

Glaucoma 2021

Making Glaucoma Care the Big Easy

Under Pressure®

Program Directors

Brian A Francis MD and Kelly W Muir MD

In conjunction with the American Glaucoma Society

Ernest N Morial Convention Center
New Orleans, Louisiana
Friday, Nov. 12, 2021



Presented by:
The American Academy of Ophthalmology

Supported by an unrestricted educational grant from
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AMERICAN ACADEMY
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2021 Glaucoma Planning Group

Brian A Francis MD

Program Director

Kelly W Muir MD

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Salwa Abdel-Aziz MD

Donald L Budenz MD MPH

Teresa C Chen MD

Ian Patrick Conner MD PhD

Babak Eliassi-Rad MD

Ronald Leigh Fellman MD OCS

Davinder S Grover MD MPH

Lily T Im MD

Christine LeeAnn Larsen MD

John T Lind MD

Former Program Directors

2020 Eydie Miller-Ellis MD

Brian A Francis MD

2019 JoAnn Giacon MD

Eydie Miller-Ellis MD

2018 Shan C Lin MD

JoAnn Giacon MD

2017 Jody R Piltz-Seymour MD

Shan C Lin MD

2016 Joel S Schuman MD

Jody R Piltz-Seymour MD

2015 James D Brandt MD

Joel S Schuman MD

2014 David S Friedman MD MPH PhD

James D Brandt MD

2013	Thomas W Samuelson MD
	David S Friedman MD MPH PhD
2012	Wallace L M Alward MD
	Thomas W Samuelson MD
2011	Leon W Herndon MD
	Wallace LM Alward MD
2010	Rohit Varma MD MPH
	Leon W Herndon MD
2009	Donald L Budenz MD MPH
	Rohit Varma MD MPH
2008	Henry D Jampel MD MHS
	Donald L Budenz MD MPH
2007	Anne Louise Coleman MD PhD
	Henry D Jampel MD MHS
2006	Christopher A Girkin MD
	Anne Louise Coleman MD PhD
2005	Claude F Burgoyne MD
	Christopher A Girkin MD
2004	David S Greenfield MD
	Claude F Burgoyne MD
2003	Kuldev Singh MD MPH
	David S Greenfield MD
2002	Theodore Krupin MD
	Kuldev Singh MD MPH
2001	Robert D Fechtner MD
	Theodore Krupin MD
2000	Jeffrey M Liebmann MD
	Robert D Fechtner MD
1999	Robert N Weinreb MD
	Jeffrey M Liebmann MD
1998	George A Cioffi MD
	Robert N Weinreb MD

1997	Richard A Lewis MD
	George A Cioffi MD
1996	M Bruce Shields MD
	E Michael Van Buskirk MD
1995	Reay H Brown MD
	Mary Gerard Lynch MD
1994	Richard A Lewis MD

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Gina Comaduran, *Cover Design*

2021 Glaucoma Subspecialty Day Planning Group

On behalf of the American Academy of Ophthalmology and the American Glaucoma Society (AGS), it is our pleasure to welcome you to New Orleans and **Glaucoma 2021: Making Glaucoma Care the Big Easy.**



Brian A Francis MD
Program Director

None



Kelly W Muir MD
Program Director

None

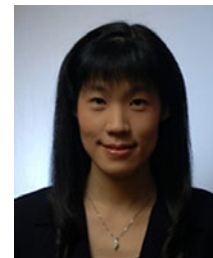
Program Planning Group



Salwa Abdel-Aziz MD
None



Donald L Budenz MD MPH
Carl Zeiss, Inc.: L
Heru, Inc.: C
iView: C
Nicox: C



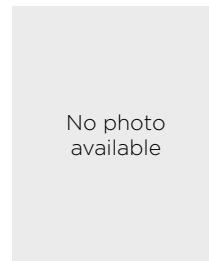
Teresa C Chen MD
Department of Defense: S
Elsevier: P
Harvard Foundation Grant (Fidelity
Charitable Fund): S

**Ian Patrick Conner MD PhD**

Ivantis: C
Ocugenix: C,O,P

**Ronald Leigh Fellman MD OCS**

Aerie Pharmaceuticals, Inc.: L
Alcon Laboratories, Inc.: C
Bausch + Lomb: L
Endo Optiks, Inc.: C
InnFocus: S



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available

Lily T Im MD

None

**Babak Eliassi-Rad MD**

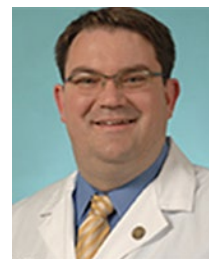
None

**Davinder S Grover MD MPH**

Aerie Pharmaceuticals, Inc.: L
Allergan: C,L,S
Bausch + Lomb: C,L
Glaukos Corp.: C
MicroOptx: C
New World Medical, Inc: C,L
Nova Eye Medical: L
Olleyes: O,C,L
Reichert, Inc.: C,L
Sanoculis: C
Santen, Inc.: C
Surgical Specialties: L

**Christine LeeAnn Larsen MD**

None

**John T Lind MD**

Heru: S
Nicox: S

2021 Subspecialty Day Advisory Committee

R Michael Siatkowski MD, Chair (Pediatric Ophthalmology)

National Eye Institute: S
OMIC-Ophthalmic Mutual Insurance
Company: C

Maria M Aaron MD (Secretary for Annual Meeting)

None

Bonnie An Henderson MD (Refractive Surgery)

Alcon Laboratories, Inc.: C,L

Michael S Lee MD (Neuro-Ophthalmology)

Horizon: O
Springer: P
Sun Biopharma: C
UptoDate: P

Jennifer Irene Lim MD (Retina)

Aldeyra Therapeutics: S
Allergan, Inc.: C
Aura Biosciences: C
Chengdu Kanghong: S
Cognition Therapeutics: C
CRC Press/Taylor and Francis: P
Eyenuk: C
Genentech: C,S
Greybug: S
Iveric Bio: C
JAMA Ophthalmology Editorial
Board: C
Luxa: C
NGM: S
Novartis Pharma AG: C
Ophthea: C
Quark: C
Regeneron Pharmaceuticals,
Inc.: S,C
Santen, Inc: C
Stealth: S
Unity: C
Viridian: C

Shahzad I Mian MD (Cornea)

Centrasight: S
Kowa American Corp.: S
National Eye Institute: S

Jody R Piltz MD (Glaucoma)

Aerie Pharmaceuticals: C,L,S

AAO Staff

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Melanie Rafaty

None

Debra Rosencrance

None

Beth Wilson

None

Glaucoma 2021 Contents

	Glaucoma 2021 Subspecialty Day Planning Group	ii
	CME	vi
	The American Glaucoma Society Subspecialty Day Lecture	viii
	Faculty Listing	ix
	How to Use the Audience Interaction Application	xiv
	Program Schedule	xv
Section I:	Diagnostics: OCT and Visual Fields	1
Section II:	MIGS Cases	9
Section III:	Medication and Lasers	15
	In These Unprecedented Times . . .	22
	The American Glaucoma Society (AGS) Subspecialty Day Lecture: The Use of Mitomycin C in Traditional and Novel Glaucoma Surgeries	24
Section IV:	Glaucoma in the Digital Age	25
Section V:	Journal Club/Late Breaking	32
Section VI:	Lens and Glaucoma	42
Section VII:	Surgery Videos Intraoperative Challenges	51
	Faculty Financial Disclosure	59
	Presenter Index	63

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.

2021 Glaucoma Subspecialty Day Meeting 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 optic disc and retinal nerve fiber layer imaging and 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

2021 Glaucoma Subspecialty Day Meeting 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. It 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.

Control of Content

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 acknowledgement 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.

2021 Glaucoma Subspecialty Day CME Credit

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

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

The American Academy of Ophthalmology 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 American Academy of Ophthalmology 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.

How to Claim CME

Attendees can [claim credits online](#).

For AAO 2021, you can claim CME credit multiple times, up to the 50-credit maximum, through Aug. 1, 2022. You can claim some in 2021 and some in 2022, or all in the same year.

For 2021 Subspecialty Day, you can claim CME credit multiple times, up to the 12-credit maximum per day, through Aug. 1, 2022. You can claim some in 2021 and some in 2022, 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 2021 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 2021.

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@ao.org.

For Continuing Certification questions, contact the American Board of Ophthalmology at MOC@abpo.org.

The American Glaucoma Society (AGS) Subspecialty Day Lecture

The Use of Mitomycin C in Traditional and Novel Glaucoma Surgeries

Friday, Nov. 12, 2021

11:19 AM - 11:49 AM



Michele C Lim MD

Michele C Lim MD was born in Torrance, California, and raised in sunny San Diego, which she identifies as her hometown. She graduated from Cornell University with a B.S. degree in Animal Science and spent a year studying abroad at the University of London. She then matriculated as a veterinary student at the UC Davis School of Veterinary Medicine but then switched over to taking care of two-legged patients. She received her medical degree from the University of California, Los Angeles, and completed her residency at the Jules Stein Eye Institute before undertaking a glaucoma fellowship at the Bascom Palmer Eye Institute, University of Miami.

In 2000, Dr. Lim joined the Department of Ophthalmology at the University of California, Davis, where her clinical practice focuses exclusively on glaucoma. She became the vice chair and medical director in 2008. Her research interests include health information technology, and she has published numerous papers on the adoption and use of electronic health record (EHR) systems, national policy regarding the use of health technology in ophthalmology, and financial and clinical impacts of EHR. Over a 10-year period, she served as a member and as co-chair of the American Academy of Ophthalmology's Medical

Information Technology Committee, which has provided education about EHR to the Academy's membership and has driven policy and evolution of EHR use in our field. Dr. Lim has also published papers in the area of personality type and glaucoma and treatment adherence, as well as on a novel application of antimetabolites in glaucoma surgery.

