®] Registry Study (2013-2017)⁸
 2. Risk factors for revision or removal of tube shunts (2013-2018)⁹
 - E. Smoking and IOP: Current and past smokers have higher IOP than patients who have never smoked.¹⁰
- IV. Pros and Cons of Big Data and the IRIS Registry
 - A. Pros
 1. Large, national dataset that is ophthalmology specific
 2. Can detect rare events and diseases
 3. Great for studying trends, practice patterns, prevalence, demographics, and clinical characteristics of cohorts
 - B. Cons/limitations
 1. Inherent limitations of EHR data
 - a. Does not capture if a patient sought care outside of the EHR system
 - b. Missing and erroneous data
 - i. Missing systemic data if this was not captured during ophthalmology appointment
 - c. Observational studies are at risk for confounding and bias.
 2. Lack of clinical notes
 3. Costs associated with use for research
- V. How to Perform Research Using the IRIS Registry
 - A. Grant funding mechanisms
 1. Research to Prevent Blindness/American Academy of Ophthalmology Award for IRIS Registry Research
 2. Hoskins Center IRIS Registry Research Fund
 3. Knights Templar Eye Foundation Pediatric Ophthalmology Fund
 4. Specialty society-funded projects
 - B. Work for an IRIS[®] Registry Analytic Center
 - C. Pay for dataset with own research funding

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LiGHT Trial: Latest Findings

Gus Gazzard FRCOphth MA MBBChir MD

The Laser in Glaucoma and Ocular Hypertension Trial (LiGHT) is a randomized controlled trial of 718 patients randomized to 2 treatment pathways—either selective laser trabeculoplasty (SLT) first or medication (drops) first and then additional treatment as needed.

The LiGHT study shows that patients newly diagnosed with open-angle glaucoma (OAG) or ocular hypertension (OHT) can be safely treated with SLT and achieve predominantly eyedrop-free IOP control over at least 3 years, with less intense treatment, fewer adverse effects and a reduced need for glaucoma and cataract surgery than patients treated with IOP-lowering eyedrops. This can be achieved at a lower cost per quality-adjusted life year than standard medical therapy alone and with a similar effect on generic health-related quality of life (HRQL), as assessed by the EQ-5D-5L. Primary SLT is a cost-effective alternative to eyedrops that can be offered to patients with OAG or OHT who need IOP-lowering treatment.

I will summarize the findings to date and report on HRQL and clinical effectiveness of initial treatment with SLT compared to IOP-lowering eyedrops after 6 years of careful, protocolized monitoring and treatment.

We found:

- No significant difference in HRQL between the patients initially treated with SLT and those treated with eyedrops. EQ-5D, Glaucoma Utility Index, and Glaucoma Quality of Life-15 scores were comparable between the 2 treatment arms.
- Reduced rates of disease progression, a reduced need for glaucoma and cataract surgery, significant drop-free IOP control, and high levels of safety of SLT as a first-line treatment

The Glaucoma Intensive Treatment Study (GITS) has also reported successful use of SLT for patients with OAG over 3 years, and the West Indies Glaucoma Laser Study (WIGLS) reported that SLT monotherapy safely provides 78% of Afro-Caribbean eyes with at least 20% IOP reduction for 12 months. With 90% of the eyes initially treated with SLT needing a maximum of 2 SLT treatments over 6 years and 56% requiring a single SLT treatment, there is great potential for SLT in many settings.

Eyes initially treated with SLT demonstrate reduced objectively defined disease progression compared to drops and less incisional glaucoma surgery. As trabeculectomy is performed on average 10 years after initial diagnosis and average life expectancy after glaucoma diagnosis is 9-13 years, SLT can delay and potentially eradicate the need for glaucoma surgery for a proportion of patients.

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Advances in Remote Monitoring and Telemedicine in Glaucoma

“Teleglaucoma”: Telemedicine in Glaucoma

Susan Liang MD

- I. Introduction
 - A. The COVID pandemic necessitated and accelerated telemedicine expansion.
 - B. Advances in diagnostic and telecommunications technologies enabled telemedicine programs.
 - C. Benefits of telemedicine
 1. Increase access to glaucoma specialists and high-quality care
 2. Decrease patient inconvenience
 - a. Travel and wait time
 - b. Time off from work
 3. Decrease overall costs to the health-care system
- II. Types of Telemedicine
 - A. Synchronous
 - B. Asynchronous
 - C. Combination
- III. Types of Teleglaucoma Programs + Key Components
 - A. Screening
 - B. Disease management and remote monitoring
 - C. Teleglaucoma in clinical practice: virtual or hybrid
 1. Personnel
 - a. Ophthalmic technicians
 - b. Nurses
 - c. Optometrists
 2. Diagnostic equipment
 - a. Pachymeter
 - b. Tonometer
 - c. Visual field perimeters
 - d. Anterior chamber imaging
 - e. Optic nerve/retinal nerve fiber layer imaging
 3. Software
 - a. Data storage
 - b. Artificial intelligence

- IV. Current Advances in Remote Monitoring
 - A. Home tonometers + serial tonometers
 - B. Tablet + virtual reality visual field testing systems
 - C. Portable fundus cameras/OCT machines
 - D. Smart phone interface with diagnostic tools
 - E. Artificial intelligence and machine learning software
- V. Legal and Reimbursement Considerations

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The OHTS: What's New in Genetics?

John Fingert MD PhD

I. Glaucoma Genetics

- A. Glaucoma is highly heritable, and genes are important in its pathophysiology.
- B. Most cases of glaucoma have a complex genetic basis and are caused by the combined action of many risk factor genes.
- C. More than 100 glaucoma risk factor genes have been discovered.

II. The OHTS

The Ocular Hypertension Treatment Study (OHTS) is a landmark study that investigated the efficacy of treating ocular hypertension in preventing or delaying onset of primary open-angle glaucoma (POAG).

- A. Extensive high-quality clinical data is available from OHTS participants.
 1. 1636 participants with ocular hypertension were followed for incident POAG for 20 years.
 2. Patients received standardized exams: biannual visual field tests and annual optic disc photos during the first phases of the OHTS.
 3. Reading centers graded optic disc photos and visual field tests for evidence of incident POAG.
 4. An endpoints committee confirmed that optic disc and/or visual field test damage was due to glaucoma.
 5. 483 of the OHTS participants (29.5%) developed POAG after 20 years of follow-up.
- B. Extensive high-quality genetics data is available from the OHTS participants.
 1. DNA samples are available from 1057 of OHTS participants (65%).
 2. These 1057 OHTS participants have been genotyped at 1,000,000 genetic markers (SNPs), which were imputed to 10,000,000 SNPs.
 3. 374 of these 1057 OHTS participants (35%) developed POAG, and 683 (65%) did not develop POAG after 20 years of follow-up.

III. Genetic Association Studies of the OHTS

- A. The OHTS cohort was tested for associations between 127 known glaucoma genetic factors and POAG.
 1. Allele frequencies of SNPs at 127 previously reported glaucoma risk factor gene loci were compared between OHTS participants with POAG ($n = 374$) and OHTS participants without POAG ($n = 683$).

2. Three genes were highly associated with POAG in the OHTS: *TMCO1*, *CDKN2B-AS1*, and *ADAMTS18/NUDT7*.

- B. A genome-wide association study (GWAS) was also conducted.

Allele frequencies of 10,000,000 SNPs evenly distributed across the genome were compared between OHTS participants with POAG ($n = 374$) and OHTS participants without POAG ($n = 683$).

IV. Kaplan Meier Survival and Cox Proportional Hazards Analyses of the OHTS Cohort

- A. One allele of *TMCO1*, *CDKN2B-AS1*, or *ADAMTS18/NUDT7*, is associated with greatly increased probability for POAG at 20 years (40%, 42%, or 35%, respectively).
- B. One allele of *TMCO1*, *CDKN2B-AS1*, or *ADAMTS18/NUDT7*, confers glaucoma risk equivalent to risk from having 4-5 mmHg higher IOP; from having 50 microns thinner cornea; or from being 10 years older.

V. Conclusions

- A. Some genetic factors confer substantial risk for glaucoma.
- B. Genotyping glaucoma suspects at these risk factor loci might be clinically useful.
- C. Therapies targeting these risk factor genes might produce a significant reduction in risk for glaucoma.