Dr. Lim has served as a member of the Academy's Preferred Practice Patterns writing committee (Glaucoma), and she is an examiner for the American Board of Ophthalmology oral examinations. She is also a member of the American Glaucoma Society, for which she has served as co-chair of the Annual Meeting, co-chair of Surgery Day at the Annual Meeting, and member of the Patient Care Subcommittee. She has given numerous invited lectures as visiting professor and as a speaker at national and international ophthalmology meetings.

Dr. Lim serves as co-director of the Paul Hsu Asian Eye Clinic, a free clinic that provides care to an underserved population in the Sacramento, California, region. She resides in Sacramento with her husband and two children, and her favorite activities are watching her kids play sports and road-biking. She is also a skiing addict.

Faculty



Salwa Abdel-Aziz MD
Tucson, AZ



Analisa Arosemena MD
Coral Gables, FL



Donald L Budenz MD MPH
Chapel Hill, NC



Iqbal K Ahmed MD
Mississauga, Canada



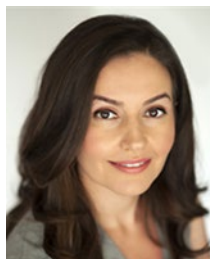
Keith Barton MBBCh
London, England



Michelle R Butler MD
Dallas, TX



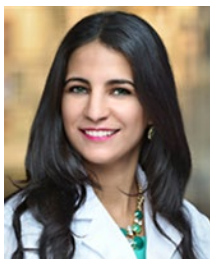
Lama A Al-Aswad MD MPH
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La Canada, CA



Cara E Capitena Young MD
Aurora, CO



Zaina N Al-Mohtaseb MD
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Craig J Chaya MD
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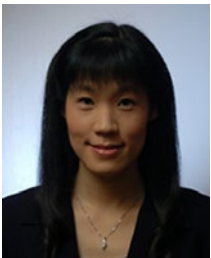
Jenny Chen MD
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Qi N Cui MD
Philadelphia, PA



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Kendall E Donaldson MD
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Garry P Condon MD
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Mark J Gallardo MD
El Paso, TX



Steven J Gedde MD
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Lily T Im MD
Baltimore, MD



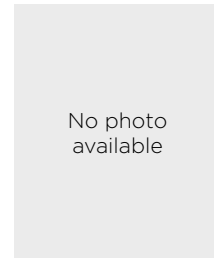
John T Lind MD
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Christine L Larsen MD
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Steven L Mansberger MD MPH
Portland, OR



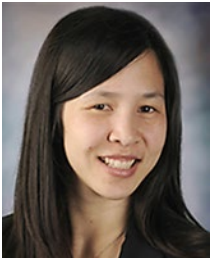
Tsoncho Ianchulev MD
Harrison, NY



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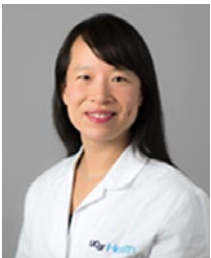
Lilian Nguyen MD
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Cincinnati, OH



Yvonne Ou MD
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Jullia A Rosdahl MD PhD
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Leonard K Seibold MD
Aurora, CO



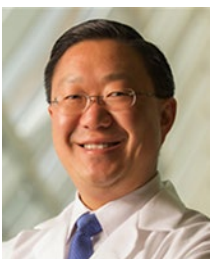
Paul F Palmberg MD PhD
Miami, FL



Ahmara V Ross MD
Philadelphia, PA



Arsham Sheybani MD
Saint Louis, MO



Douglas J Rhee MD
Cleveland, OH



Thomas W Samuelson MD
Minneapolis, MN



Aakriti Garg Shukla MD
Philadelphia, PA

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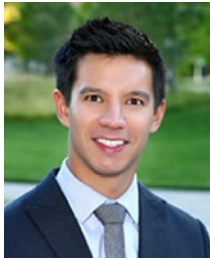
David A Sola-Del Valle MD
Boston, MA



Sarah Van Tassel MD
New York, NY



Kelly Walton Muir MD
Durham, NC



Jeffrey R SooHoo MD
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Kateki Vinod MD
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Andrew M Williams MD
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Thasarat S Vajaranant MD MHA
Chicago, IL

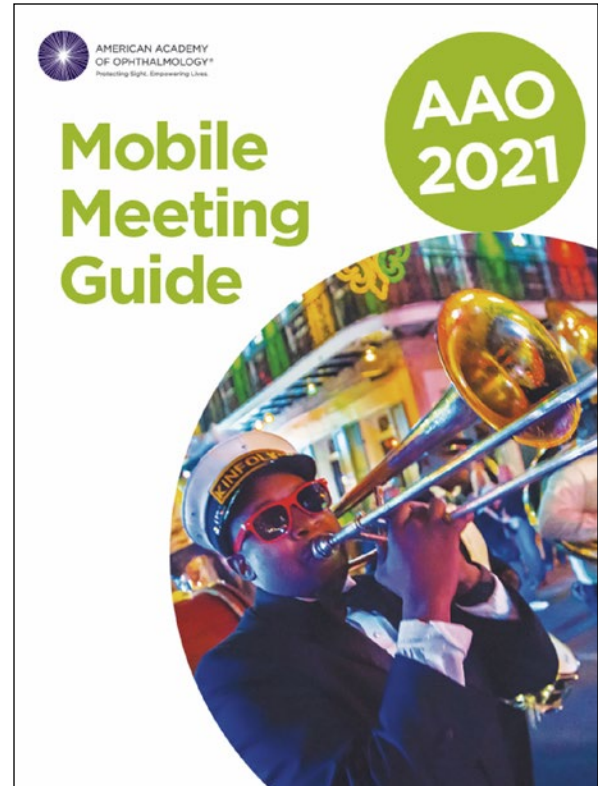


David S Walton MD
Boston, MA

Ask a Question Live During the Meeting Using the Mobile Meeting Guide

To ask the moderator a question during the meeting, follow the directions below.

- Access at www.aao.org/mobile
- Select “Program,” “Handouts & Evals”
- Filter by Meeting: Glaucoma Meeting
- Select “Current Session”
- Select “Interact with this session (live)”
to open a new window
- Choose “Ask a Question”



Glaucoma Subspecialty Day 2021: Making Glaucoma Care the Big Easy

FRIDAY, NOV. 12, 2021

7:00 AM	CONTINENTAL BREAKFAST	
8:00 AM	Welcome and Introductions	Brian A Francis MD
8:02 AM	American Glaucoma Society Introduction	Ronald Leigh Fellman MD OCS*
8:04 AM	AGS Cares	Ronald Leigh Fellman MD OCS*
8:09 AM	Announcements	Kelly Walton Muir MD

Section I: Diagnostics: OCT and Visual Fields

Moderators: Teresa C Chen MD* and John T Lind MD

Virtual Moderator: Aakriti Garg Shukla MD

8:11 AM	OCT Interpretation: Basics and Pearls	Thasarat S Vajaranant MD	1
8:19 AM	Innovations in Visual Field Testing	Steven L Mansberger MD MPH*	3
8:27 AM	OCT–Visual Field Mismatch: OCT Misinterpreting	Grace Marie Richter MPH*	4
8:35 AM	OCT–Visual Field Mismatch: VF Misinterpreting	Donald L Budenz MD MPH*	5
8:43 AM	OCT Progression	Jullia A Rosdahl MD PhD*	6
8:51 AM	Visual Field Progression	Steven J Gedde MD	7

Section II: MIGS Case-Based Section

Moderators: Davinder S Grover MD* and Christine L Larsen MD

Virtual Moderator: Aakriti Garg Shukla MD

9:00 AM	iStent: Ideal Patient, Key Pearls for Success, and Why I Didn't Do the Other MIGS	Sahar Bedrood MD PhD*	9
9:06 AM	Hydrus: Ideal Patient, Key Pearls for Success, and Why I Didn't Do the Other MIGS	Craig J Chaya MD	10
9:12 AM	Goniotomy: Ideal Patient, Key Pearls for Success, and Why I Didn't Do the Other MIGS	Leonard K Seibold MD*	11
9:18 AM	Viscodilation: Ideal Patient, Key Pearls for Success, and Why I Didn't Do the Other MIGS	Mark J Gallardo MD*	12
9:24 AM	Gonioscopy-Assisted Transluminal Trabeculotomy: Ideal Patient, Key Pearls for Success, and Why I Didn't Do the Other MIGS	Matthew E Emanuel MD*	13
9:30 AM	Xen Gel Stent: Ideal Patient, Key Pearls for Success, and Why I Didn't Do the Other MIGS	Analisa Arosemena MD*	14
9:36 AM	Discussion		
9:51 AM	REFRESHMENT BREAK		

* Indicates that the presenter has financial interest. No asterisk indicates that the presenter has no financial interest.

Section III: Medication and Lasers

Moderators: Salwa Abdel-Aziz MD and John T Lind MD

Virtual Moderator: Aakriti Garg Shukla MD

10:21 AM	Are All Ciliary Body Destruction Procedures Created Equal?	Jenny Chen MD	15
10:29 AM	Mythbusters: Real or Fake Contraindications	Kateki Vinod MD	16
10:39 AM	Systemic Drugs and Glaucoma: The Effect of Various Systemic Medications on Open-Angle and Closed-Angle Glaucoma	Cara E Capitena MD	17
10:47 AM	Targets of the Medication Pipeline: New and Emerging Treatments	David A Sola-Del Valle MD*	18
10:55 AM	Alternative Therapeutic Treatments for Glaucoma	Angela R Elam MD	19
11:03 AM	Emerging Technologies in the Treatment of Glaucoma	Ahmara Ross MD PhD*	20
11:12 AM	In These Unprecedented Times . . .	Donald L Budenz MD MPH*	22

The American Glaucoma Society Subspecialty Day Lecture

Virtual Moderator: Aakriti Garg Shukla MD

11:17 AM	Introduction of the Lecturer	Donald L Budenz MD MPH*	
11:19 AM	The Use of Mitomycin C in Traditional and Novel Glaucoma Surgeries	Michele C Lim MD*	24
11:49 AM	Presentation of the Award	Donald L Budenz MD MPH*	
11:50 AM	LUNCH		

Section IV: Glaucoma in the Digital Age

Moderators: Ian P Conner MD PhD* and Babak Eliassi-Rad MD

Virtual Moderator: Andrew M Williams MD

1:05 PM	Home Tonometry	Jeffrey R SooHoo MD	25
1:12 PM	Virtual Reality Visual Fields	Yvonne Ou MD*	26
1:19 PM	Teleglaucoma	Lama A Al-Aswad MD MPH*	27
1:26 PM	App-Based Visual Aids	Terry L Schwartz MD	28
1:33 PM	Deep Learning/Artificial Intelligence	Anthony P Khawaja MBBS*	30
1:40 PM	Discussion		

Section V: Journal Club/Late Breaking

Moderators: Ian P Conner MD PhD* and Kelly Walton Muir MD

Virtual Moderator: Andrew M Williams MD

1:55 PM	Introduction	Ian P Conner MD PhD*	
1:57 PM	Case Presentation	James C Liu MD	32
2:01 PM	Clinical Trial Update for Bimatoprost Implant	Felipe A Medeiros MD*	33
2:09 PM	Potential Scientific Basis for Sustained Response to Implant	Douglas J Rhee MD*	35
2:17 PM	Synthesizing the Clinical and Basic Science Information for This Patient	Qi N Cui MD*	36
2:23 PM	Best of AGS: Surgery in the Advanced Angle-Closure Patient	Sarah Van Tassel MD*	37
2:30 PM	Best of AGS: Surgery in the Advanced Uveitic Glaucoma Patient	Keith Barton MBBCh	39

* Indicates that the presenter has financial interest. No asterisk indicates that the presenter has no financial interest.

2:37 PM	First System for Robot-assisted Ab-Interno Gonio-Intervention: From Stent Implantation to Trabeculotomy	Tsontcho Ianchulev MD*	40
2:44 PM	Status of the CMS Bundling for MIGS and How We Got There	Leon W Herndon Jr MD*	41
2:51 PM	REFRESHMENT BREAK		

Section VI: Lens and Glaucoma

Moderators: Teresa C Chen MD* and Christine L Larsen MD

Virtual Moderator: Andrew M Williams MD

Glaucoma and Your Native Lens

3:21 PM	Lens-Related Glaucoma and Considerations for Surgical Management	Thomas W Samuelson MD*	42
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Glaucoma and No Lens

3:26 PM	Aphakic Glaucoma	David S Walton MD*	44
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Glaucoma and Pseudophakic Lenses

3:31 PM	Uveitis-Glaucoma-Hyphema Syndrome	Iqbal K Ahmed MD*	45
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3:36 PM	Premium and Toric Lenses in Glaucoma Patients	John P Berdahl MD*	46
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Glaucoma and Displaced Lenses

3:41 PM	Fix It With an Anterior Chamber IOL	Kendall E Donaldson MD*	47
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3:46 PM	Fix It With an Iris-Sutured Lens	Garry P Condon MD*	48
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3:51 PM	Fix It With a Scleral-Fixated Lens	Zaina N Al-Mohtaseb MD*	50
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3:56 PM	Discussion		
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Section VII: Surgery Videos Intraoperative Challenges

Moderators: Davinder S Grover MD* and Lily T Im MD

Virtual Moderator: Andrew M Williams MD

4:11 PM	Challenges With Tubes: Conj Tricks, Tube Tricks	Ronald Leigh Fellman MD OCS*	51
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4:20 PM	Challenges With Trabs: Conjunctiva, Flaps, Etc.	Paul F Palmberg MD PhD*	53
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4:29 PM	Challenges With Cataract Surgery in Angle Closure	Lilian Nguyen MD	55
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4:38 PM	Complications With Intraoperative Angle Bleeding	Michelle R Butler MD*	56
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4:47 PM	Complications With Aqueous Misdirection on the Table; or, Preventing Aqueous Misdirection	Arsham Sheybani MD	57
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4:56 PM	Discussion		
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5:06 PM	Closing Remarks	Brian A Francis MD Kelly Walton Muir MD	
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* Indicates that the presenter has financial interest. No asterisk indicates that the presenter has no financial interest.

OCT Interpretation: Basics and Pearls

Thasarat Sutabutr Vajaranant MD MHA

Optical coherence tomography (OCT), an imaging technique based on interferometry to reconstruct 3-D cross-sectional images of the optic nerve and macula, has become the standard of care for glaucoma. Low-quality scans can negatively impact the interpretations and lead to mismanagement of glaucoma; hence it is imperative for clinicians to recognize its limitations and common artifacts. This section will provide basics and pearls for OCT interpretations.

OCT Basics

Different scanning protocols

1. Raster cube scan of the optic nerve and the macula: An area of interest is scanned from side to side in lines from top to bottom.
2. Circular scan of the optic nerve: A circular scan, approximately 3.45 mm in diameter around the optic nerve, captures the retinal ganglion cell axons as they travel through the retinal nerve fiber layer from the entire retina toward the optic nerve head.

3. Radial scan and radial-concentric scan of the optic nerve: A spoke-like scan, centered around the optic nerve (may be combined with concentric scan).
4. Wide-field scan of the optic nerve and macula: A set of wide raster scans that captures both the optic nerve and macula.

OCT analysis

1. Retinal nerve fiber layer parameters
2. Optic disc parameters
3. Macular parameters
4. OCT progression analysis

Essential Pearls for Interpretations

1. Recognize red vs. green diseases
2. Recognize preferential glaucomatous pattern
3. Identify low-quality scans based on different types of artifacts (see Table 1)

Table 1

Type of Artifacts	Definition	Potential Causes	Effects
Low signal strength	Signal strength below the device manufacturer's recommended minimum threshold	Media opacity Vitreous floaters Small pupil Dirty OCT lens	Artificially low thickness
Decentration	Circular scan that is not centered in the optic nerve or macula	Uncommon due to the automated centration system May occur due to malfunction or poor fixation	The closer circle leads to thicker measurement, whereas the farther circle leads thinner measurement.
Segmentation error	Incorrectly outlines the anatomical boundaries	May be caused by the presence of peripapillary atrophy, vitreoretinal diseases, or advanced glaucoma	Either artificially low or high thickness
Out-of-range scan	Scans that are outside the scanning range	High myopia Poor image acquisition such as misalignment	Cut-out OCT images Artificially low thickness
Blinking artifact	Blinking that interrupts the scanning during image acquisition	Blinking	Black horizontal bands across the en face image, the thickness and deviation maps <i>or</i> Vertical lines on the B scan Artificially low thickness
Motion artifact	Tracking system only reduces horizontal, not axial motion	Head movement	The presence of shift or misalignment of the retinal vessels on the deviation map or misalignment of the optic nerve and cup margins, double fovea
Mirror artifact	Processing error; an inability to differentiate positive and negative time delays	Occurs when the distance between the eye and the OCT is smaller than optimal, eg, high myopia (high axial length and significant curvature), massive retinal thickening, or masses, or poor scan placement	The final OCT image is flipped on itself. Recognized by one edge of image appearing folded back onto itself, or the image extending past the retina into choroid

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Innovations in Visual Field Testing

Advances in Perimetry

Steven L Mansberger MD MPH

I. Background

Glaucoma progression can lead to visual disability even if treated.

- A. In a retrospective study of 295 treated patients with newly diagnosed open-angle glaucoma in Olmsted County, Minnesota, whose IOP was not appropriately controlled¹
- B. Probability of blindness after 20 years:
 - 1. 27% in 1 eye
 - 2. 9% in both eyes
- C. Of 114 patients initially treated for ocular hypertension, probability of blindness after 20 years:
 - 1. 14% in 1 eye
 - 2. 4% in both eyes

II. Importance of Detecting Slope of Progressive Glaucoma

Single-field analysis with glaucoma progression analysis (GPA) results

- A. GPA printout is the preferred method for event analysis.
- B. Technician must set up single-page printout for GPA.
- C. Clinician must choose baseline fields to be used.

III. Rate-Based Change Glaucoma Change Analysis

- A. What rate of loss is significant?²
- B. 402,357 anonymized VFs from 75,857 patients recorded between 1989 and 2012
- C. Median life expectancies, based on age and sex, from UK Office for National Statistics
- D. 7.5% had a rate worse than -1 dB/y.
- E. 3.0% of eyes progressed at faster than -1.5 dB/y.
- F. But 33.3% had positive MD rates.
- G. 90.7% of blindness cases were < -6 dB at baseline in 1 eye.
- H. 5%-7.2% blind over their lifetime

IV. What Rate of Loss Is Significant?

- A. Early Manifest Glaucoma Trial: 1.08 dB/yr
- B. Rosetti L: 1.1 ± 3.5 dB/yr
- C. DeMoraes (10-2 visual fields): 1.0 dB/yr
- D. Visual Field Index: 2.5%/yr

V. What to Do With Poor Sensitivity <19 dB?

VI. When to Check 10-2 Visual Fields?

- A. 10-2: 2 degree grid (vs. 6 degree), 68 points in central 10 degrees, 44 in central 8 degrees vs. 4 points with 30-2/24-2
- B. 12% of patients with normal 30-2 VFs¹
- C. 50% with mild to moderate glaucoma have repeatable 10-2 loss.²

VII. Research and Future Applications of Perimetry: Benefits and Disadvantages

- A. 24-2c (SITA Faster)
- B. Portable perimetry
 - 1. Virtual reality
 - 2. Tablet-based computer approach
- C. Cluster perimetry
- D. Real-life situation (driving, ambulation) perimetry
- E. Data analysis methods: Application of artificial intelligence for visual field testing
- F. Combining structure and function perimetry

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OCT-Visual Field Mismatch: OCT Misinterpreting

Grace Marie Richter MD MPH

NOTES

OCT-Visual Field Mismatch: VF Misinterpreting

Donald L Budenz MD MPH

Introduction

Misinterpretation of a visual field can result in a mismatch with OCT diagnosis in numerous ways. These fall into 3 broad categories: (1) falsely abnormal visual field with normal OCT, (2) falsely normal visual field with abnormal OCT, and (3) OCT makes correct diagnosis but visual field interpretation results in a different and incorrect diagnosis. One of the reasons it is so helpful to have both diagnostic tools is that one can serve as a reality check for the other.