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Patient-Reported Outcome Tools: The New AAO/AGS Questionnaire

The FDA/AGS/AAO/Verana Project

George L Spaeth MD

Rationale

When one types, “What do patients want to know?” into a Google Search bar, up comes information from many sources: from health-care professionals and their societies, health-related publications, government and industry, and from charlatans. Most patients want to know about their own personal outcome, but most of these articles deal with the “process” of care, often of primary concern to physicians.¹ A few wisely note that “one size does not fit all.” Some patients insist on full disclosure, including the grisly details, whereas others truly want to leave everything up to the doctor.²

What does not surface in the published material is information from patients about what they themselves really want to know. This is not surprising, because Patient X is interested not in what “patients” want to know but rather in what he or she—as a unique individual person—wants to know.

The Need to Learn More

Physicians are taught what “experts” believe they need to know, such as how to perform a particular procedure and how to “obtain an informed consent”; sometimes they are taught “what patients want to know.” But Patient X, the one being cared for, is not “patients.” How does the physician know what the specific person under consideration wants to know? The traditional manner is to “take a history.” However, obtaining an accurate, relevant, significant history is difficult and a great skill, the teaching of which usually ignores the significant heterogeneity of the personalities, skills, and biases of the history-takers as well as great heterogeneity of patients.

How the Project Originated

The U.S. Food and Drug Administration (USFDA)/American Glaucoma Society (AGS) project to develop an “instrument” that would help doctors learn about outcomes important to patients having minimally invasive glaucoma surgery (MIGS) in which a device is used grew out of an AGS conference on MIGS, with a conversation between Malvina Eydelman of the USFDA and Kuldev Singh of the AGS.

Participants

This project involves individuals and groups with different skills:

- Representatives of the USFDA, an agency focused on the health of citizens of the United States of America, related to safety and efficacy of foods, various tests, medications, and devices
- The AGS, whose members want to know how to give patients the safest and most effective care
- The Center of Excellence in Regulatory Science and Innovation (CERSI) at Johns Hopkins University and the CERSI at Stanford, both involved in the science of developing information
- AGS members from several academic programs and AGS practitioners spread across the United States played essential roles, including testing the instrument.
- Verana Health, a 4-year-old company that partners with medical societies to assemble, analyze, and activate large, real-world clinical databases in a common regulatory-grade data platform
 - Much of the data are derived from clinical data registries owned by the American Academy of Ophthalmology (the Academy), the American Academy of Neurology, and the American Urological Association. The Intelligent Research in Sight (IRIS®) Registry of the Academy provides valuable data that Verana Health uses to deliver insights back to ophthalmologists, researchers, and life sciences companies to enhance evidence generation and advance ophthalmology; Verana has provided financial help for the study.

The Instrument

The result is a patient-reported outcomes “survey” based on studies establishing what is important to patients. There were many challenges. For example, patients often internalize information presented to them by others, such as their doctor, which in fact is not of actual importance to them. The instrument has been developed and evaluated and is in its final stages of testing. It will be available, without charge, to those wishing to use it to learn what a specific patient considers important with regard to the pluses and minuses of MIGS. It should result not only in better-informed patients and surgeons but also in continually better-informed patients and physicians.

The Future Benefit

While this survey instrument is specifically related to MIGS, the principles are applicable to other treatments. Perhaps most important is the effective demonstration of learning how better to put the patient at the center of care.