Falsely Abnormal Visual Field With Normal OCT

In this situation, the OCT appears normal and the visual field is abnormal in a glaucomatous pattern. We see this most often in the workup of the glaucoma suspect. A commonly seen phenomenon called “pattern reversal” occurs when the Total Deviation Plot is normal but an early glaucomatous visual field defect is seen in the Pattern Deviation Plot. This is due to a slightly better than average performance by the patient compared to age-matched controls and the General Height Adjustment causing a depression, rather than elevation, in the entire visual field. Careful examination of the Total Deviation Plot reveals multiple positive integers, enough to cause the General Height Adjustment to do the opposite of what was intended. It is critical to look at the Total Deviation Plot before interpreting the Pattern Deviation Plot. If the Total Deviation Plot is Normal, then the patient is normal and you should stop and not even look at the Pattern Deviation Plot.

One of the problems with the Humphrey GPA overview printout is that to save space, only the Total Deviation Plot is displayed. One needs to print out the entire day’s visual field to make sure this phenomenon is not occurring because it will be missed in the GPA printout alone. In the age of EHRs, there is no reason *not* to refer to the original printout since we are not killing trees or making paper charts thicker!

A variety of commonly seen false positive artifacts in visual fields have been well described, and their recognition and proper interpretation can avoid misdiagnosis. Using the OCT as a reality check is very helpful in all of these situations. These include patient inexperience/learning effect, eyelid and brow artifacts, lens rim artifacts, inattentive patient, fatigue, incorrect fixation, incorrect trial frame correction, and incorrect date of birth entered. Having a Normal OCT for patients in these situations is very helpful in pointing out a mismatch, and pattern recognition of these false positive visual field results can prevent misinterpretation and misdiagnosis.

Falsely Normal Visual Field With Abnormal OCT

A visual field that is normal when the patient has glaucoma by clinical examination and OCT is less common, although we all accept that OCT and structural changes occur before visual fields become abnormal. In a phenomenon called “progression in the green,” the OCT is normal to begin with and slowly worsens due to glaucoma, but the wide genetic variability in retinal nerve fiber layer thickness and other OCT parameters makes it difficult to diagnose early glaucoma. The white-on-white and sometimes even blue-on-yellow visual fields remain normal during this period because they are not sensitive enough to pick up this early damage. Trigger-happy patients cause a high false-positive reliability index and an artifactually normal visual field that can mask glaucoma, so having an abnormal OCT can be helpful in pointing one in the right direction. Poor fixation, when the patient looks at the stimuli being presented instead of the central fixation light, can cause an artifactually good visual field in the face of clear OCT and optic disc abnormality.

OCT Correct Diagnosis, Visual Field Different and Incorrect Diagnosis

Nonglaucomatous optic neuropathies, cerebrovascular accidents, and retinal disease can cause abnormal visual fields in our glaucoma patients that simulate glaucoma or glaucoma progression. The OCT (as well as careful fundus examination and neuroimaging when indicated) can be very helpful in sorting out these mismatches.

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OCT Progression

Jullia A Rosdahl MD PhD

I. Illustrative Case Example

Glaucoma is a progressive optic neuropathy characterized by optic nerve thinning with corresponding visual field defects. OCT is a powerful technology enabling quantitative and qualitative evaluation of the optic nerve and subsequent changes over time that would indicate glaucomatous progression.

II. When OCT Is Most/More Useful for Determining Progression

Both OCT and visual field testing are used to assess for disease progression in glaucoma patients. Often, OCT is more useful in earlier stages of glaucoma; and visual field testing, in later stages. In later stages of glaucoma, macular OCT in particular can be helpful.

III. What Constitutes “Real” Progression?

The “rule of 5” is commonly used to identify changes in OCT measurements that are likely to be clinically significant. Trend-based analyses may be better for detecting glaucomatous progression.

IV. Beware of False “Progression”

Just as artifacts and masqueraders can affect the diagnostic capabilities of OCT, so also can they affect its ability to detect progression. Pathologies of the vitreous and macula can affect OCT measurements of the retinal nerve fiber layer and macula. Evaluation of the OCT scans in addition to the thickness maps and progression analyses can help mitigate clinical misjudgments.

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Visual Field Progression

Steven J Gedde MD

Introduction

Perimetry plays an important role in the diagnosis and management of glaucoma. Visual field (VF) changes that are statistically and clinically significant can provide a basis for adjustments in treatment. Ocular imaging of the optic disc, retinal nerve fiber layer, and ganglion cells provides valuable information that compliments but does not replace VF testing. Notably, a floor effect with OCT measurements makes it impossible to detect further deterioration with this technology in eyes with advanced disease.

A paradigm shift in glaucoma management has occurred over the past decade. Clinicians previously were mainly focused on whether or not VF progression had occurred, and they are now interested in determining the rate of progression. The goal of glaucoma treatment is to prevent loss of visual function, especially as it relates to quality of life.

Selecting a Test Strategy

Selecting the best VF test strategy for an individual patient can increase the likelihood of detecting glaucomatous progression. The most commonly used is a 24-2 test pattern with a size III stimulus, consisting of 54 test points spaced 6 degrees apart. The 24-2 test pattern has gradually replaced the 30-2 test pattern because little diagnostic information is lost and test time is reduced.¹ The Swedish Interactive Thresholding Algorithm (SITA) has supplanted the older full-threshold strategy and includes SITA Standard, SITA Fast, and SITA Faster. A 10-2 test covers the area within 10 degrees of fixation with a grid of test points 2 degrees apart. This testing strategy may be preferred in glaucoma patients with advanced VF constriction, or in those with scotomas close to fixation at any stage of disease. A study found 61.5% of eyes with glaucoma and 39.5% with a suspicion of glaucoma had VF defects on 10-2 testing that were missed with a 24-2 strategy.²

One shortcoming of 10-2 VFs is the lack of a reference database for progression analysis. However, an event-based algorithm similar to Guided Progression Analysis (GPA) for 24-2 and 30-2 SITA tests was recently developed.³ Using a size V stimulus with a 24-2 or 10-2 test pattern is another option for patients with advanced glaucoma or media opacities. The larger stimulus will extend the available range of sensitivities to monitor for progression. Unfortunately, nonstandard stimulus sizes cannot be used with the SITA testing strategies and require a more time-consuming algorithm (Fastpac or full threshold). Furthermore, the benefit of a normative database or GPA is not available with a size V stimulus.

Repeat Testing

Repeat VF testing should be performed soon after a patient is diagnosed with glaucoma because obtaining 2 similar and representative baseline tests is foundational to future management decisions. Development of a new VF defect or worsening of existing ones should prompt repeat testing. Clinical trials

have highlighted the importance of repeat testing to confirm or refute progression. Stricter endpoint criteria that included additional confirmatory VFs were adopted during the course of the Collaborative Normal Tension Glaucoma Study, and this protocol change reduced false calls of progression from 57% to 2%.⁴ In the Ocular Hypertension Treatment Study, 85.9% of new VF defects were not confirmed on repeat testing.⁵ However, high test-retest variability is characteristic of areas of VFs affected by glaucoma. Variable sensitivity measurements occurring in the same area, but not always in the same location, commonly precede definite glaucomatous VF progression.

At least 5 threshold VFs are generally needed to quantify how rapidly a patient with glaucoma may be progressing. It's particularly important for clinicians to identify patients who are experiencing rapid rates of progression that could result in visual disability. A study found the time to detect rapid progression (defined as mean deviation change of 2 dB/year) was 1.7 years with triannual testing compared with 5 years with annual testing.⁶ Therefore, it has been recommended that 3 VFs per year (including baseline tests) be obtained during the first 2 years of follow-up for newly diagnosed patients with glaucomatous VF loss. More frequent VF testing should be performed in glaucoma patients with field loss until they have been shown to be stable or progressing at an acceptable rate.

Guided Progression Analysis (GPA)

The Humphrey perimeter's GPA offers both event and trend analysis.⁷ Follow-up VF tests are compared to baseline VFs to quantify the amount and rate of change. Baseline tests should define the patient's status at a particular time, such as when therapy was started or significantly modified. GPA has been programmed to select by default the first 2 VFs as baseline. However, the clinician may choose other VFs to serve as the baseline tests, and GPA will remember these in subsequent follow-up examinations. The SITA testing strategies (SITA Standard, SITA Fast, and SITA Faster) may be freely intermixed in the upgraded GPA program.

Event analysis

The goal of event analysis is to determine whether there has been any statistically significant worsening in the VF. The GPA's Glaucoma Change Probability Map highlights test points on 24-2 and 30-2 VFs in which pattern deviation values have deteriorated from baseline by more than the expected range of testing variability found in glaucoma patients. Open, half black, and filled-in black triangular symbols indicate test points showing deterioration from baseline that is statistically significant at the $P < .05$ level on 1, 2, and 3 or more consecutive VFs, respectively. Test points that fall outside the range that can be analyzed for statistically significant change are marked with an "X." The GPA Alert posts a message based upon the criteria used for progression in the Early Manifest Glaucoma Trial.⁸ "Possible Progression" is displayed when the same 3 or more test points have shown statistically significant deterioration on

2 consecutive follow-up examinations, and “Likely Progression” is shown when this deterioration is seen on 3 or more consecutive follow-up tests.

Trend analysis

The aim of trend analysis is to quantify the rate of VF progression to help clinicians evaluate the risk of future visual impairment. The GPA trend analysis estimates the rate of progression using linear regression analysis of the Visual Field Index (VFI) over time. The VFI parameter summarizes a patient’s VF status as a percentage of normal age-corrected sensitivity, with 100% being a completely normal VF and 0% representing perimetric blindness. The GPA trend analysis is automatically calculated when 5 or more eligible VFs are available. A projection of the linear regression line into the future is provided by GPA, if 5 or more VFs covering at least 2 years’ area are available and if the width of the calculated 95% confidence interval for VFI slope is not greater than a VFI value of $\pm 2.5\%$.

Conclusions

Clinical trials have shown that many treated patients with glaucoma will progress, which is evident if perimetric testing is done regularly for multiple years.⁸⁻¹⁰ Selecting the best VF test strategy and establishing a baseline of VFs will assist clinicians in the detection of glaucomatous progression. If a VF change is suspected, repeat testing should be performed to confirm or refute progression. Humphrey’s GPA can assist in identifying and quantifying VF progression. Event analysis is an effective method for finding statistically significant perimetric glaucoma progression events, especially in the setting of clinical trials.

In clinical practice, statistically significant changes on event analysis can prompt examination of a patient’s trend analysis to determine whether clinically significant changes may be occurring. Perimetric progression rates vary widely among glaucoma patients. While some patients progress slowly and need little if any change in treatment, an important minority will progress at rates that lead to functional impairment if appropriate treatment is not implemented. More frequent VF testing for newly diagnosed patients with glaucomatous VF loss serves to identify rapid progressors.

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iStent: Ideal Patient, Key Pearls for Success, and Why I Didn't Do the Other MIGS

Sahar Bedrood MD PhD

- I. Introduction of iStent Inject
- II. FDA-Approved Indications for Use of iStent/iStent Inject
- III. The Ideal Patient
 - A. Patient with primary open-angle glaucoma in the mild to moderate stage on at least 1 IOP-lowering drop undergoing cataract surgery
 - B. Case presentation of ideal patient
- IV. Pearls for Success
 - Video montage/presentation pearls
- V. Real-World Data on Patient Outcomes
- VI. Personal Real-World Data for iStent Inject and IOP Lowering
- VII. Summary
 - Why I wouldn't use any other MIGS in these patients

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Hydrus: Ideal Patient, Key Pearls for Success, and Why I Didn't Do the Other MIGS

Craig J Chaya MD

NOTES

Goniotomy: Ideal Patient, Key Pearls for Success, and Why I Didn't Do the Other MIGS

Leonard K Seibold MD

I. Goniotomy Overview

- A. Long-standing procedure of choice in children
- B. Targets site of greatest aqueous outflow resistance in most cases
- C. Novel devices allow easier, more complete treatment of angle in adults
 - 1. Kahook Dual Blade
 - 2. Trabectome/TrabEx
 - 3. OMNI
- D. Excisional vs. incisional goniotomy
- E. Excellent IOP and medication reduction while maintaining safety
- F. Supreme versatility applicable in a wide range of patients

II. Ideal Patient

- A. Mild to moderate open-angle glaucoma, including pseudoexfoliation and pigmentary
- B. Coexisting cataract; can be performed in phakic or pseudophakic patients
- C. Open angle with well-delineated trabecular meshwork (TM) and other angle structures
- D. Compliant, cooperative patient, able to remain still
- E. No significant blood thinner usage
- F. Preop IOP of upper teens or higher on 1 or more medications
- G. Treatment goals
 - 1. Medication reduction of 1 or more
 - 2. IOP reduction to low to mid teens

III. Pearls for Success

- A. Practice on MIGS model eyes before first cases.
- B. Ensure sound intraoperative gonioscopy skills.
 - 1. Deepen anterior chamber with cohesive viscoelastic.
 - 2. Optimize head and microscope rotation to ensure "en face" view.
 - 3. Mag up.
- C. Use trypan blue or look for blood reflux to help visualize TM.
- D. Avoid limbal vessels during wound construction.
- E. Don't treat what you can't see.

F. Kahook Dual Blade/Trabectome

- 1. Start with blade angled 10-15 degrees up.
- 2. Initially apply some pressure to ensure footplate is well seated in canal.
- 3. Relax hand once seated to allow device to glide in the canal.
- 4. Too much pressure will rotate the eye.
- 5. Too little pressure will only scrape/incise superficial TM.

G. OMNI

- 1. Ensure cannula tip is through TM before deploying cannula; consider small blade/needle incision first.
- 2. Confirm correct placement of catheter in canal before goniotomy.
- 3. Retract catheter as cannula is withdrawn along angle.

H. Set postoperative recovery expectations preop.

- I. Consider continuing 1 medication postop until after steroid taper.

IV. Why I Didn't Do the Other MIGS

- A. No implant left behind to worry about as with iStent/Hydrus/Xen
- B. Optimizes natural outflow pathway rather than fistulous pathway with Xen
- C. More durable response with removal of tissue compared to temporary viscodilation of canal
- D. Avoids bleb and bleb-related complications of Xen
- E. Better IOP and medication reduction compared to iStent
- F. Greatest versatility to treat a wide variety of eyes
 - 1. Phakic or pseudophakic
 - 2. Mild, moderate, or severe disease
 - 3. Can be used in some angle closure patients as well
- G. Established procedure code without strict labelling limitations of iStent/Hydrus
- H. Much lower rate of hyphema than gonioscopy-assisted transluminal trabeculotomy with similar efficacy

Viscodilation: Ideal Patient, Key Pearls for Success, and Why I Didn't Do the Other MIGS

Mark J Gallardo MD

NOTES

Gonioscopy-Assisted Transluminal Trabeculotomy: Ideal Patient, Key Pearls for Success, and Why I Didn't Do the Other MIGS

Matthew E Emanuel MD

Minimally invasive glaucoma surgeries (MIGS) have offered ophthalmologists an alternative to traditional glaucoma surgeries such as trabeculectomies and glaucoma drainage implants. Rates of traditional surgeries have been declining since the advent of MIGS, and in 2017 nearly 75% of all glaucoma surgeries completed in the United States were MIGS.¹ In general, MIGS offer IOP reduction with a higher safety profile and quicker recovery. Over the last decade, various MIGS surgeries have been developed, most of which aim to bypass the trabecular meshwork via either a small intraocular implant or by excising the trabecular meshwork.

Gonioscopy-assisted transluminal trabeculotomy (GATT), initially presented in the literature in 2014, was the first technique described to cannulate the Schlemm canal and cleave the trabecular meshwork 360 degrees via a conjunctival-sparing ab interno approach.² GATT has a strong safety profile and can significantly lower IOP in various forms of glaucoma, ranging from primary and secondary open-angle glaucoma to traumatic and juvenile glaucoma.³

While the ideal patient for any glaucoma surgery may be difficult to identify, there are several factors that may increase the chance of success, particularly for a novice surgeon. Patients with obvious pathology in the trabecular meshwork are likely best suited for GATT. A number of the secondary open-angle glaucomas may be ideal first cases—specifically, pseudoexfoliation glaucoma and pigment dispersion glaucoma. These glaucomas are believed to be almost exclusively due to accumulation of deposits in the trabecular meshwork and have been shown to respond well to GATT. Additionally, since identifying angle landmarks on gonioscopy is so critical for a successful GATT surgery, these glaucomas typically have significant trabecular meshwork pigmentation and improve the surgeon's ability to successfully cannulate the Schlemm canal.

Another benefit of GATT is that it may be performed with or without cataract surgery. Nearly all patients having undergone GATT have intraoperative bleeding and a postoperative hyphema, though those having undergone concomitant cataract surgery tend to have less bleeding. Therefore, combining GATT with cataract surgery may be beneficial for first-time surgeons.

GATT is an effective and relatively safe MIGS that can be considered for a wide range of glaucoma patients. When initially performing GATT surgeries, ophthalmologists should take into account a few simple considerations to improve their chances of success.

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Xen Gel Stent: Ideal Patient, Key Pearls for Success, and Why I Didn't Do the Other MIGS

Analisa Arosemena MD

With glaucoma being one of leading causes of blindness in the USA, navigating the treatment options hand in hand with the patient is crucial. Once surgery is indicated, achieving the best outcome depends on matching the ideal surgery with the ideal patient.

The Xen Gel Stent is a porcine gel stent that bypasses the trabecular meshwork to drain the aqueous from the anterior chamber to the subconjunctival space. Placement of the implant is the key to success. Care should be taken to avoid intratenon placement, and depending on the patient, different implant approaches can be used. In the internal approach, patients need to have a healthy superonasal conjunctiva and a deep chamber, and we should avoid prominent cheek bones or deep-set eyes. The external approach (Xen-Ex) can be performed with open or closed conjunctiva. The closed conjunctiva is great for patients with previous glaucoma surgery since we can place the implant in the healthy conjunctiva between other surgeries. The open approach is best for patients with high risk of scarring since it can be combined with tenectomy. Patients with poor visibility due to cornea issues also benefit from the external placement. With the use of mitomycin C and steroids we can help prevent bleb scarring and decrease the need for needling of the bleb.

There is a high motivation to prevent complications from traditional glaucoma surgery, hypotony, expulsive choroidal hemorrhages, and bleb leaks, among others. Having a minimally invasive subconjunctival surgery allows us to reduce the risk of these complications.

The ideal patient for Xen gel stent is a patient with low risk of scarring, a deep angle without synechiae, and motile conjunctiva at the location of the implant placement. A healthy conjunctiva is ideal, and the patient should not have neovascularization or inflammation in the eye.

I choose Xen on patients who have to return to work and resume physical activity early in the postop period, since the post-Xen visual disturbance is minimal; it is my go-to surgery in patients with previous multifocal or toric IOLs—also in patients with previous glaucoma or retinal surgery, with limited conjunctival real estate, and patients that are anticoagulated, since it decreases the risk of hemorrhages and using the external closed approach minimizes the trauma to the eye.