Some of the Major Players

- From the AGS: Husam Ansari, Joseph Caprioli, Qi Cui, Ronald Fellman, Davinder Grover, Dale Heuer, Leslie Jones, Richard Lee, Richard Lewis, Cynthia Mattox, Richard Parrish, Louis Pasquale, Sunita Radhakrishnan, Douglas Rhee, Angela Turalba, Steven Vold
- From the Stanford CERSI: Kuldev Singh, Ron Hays
- From the Hopkins CERSI: Tianjing Li, Jimmy Le, Amanda Bicket, John Bridges
- From the USFDA: Malvina Eydelman, Michelle Tarver, Kinneri Chada, Audry Thomas
- From Verana Health: Matthew Roe, Michael Mbagwu, Shrujal Baxi
- From the Academy: Flora Lum
- AGS practices involved in final testing:
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 - BVA Advanced Eye Care; Edmond, OK; Don Nguyen
 - University Eye Specialists; Chicago, IL; Lisa Rosenberg
 - Cincinnati Eye Institute; Cincinnati, OH; Lorraine M Provencher
 - Glaucoma Associates of Texas; Dallas, TX; Oluwatosin Smith
 - Moran Eye Center/University of Utah; Salt Lake City, UT; Craig Chaya
- University of Michigan Kellogg Eye Center; Ann Arbor, MI; Amanda Bicket
- Mayo Clinic Health System; La Crosse, WI; Nitika Arora
- Tulane University School of Medicine; New Orleans, LA; Ze Zhang
- Virginia Eye Associates; Norfolk, VA; Constance Okeke
- Minnesota Eye Consultants; Bloomington, MN; Clara Choo
- Ophthalmology Associates; Ft. Worth, TX; Brian Flowers
- Carolina Eye Associates; Southern Pines, NC; Winston Garris
- University Hospitals of Cleveland Eye Institute; Cleveland, OH; Douglas Rhee
- University of Colorado; Aurora, CO; Leo Seibold
- West Virginia University Eye Institute; Morgantown, WV; Brian McMillan
- Tufts Medical Center; Boston, MA; Sarwat Salim
- UCLA Doheny and Stein Eye Institutes; Pasadena, CA; Brian Francis

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The Art of the Trab

Kuldev Singh MD MPH

While many have predicted the demise of trabeculectomy over several decades, it remains the preferred go-to procedure for the small subset of glaucoma patients who are at high risk of severe vision loss from the disease if very low IOPs are not achieved. As our glaucoma population ages, there will undoubtedly be a need to reach single-digit IOPs to prevent blindness in greater numbers of patients in each successive generation, and there is no novel operation on the near horizon that will allow us to titrate IOPs in this very low range in a substantial proportion of those undergoing surgery.

The increasing number of primary tube procedures for advanced disease and the proliferation of MIGS procedures, including some that are bleb forming, have led to a decline in the number of trabeculectomy procedures performed in fellowship programs. Such a decline, with the associated decrease in experience relating to the art of perioperative manipulation to optimize results, has the potential to create a downward spiral, where less training results in poor results followed by further reduction in procedures performed leading to further decrease in training.

A circumstance worse than a practitioner not offering a trabeculectomy to a patient who needs the procedure is someone performing this procedure without appropriate training in intraoperative and early postoperative care techniques. Because of the increased risk of scarring and bleb failure in patients who have scarred conjunctiva from prior surgery, this may decrease the probability of a future successful result in the hands of someone who is appropriately trained to perform trabeculectomy. Thus mastering the art of trabeculectomy should be essential for all who strive to care for patients with vision-threatening glaucomatous disease.

Whether one prefers fornix- or limbus-based procedures, there are a few general surgical principles that are applicable.

1. The conjunctiva should be handled carefully and closed such that there is absolutely no leakage at the incision site or anywhere else in the bleb.
2. While the size and shape of the trabeculectomy flap and the number of sutures required for closure vary between surgeons, smaller flaps, all other things being equal, generally result in greater flow, with the associated risks and benefits.
3. Initial entry into the anterior chamber should be through corneal tissue rather than trabecular meshwork. Posterior entry, particularly over the ciliary body, may cause excessive bleeding.
4. There are generally no rewards for trying to make the smallest possible iridectomy.
5. Hypotony should be avoided by titrating flow through the trabeculectomy flap using sutures that can be lysed or released postoperatively. Single digit IOPs are generally not desirable in the very early postoperative period.
6. Digital massage performed by the surgeon at the slit lamp can be both diagnostic and therapeutic in the early postoperative period, providing guidance on optimal time to lyse or release trabeculectomy flap sutures.
7. Perioperative antifibrotic application should be titrated based upon risk factors for trabeculectomy failure, as well as intraoperative and postoperative course.
8. The frequency of postoperative visits should be based upon an individual patient's course.
9. Topical atropine should be used in eyes with shallow anterior chambers, with reformation reserved for flat rather than simply shallow chambers.
10. Topical steroids should not be tapered too quickly; a 3-month or longer postoperative course is generally appropriate.

It is important for the surgeon to make certain that patients undergoing trabeculectomy are well informed regarding the likely postoperative course, including the long recovery period relative to other commonly performed anterior segment procedures. Patients should also be educated on the do's and don'ts regarding activity in the postoperative period, as well as the signs and symptoms that should lead them to seek urgent care. Some of the most grateful patients in any glaucoma practice are those who have been able to maintain vision, often for decades, because of successful trabeculectomy.