Minimally invasive glaucoma surgery has revolutionized glaucoma management, allowing for faster recovery of vision and functionality, minimizing patient risk, and resulting in a high success rate. For most patients who require better IOP control you can offer this versus a trabeculectomy or a glaucoma drainage device.

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Are All Ciliary Body Destruction Procedures Created Equal?

Jenny Chen MD

- I. Understanding Patient Visual Goals
- II. Understanding IOL Options
 - A. Presbyopic
 - B. Toric
 - C. Light-adjustable lens
- III. Special Considerations for Glaucoma Patients
 - A. Contrast sensitivity
 - B. Ocular surface disease
 - C. Zonular stability
 - D. Progression of glaucoma
- IV. Summary

MythBusters: Real or Fake Indications and Contraindications

Kateki Vinod MD

I. MYTH: Prostaglandin analogues are contraindicated during the perioperative period of cataract surgery.

A. Background

1. Incidence and risk factors for pseudophakic cystoid macular edema (CME)
2. Proposed mechanism for prostaglandin analogue (PGA)-mediated pseudophakic CME

B. What does the evidence show?

1. Preoperative vs. continuous vs. postoperative PGA use and risk of pseudophakic CME
2. Role of topical nonsteroidal anti-inflammatory drugs

C. Conclusions and recommendations

II. MYTH: Laser peripheral iridotomy should be performed in every patient with a narrow angle.

A. Background

1. Modern classification of the narrow angle
2. Natural history of untreated primary angle-closure suspects

B. What does the evidence show?

1. Efficacy of laser peripheral iridotomy
2. Role of lens extraction

C. Conclusions and recommendations

III. MYTH: Selective laser trabeculoplasty (SLT) is a repeatable procedure.

A. Background

1. Role of SLT in management of open-angle glaucoma
2. Efficacy of initial SLT

B. What does the evidence show?

1. Efficacy of repeat SLT vs. initial SLT
2. Safety considerations

C. Conclusions and recommendations

Selected Readings

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Systemic Drugs and Glaucoma: The Effect of Various Systemic Medication on Open-Angle and Closed-Angle Glaucoma

Cara Capitena Young MD

I. Open-Angle Glaucoma: Corticosteroids

- A. Mechanism of action: Increased resistance of aqueous outflow through the trabecular meshwork
- B. Incidence: True incidence is unknown; likely 25%-33% of the general population.
- C. Time to onset
 1. Varies based on potency of steroid
 2. Most studies quote 3-6 weeks, but there are documented cases as early as 1 week.
- D. Culprits: Any and all steroids, though systemic use is less likely than topical formulations to cause IOP elevation
- E. Treatment
 1. Cessation of steroid treatment or alternative formulation ± topical and/or oral IOP-lowering therapy.
 2. Some cases are refractory to medical treatment and require surgical intervention.
- F. High-risk populations
 1. Patients with known history of steroid-induced ocular hypertension
 2. Patients with history of primary open-angle glaucoma or a first-degree relative with open-angle glaucoma
 3. Age: older adults and children
- G. What to tell your patients
 1. Known steroid responders and those at high risk: Educate them, consider IOP check 2-6 weeks after starting any new steroid.
 2. General patient population: Educate them that steroids can cause elevated IOP. Communicate with your eye care provider when you start a new one and call urgently for any eye pain or changes in vision after starting one.

II. Closed-Angle Glaucoma

- A. Classes of medications and more common offenders
 1. Sulfa derivatives: acetazolamide, hydrochlorothiazide, topiramate
 2. Adrenergics: nasal ephedrine, phenylephrine, epinephrine, salbutamol

3. Anti-cholinergics: ipratropium bromide, anti-histamines (eg, promethazine), TCA antidepressants (eg, imipramine), SSRI antidepressants (eg, fluoxetine), botulinum toxin
4. Anticoagulants: heparin, warfarin, clopidogrel
5. Monoclonal antibody: daratumumab
- B. Mechanism of action and typical associated medications
 1. Pupillary block
 - a. Adrenergics
 - b. Anticholinergics: Classically cough and cold medications, antidepressants, and some inhalers
 2. Anterior dislocation of the lens-iris diaphragm
 - a. Sulfa derivatives: Classic example is topiramate
 - b. Anticoagulants
 - c. Monoclonal antibody/chemotherapeutic agent
- C. Treatment: Depends on the etiology
 1. Pupillary block
 - a. Peripheral iridotomy
 - b. IOP-lowering meds as needed
 2. Anterior shifting of the lens-iris diaphragm
 - a. Cessation of medication
 - b. IOP-lowering medications and/or surgery if required
 - c. Iridotomy is *not* effective in these cases.
- D. What to tell your patients
 1. Discuss risks of these common medications with any patient with narrow angles, a history of angle closure, hyperopia.
 2. Discuss risk with patients on topiramate and anti-depressants. This commonly occurs within weeks of starting the medication, therefore it is important to discuss with your primary care, neurology, and psychiatry colleagues as well.

Targets of the Medication Pipeline: New and Emerging Treatments

David A Sola-Del Valle MD

NOTES

Alternative Therapeutic Treatments for Glaucoma

Angela R Elam MD

I. Introduction to Alternative Treatments for Glaucoma

A. Nutraceuticals

Morrone LA, Rombola L, Adornetto A, Corasaniti MT, Russo R. Rational basis for nutraceuticals in the treatment of glaucoma. *Curr Neuropharmacol*. 2018; 16(7):1004-1017. doi: 10.2174/1570159X15666171109124520. PMID: 29119928; PMCID: PMC6120110.

B. Exercise

Zhu MM, Lai JSM, Choy BNK, et al. Physical exercise and glaucoma: a review on the roles of physical exercise on intraocular pressure control, ocular blood flow regulation, neuroprotection and glaucoma-related mental health. *Acta Ophthalmol*. 2018; 96(6):e676-e691. doi: 10.1111/aos.13661. Epub 2018 Jan 16. PMID: 29338126.

C. Meditation

Dada T, Bhai N, Midha N, Shakrawal J, et al. Effect of mindfulness meditation on intraocular pressure and trabecular meshwork gene expression: a randomized controlled trial. *Am J Ophthalmol*. 2021; 223:308-321. doi: 10.1016/j.ajo.2020.10.012. Epub 2020 Oct 22. PMID: 33393484.

D. Cannabis

Merritt JC, Crawford WJ, Alexander PC, Anduze AL, Gelbart SS. Effect of marijuana on intraocular and blood pressure in glaucoma. *Ophthalmology* 1980; 87(3):222-228. doi: 10.1016/s0161-6420(80)35258-5. PMID: 7053160.

E. Antioxidants

Garcia-Medina JJ, Rubio-Velazquez E, Lopez-Bernal MD, et al. Glaucoma and antioxidants: review and update. *Antioxidants (Basel)* 2020; 9(11):1031. doi: 10.3390/antiox9111031. PMID: 33105786; PMCID: PMC7690615.

F. Mitochondria

Yang XJ, Ge J, Zhuo YH. Role of mitochondria in the pathogenesis and treatment of glaucoma. *Chin Med J (Engl)*. 2013; 126(22):4358-4365. PMID: 24238529.

II. Recommendations for Patient Care

Emerging Technologies in the Treatment of Glaucoma

Ahmara Gibbons Ross MD

Introduction

Each cell in our body contains inherited genetic material called deoxyribonucleic acid (DNA). This material contains information on how our bodies will function. Genes are made up of DNA and contain the “critical code” for building enzymes or proteins that will perform these essential bodily functions. Gene mutations can be inherited or can occur as cells age and are damaged.

What is gene- and cell-based therapy?

Gene therapy is the introduction, removal, or alteration of genetic material in a patient’s cells or organ. This transfer can repair a gene itself or compensate for a loss of gene function to treat a specific disease. Once our gene of interest, or target gene, is inside the cell, the therapeutic intervention will correct the disease phenotype by (1) reducing the levels of disease-causing proteins, (2) increasing production of disease-fighting proteins, or (3) producing new or modified proteins. It is important to acknowledge that most gene therapy or gene editing is targeted on monogenetic disease to correct a known mutation, making glaucoma difficult to address with this type of therapy.

How does gene therapy work?

Mainstream and scientific literature describes the aim of gene therapy as addressing human disease in 4 major ways:

1. Gene replacement: The target gene replaces a gene that does not work with a healthy functional one. This mechanism is often referred to as “loss of function.”
2. Gene silencing: The target gene inactivates a gene that has become toxic to cells. This mechanism is often referred to as “gain of function.”
3. Gene editing: Permanent manipulation of a patient’s genome
4. Gene addition: The target gene is overexpressed to impact a disease state.

The target gene is introduced into the patient’s cell using a vector to carry the genetic material. Thus far, the most promising vectors are those derived from viruses because of their ability to enter cells efficiently and with minimal damage. When viral vectors are used, all the genes from that virus are removed and replaced by engineered genes and consist of just the viral protein coats.^{1,2}

Table 1

Viral Vectors			Nonviral Vectors		
RNA Viruses	DNA Viruses		DNA Material		Protein
Retroviruses	Adenoviruses	Adeno-associated viruses	Liposomes	“Naked” DNA	Cell-based therapy

Table 2. Gene Therapy: Where Are We?

1990	1995	1999	2002	2008	2011	2012	2017
First human gene therapy for adenosine deaminase deficiency via retrovirus	First AAV treatment for cystic fibrosis	Unexpected death of Jesse Gelsinger due to complications from gene therapy for ornithine transcarbamylase deficiency	Discovery of AAV8	AAV2 gene transfer to treat LCA	AAV8 to treat hemophilia B and First CAR-T-cell therapy	Alipogene tiparvovec (Glybera) approved by the EMA	Voretigene neparvovec (Luxturna) approved by the FDA and Ex vivo gene therapy approved by FDA
	Positive safety outcome led to discovery of more AAV serotypes promoting more tissue-specific targeting, specifically, the eye	Learned a lot about regulations and selection criteria for gene therapy trials					

Abbreviations: AAV, adeno-associated viruses; LCA, Leber congenital amaurosis.

Where are we in the development of ocular gene therapies?

Adeno-associated viruses (AAV) are believed to be the future of gene therapy and have driven eye-related gene therapy treatment.³ As of 2019, there were 145 registered trials categorized on the basis of AAV capsid serotype. In these subsets of trials, over 25%-30% were designed for use in the eye. Most of these were identified as Phase 1 and 2 clinical trials.⁴

Two widely reported and concluded gene therapy trials for optic nerve disease are GenSight's RESCUE and REVERSE trials. These trials are separate Phase 3 trials evaluating the efficacy of a single intravitreal injection of GS010 in patients that sustained vision loss due to the 11778 mutation in the ND4 gene.⁵ These trials have paved the way for many of trials for optic nerve disease, more specifically glaucoma, in the form of gene- and cell-based therapy.⁶

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6. Information regarding active gene therapy trials can be found at the American Society of Gene + Cell Therapy's Clinical Trials Finder: <https://www.asgct.org/clinicaltrials>.

Table 3

Trials	Eye-Specific Diagnosis	Location	Trial Summary	Phase and Trial Endpoints
Dual Intravitreal Implantation of NT-501 Encapsulated Cell Therapy for Glaucoma22	Glaucoma	Stanford University	To determine the safety and efficacy of dual NT-501 CNTF encapsulated cell therapy (ECT) on visual impairment related to glaucoma	Phase 2 Endpoints: visual fields, structure measurement of GC-IPL and RNFL
Study of NT-501 Encapsulated Cell Therapy for Glaucoma Neuroprotection and Vision Restoration	Glaucoma	Stanford University	To determine efficacy of NT-501 CNTF encapsulated cell therapy on visual impairment from glaucoma	Phase 2 Endpoints: visual fields, structure measurement of GC-IPL and RNFL
Safety Assessment of Intravitreal Mesenchymal Stem Cells for Acute Non-arteritic Anterior Ischemic Optic Neuropathy	Ischemic optic neuropathy	Instituto Universitario de Oftalmobiología	To evaluate the safety of cell therapy as a new treatment for patients who suffer from acute non-arteritic anterior ischemic optic neuropathy (NAION)	Phase 2 Absence of ocular inflammatory reaction, adverse events that are procedure-related
Efficacy Study of Gene Therapy for the Treatment of Acute Leber's Hereditary Optic Neuropathy (LHON) onset within 3 months	Leber congenital optic neuropathy		To study the efficacy of rAAV2-ND4 (NADH dehydrogenase subunit 4) for the treatment of acute LHON onset within 3 months	Unassigned phase BCVA and visual fields
RESCUE and REVERSE Long-term Follow-up	Leber congenital optic neuropathy	GenSight Biologics	To assess the long-term and efficacy of GS010 and assess the quality of life in subjects with LHON due to the G11778A mitochondrial mutation in patients 5 years post treatment	Phase 3 Adverse events, BCVA, and HVF
A Single Intravitreal Injection of rAAV2-ND4 for the Treatment of Leber's Hereditary Optic Neuropathy	Leber congenital optic neuropathy	Huazhong University of Science and Technology	This study is meant to evaluate the safety and efficacy of rAAV2-ND4 treatment for Leber hereditary optic neuropathy with the G11778A mutation in mitochondrial DNA.	Phase 2/3 BCVA, VF, VEP, structure measurement of RNFL
Safety Study of an Adeno-associated Virus Vector for Gene Therapy of Leber's Hereditary Optic Neuropathy	Leber congenital optic neuropathy	National Eye Institute	To study the potentially toxic effects of scAAV2-P1ND4v2 in patient with LHON and the G11778A mitochondrial gene mutation	Phase 1 Assessment of toxicity

Abbreviations: CNTF, ciliary neurotrophic factor; HVF, Humphrey visual field; VF, visual fields; VEP, visual evoked potentials.

In These Unprecedented Times . . .

2021 Glaucoma Subspecialty Day

Donald L Budenz MD MPH

The COVID-19 pandemic has impacted us in many ways, including our ability to effectively raise critical funds used to protect sight and empower lives. This objective requires active participation and commitment to advocacy from every ophthalmologist. Contributions to the following three critical funds are a part of that commitment:

- OPHTHPAC®
- Surgical Scope Fund (SSF)
- State Eye PAC

During AAO 2021 in New Orleans, invest in OPHTHPAC and Surgical Scope Fund at one of our two booths in the convention center or [online](#). You may also invest via phone by texting MDEYE to 41444 for OPHTHPAC and SCOPE to 51555 for the Surgical Scope Fund.

We also encourage you to stop by our booth in the Hall B Lobby to learn more about [OPHTHPAC Direct](#), a unique program that lets you decide who receives your political support.

Please help us in these unprecedented times to continue to protect quality patient eye care for everybody. Two Academy committees made up of your ophthalmology colleagues are working hard on your behalf to ensure this outcome. 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 to be used to protect Surgery by Surgeons during scope battles at the state level.

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 strive, especially in these unprecedented times.

OPHTHPAC®

OPHTHPAC represents the profession of ophthalmology to the U.S. Congress. OPHTHPAC’s most recent victories include the following:

Physician Relief

- ✓ Securing access to COVID-19 relief, including Provider Relief Funds and forgivable small business loans
- ✓ Pushing Congress to enact a provider-friendly “surprise” medical billing law

Medicare Payment

- ✓ Mitigating drastic Medicare cuts
- ✓ Obtaining a one-year moratorium extension on the 2% Medicare budget sequestration cut

Research & Relationships

- ✓ Increasing vision research funding by \$11.6 million
- ✓ Helping get three new physicians elected to Congress, including an ophthalmologist

However, facing ophthalmology’s federal issues is a continuous battle, and OPHTHPAC is always under pressure to ensure we have strong political connections in place to help protect ophthalmology, its members, and their patients.

The support OPHTHPAC receives from invested U.S. Academy members helps build the federal relationships that advance ophthalmology’s agenda on Capitol Hill. These relationships allow us to have a seat at the table with legislators willing to work on issues important to us and our patients. We also use these congressional relationships to help shape the rules and regulations being developed by federal health agencies.

Get engaged with OPHTHPAC and help strengthen ophthalmology’s voice on Capitol Hill as we address the following legislative and regulatory issues this year:

- Improving Medicare physician payments
- Fighting optometric scope expansion in the Veterans’ Health Administration
- Obtaining relief from prior authorization and step therapy requirements that delay patient care
- Seeking solutions for rising drug prices and access to drugs in shortage
- Ensuring fair reimbursements for Part B drugs

At the Academy’s annual Congressional Advocacy Day, the Academy and the American Glaucoma Society (AGS) ensure a strong presence of glaucoma specialists to support ophthalmology’s priorities. AGS also supports participation of young ophthalmologists via the Academy’s Advocacy Ambassador Program. Ophthalmologists visit members of Congress and their key health staff to discuss ophthalmology priorities as part of Congressional Advocacy Day. The AGS remains a crucial partner with the Academy in its ongoing federal and state advocacy initiatives.

Surgical Scope Fund (SSF)

The Surgical Scope Fund (SSF) provides grants to state ophthalmology societies to support 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, has helped 41 state/territorial ophthalmology societies reject optometric scope-of-practice expansions into surgery.

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

Dollars from the SSF are critical to building complete, cutting-edge political campaigns, including media efforts (TV, radio, and social media), educating and building relationships with legislators, and educating the voting public to contact their legislators. These political campaigns help the SSF to protect patient safety 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 and to fight for patient safety.

The Secretariat for State Affairs thanks the American Glaucoma Society, who has joined state ophthalmology societies in the past in contributing to the SSF, and looks forward to its 2021 contribution. These ophthalmic organizations complete the necessary SSF support structure for the protection of our patients' sight.

State Eye PAC

It is increasingly important for all ophthalmologists to support their respective State Eye PACs because campaign contributions to legislators at the state level must come from individual ophthalmologists and cannot come from the Academy, OPHTHPAC, or the Surgical Scope Fund. 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 all fought on the state level.

ACTION REQUESTED: Support ophthalmology's advocacy efforts

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

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. Please be part of the community that ensures ophthalmology has a strong voice in advocating for patients.

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Surgical Scope Fund	OPHTHPAC®	State EyePAC
To protect patient safety by defeating optometric surgical scope-of-practice initiatives that threaten quality surgical care	Working across the political spectrum to advance ophthalmology and protect its members and patients at the federal level. 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	Campaign contributions, legislative education	Campaign contributions, legislative education
No funds may be used for campaign contributions or PACs.		
Contributions: Unlimited.	Contributions: Limited to \$5,000	Contribution limits vary based on state regulations.
Individual, practice, corporate, and organization	Personal and corporate contributions are accepted.	
Contributions are 100% confidential.	Contributions \$200 and above are on the public record.	Contributions are on the public record depending upon state statutes.

The Use of Mitomycin C in Traditional and Novel Glaucoma Surgeries

Michele C Lim MD

"The bleb is dead; long live the bleb!"

Although the minimally invasive glaucoma surgeries (MIGS) dominate much of the conversation about glaucoma surgical management, trabeculectomy surgery still reigns as king when striving for low IOPs. In addition, new "bleb-forming" MIGS are emerging as a tool to fill the glaucoma treatment gap between early and advanced glaucoma, and these surgeries still rely on the antifibrotic agent mitomycin C (MMC). Thus, it is still worthwhile for us to understand how the use of MMC evolved and continues to evolve and how it may affect bleb morphology in both traditional and novel glaucoma procedures.