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Tube Switches and Tricks

Mary Qiu MD

All tube exchanges will demonstrate the technique of utilizing autologous capsule material from the original tube as patch graft material for the new tube.

Video 1

Same-quadrant Ahmed-to-Ahmed exchange. Tube repositioning from anterior chamber (AC) to sulcus. Capsular autograft.

This is a pseudophakic eye with uveitic glaucoma secondary to sarcoidosis and prior superotemporal Ahmed FP7 in the AC. The tube tip is chafing the iris and causing recalcitrant anterior uveitis and cystoid macular edema. The IOP is uncontrolled on the current medical regimen, and a lower IOP is needed. The old Ahmed FP7 is slightly short, so an extender would be needed to reposition it into the sulcus. The IOP is too high, so an Ahmed capsule revision would be helpful to lower the IOP.

As a result, the old Ahmed is removed in its entirety, including the endplate, and the entire capsule, a new Ahmed FP7, is affixed to the bare sclera, the tube tip is inserted into the ciliary sulcus, and a piece of autologous capsular tissue from the old Ahmed's capsule is used as patch graft material to cover the new tube's entry site.

Video 2

Same-quadrant Ahmed-to-Baerveldt exchange. Tube repositioning from AC to pars plana. Capsular autograft.

This is a pseudophakic eye with neovascular glaucoma secondary to proliferative diabetic retinopathy and prior superotemporal Ahmed FP7 in the AC. The tube tip is chafing the iris since there is total synechial angle closure and high peripheral anterior synechiae. There is a sulcus IOL and not a lot of space for a sulcus tube. There is active iris neovascularization and need for fill-in panretinal photocoagulation.

A tube exchange is chosen instead of a second tube, to minimize the total number of tubes in the eye. A pars plana vitrectomy and endolaser is performed by the retina service. The old Ahmed FP7 is removed in its entirety, including the endplate and entire capsule; a new Baerveldt 350 is affixed to the bare sclera; the tube tip is inserted into the pars plana; and a piece of autologous capsule tissue from the old Ahmed capsule is used as patch graft material to cover the new tube's entry site. Micro-pulse cyclophotocoagulation was performed preoperatively to provide some early IOP lowering while waiting for the new Baerveldt ligature to dissolve. A 3-0 Prolene ripcord suture is left in place to prevent hypotony-associated complications.

Video 3

Same-quadrant Baerveldt-to-Baerveldt exchange. Tube repositioning from AC to sulcus. Capsular autograft. Conjunctival autograft from different quadrant of same eye.

This is a pseudophakic eye with primary open-angle glaucoma with prior failed superior trabeculectomy, superotemporal Baerveldt 350 in the AC, and inferonasal Baerveldt 350 in the AC, which had become recurrently eroded due in part to the plate being anchored too anteriorly, and the tube tip is chafing the iris root and causing recurrent anterior uveitis.

A tube exchange is performed to remove the entire old inferonasal Baerveldt 350 and the anterior and posterior aspect of the Baerveldt capsule that was not under the rectus muscles. A new Baerveldt 350 is ligated and anchored more posteriorly on the sclera, and the new tube tip is placed in the sulcus. A piece of autologous capsule tissue from the old Baerveldt capsule is used as patch graft material to cover the new tube's entry site. A conjunctival autograft is taken from the superonasal quadrant to close the inferonasal quadrant under no tension. A Kahook Dual Blade goniotomy was also performed at the beginning of the surgery to provide early IOP lowering until the new tube's ligature dissolves.

MIGS Complications

Sarah H Van Tassel MD

I. Blood Complications

- A. Intraoperative hyphema
- B. Early/postoperative day 1 hyphema
- C. Recurrent hyphema
 - 1. Literature includes mostly case reports.
 - 2. Can occur with implants and implant-free surgeries¹⁻³

II. Tissue Complications

- A. Intraoperative
 - 1. Descemet detachment
 - 2. Angle trauma
 - 3. Iridodialysis
 - 4. Cyclodialysis
- B. Postoperative: endothelial cell loss/chronic corneal edema⁴

III. Device Complications⁵

- A. Unable to implant device
- B. Malpositioned device
- C. Device migration
- D. Device lost in eye

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Financial Disclosure

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