The enemy of incisional glaucoma surgery success is the body's own propensity to heal an open wound, and glaucoma surgeons have tried for decades to modify bleb morphology and function. The antifibrotic agent MMC has been used in trabeculectomy surgery since 1990, and the traditional method of intraoperative application is with gel-foam sponges. Other methods of MMC application include the use of amniotic membrane-soaked tissue and the use of scleral patches or contact lenses soaked in MMC. In the past few years, a newer method of MMC application, by injection, has become widespread among glaucoma surgeons, and many younger ophthalmologists now train with this technique.

This lecture will review the evolution of wound-healing modulation and present current literature on the efficacy and safety of MMC injection. We will pay particular attention to how it may affect bleb morphology in trabeculectomy surgery as well as with the newer bleb-forming MIGS.

MMC and Trabeculectomy

The problem: In trabeculectomy surgery, the ideal bleb is diffuse, low profile, and minimally vascular. The scary bleb is one that is thin, cystic, avascular, and prone to leaks. The useless bleb is flat, scarred, and associated with poor IOP control. How do we create the ideal bleb?

- A. Review of methods to alter wound healing in trabeculectomy surgery
- B. The goals of wound healing modulation are 3-fold:
 1. Retard wound healing
 2. Promote ideal bleb morphology
 3. Improve IOP control
- C. Trabeculectomy: a brief history of MMC use
- D. Alternate methods of applying MMC during trabeculectomy surgery

E. Review of MMC injection for trabeculectomy: goals and published literature¹⁻⁴

1. Does it allow for better IOP control?
2. Does it promote more diffuse blebs?
3. Does it alter bleb vascularity?
4. Would we avoid focal, cystic blebs?

F. Advantages of MMC injection in comparison to sponge application

G. Preparation of MMC for injection

H. Safety of MMC injection for trabeculectomy surgery

MMC and MIGS

- A. The bleb-forming MIGS^{5,6} in the context of other MIGS
- B. MMC and clinical outcomes of bleb-forming MIGS
- C. Is bleb-formation in a MIGS different than that of a trabeculectomy?

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Home Tonometry

Jeffrey R SooHoo MD

I. Why measure tonometry at home?

- A. IOP is the only modifiable risk factor in glaucoma.
- B. IOP is typically measured for a few seconds a few times a year during office hours.
- C. We need to better understand IOP outside of office hours to understand the total range, variation, and peak IOP.
- D. IOP is dynamic, with short-, intermediate-, and long-term fluctuations.
- E. IOP fluctuations have been correlated with progression in some studies (and not in others).
 - 1. The Advanced Glaucoma Intervention Study (AGIS) and Collaborative Initial Glaucoma Treatment Study (CIGTS) found that fluctuation was associated with progression.
 - 2. The Early Manifest Glaucoma Trial (EMGT) and Ocular Hypertension Treatment Study (OHTS) found no relationship between fluctuation and progression.
- F. Other options for expanding IOP measurements, such as diurnal tension curves or 24-hour IOP monitoring, are time consuming and resource intensive.

II. Home Tonometry

- A. iCare home rebound tonometer
 - 1. IOP determined by deceleration and contact time
 - 2. Lightweight probe that does not require corneal anesthesia
- B. Studies have shown that use of iCare home is similar to Goldmann applanation.

III. Ideal Patients

- A. Pigmentary glaucoma, known fluctuations in IOP
- B. Considering surgery to smooth out IOP fluctuations, identify IOP rhythm
- C. Progressing despite in-office IOP at goal

IV. Practical Considerations

- A. Billing: No current billable codes
- B. Expensive: Could consider cash pay service (eg, rental fee per week)
 - 1. Limits use to patients with adequate resources or enrolled in a study
 - 2. Opportunity for philanthropy?
- C. Not suitable for all patients; not everyone can be trained
- D. No nocturnal data
- E. Still intermittent and not continuous data

V. Current Practice at the University of Colorado

- A. Clinical trials
- B. Patient rental

Virtual Reality Visual Fields

Yvonne Ou MD

- I. Why monitor visual fields using mobile VR headsets?
 - A. Low cost
 - B. Portability
 - C. Built-in lighting environment
 - D. No need for highly skilled examiner
 - E. Potential for testing in a wide variety of contexts
 - F. Potential for home testing
 - G. Frequent testing may overcome intertest variability.
 - H. Advantages/disadvantages compared to other portable strategies (eg, online testing, iPad, etc.)
- II. Indications for VR Visual Fields
 - A. Glaucoma screening and diagnosis
 - B. Remote settings
 - C. Testing bedridden or disabled patients
 - D. Home testing
 - E. Glaucoma progression evaluation
 - F. Teleglaucoma
- III. Variety of Platforms Incorporating Different Test Strategies
 - A. Subjective approaches requiring patient response; concordance with static automated perimetry
 - B. Objective approaches
- IV. Virtual Reality Oculokinetic Perimetry (VR-OKP)
 - A. Experience with VR-OKP in the clinic setting
 - 1. Test time
 - 2. Test-retest variability
 - 3. Correlation with static automated perimetry
 - 4. Structure-function relationship
 - B. Real-world experience with VR-OKP in the home setting
 - 1. Patient acceptance and remote training
 - 2. Test-retest variability
 - 3. Longitudinal testing at home
- V. The Future of VR Visual Fields
 - A. Heightened value in the setting of global pandemic
 - B. Development of improved testing algorithms
 - C. Prospective studies to determine its ability in monitoring glaucoma progression

Teleglaucoma

Glaucoma in the Digital Age

Lama A Al-Aswad MD MPH

I. Introduction

COVID and the digital transformation of the glaucoma practice

II. The Future Glaucoma Practice

A. Practice structure and models

B. Devices and technology

C. Remote monitoring

III. Conclusion

App-Based Visual Aids

Apps for Low Vision 2021

Terry Schwartz MD

Completing Assignments (note taking, scanning, completing worksheets)

Notability (iOS)

- Take notes, annotate PDFs, complete worksheets, markup photos, record lectures, provide audio feedback, and more
- Take notes directly on PDF slides
- Teachers email a worksheet, the student completes it and then returns via email to the teacher.
- Create folders/dividers to organize and save work.

OneNote (Microsoft, Android)

- Free app like Notability

Audionote (iOS, Mac, Windows, and Android)

- Notes linked to voice recordings (instant seek), automatically adapts to room size and volume level.
- Notes automatically highlight and scroll with audio playback.
- Take notes directly on PDF slides
- Notes can be organized by subject.
- Can sync between devices (iCloud, Dropbox)

Joinme (iOS, Android)

- Screen sharing/meeting app
- Allows direct access to instruction on a white board or teacher's computer onto the student's tablet
- Presentation size can be enlarged
- Screenshots can be kept as notes
- School buys the "basic" version (about \$10/month), and the student downloads the app (free of charge).

Genius Scan (iOS, Android)

- Scan single or batch documents with phone/tablet and create a PDF
- Take a photo; app automatically recognizes the paper against the background, crops it, and cleans up the result. Upload PDF document to complete assignments.

Apple accessibility options

- <https://support.apple.com/accessibility>
- www.applevis.com

Chromebook

- <https://www.controlaltachieve.com/2016/10/special-needs-extensions.html?m=1>

Android accessibility options

- <https://support.google.com/accessibility/android/answer/6006564?hl=en>

Books

Bookshare (www.bookshare.org)

- Huge online library (400,000 digital books) for people with print disabilities
- Confirmation of low vision/blindness, physical or learning disability by a professional (eg, MD, OD, teacher) is required.
- Various formats are available (eg, text to speech, digital braille, enlarged fonts).
- Free for U.S. students (funded by Office of Special Ed Programs, U.S. Dept of Ed). Nonstudents pay a nominal fee.

Bard Mobile (iOS, Android)

- BARD app allows users to download and listen to books and to read braille books using a Bluetooth-connected braille display.
- Library includes books, magazines, music instruction, and music scores. New selections added daily.
- Must enroll in the National Library Service for the Blind and Print Disabled (NLS) at the Library of Congress. To enroll, call 1-888-NLS-READ (1-888-657-7323) and follow the prompts for your state or request enrollment information at <https://www.loc.gov/thataillmayread>.

Voice Dream Reader and Scanner (iOS, Android)

- Reading tool with dyslexia friendly font, text and audio synchronization, customizable font size and color combinations, and full VoiceOver support.
- Options include navigation by sentence, paragraph, page, and chapter. Can add bookmarks, notes, and highlights.
- Many file formats are supported, including DAISY 3.0 text-only, DAISY 2.02 audio, DRM-free EPUB, PDF, Microsoft Word, Microsoft PowerPoint, HTML, and zipped MP3 files.
- Integrated with Bookshare and Gutenberg
- It can load files from Dropbox, Google Drive, or iTunes via USB or Wi-Fi.

KNFB reader (iOS, Android)

- Optical character recognition (OCR) reader for auditory access of printed material

Accessibility: Narrating the Visual Environment (Read short text and cursive, currency, description of scenes, facial recognition, colors)

Seeing AI (iOS)

- Free app that describes short text, documents, products, people, currency scenery, colors, handwriting, and light levels
- Scans barcodes (with the help of sounds to help focus) to describe a product

- Description of people (eg, estimates person's age, facial expression)
- Available in multiple languages

Lookout by Google (Android)

- Similar app to Seeing AI—same concept but limited
- Can read barcodes, currency, objects, short text, document scan, and OCR

TapTapSee (iOS) (Android)

- Uses AI and human to interpret photographed objects/scenes verbally
- Double-tap the screen to photograph any 2- or 3-dimensional object at any angle, and have it accurately identified within seconds. VoiceOver then narrates the findings.

Dentifi (iOS)

- Uses AI to recognize virtually any object, brand, color, facial expression, handwriting, or text, and subsequently deliver an audible description of the image's contents to the user.

BeSpecular (iOS) (Android)

- A photo, taken by the user, is sent (along with a voice message/query) to the BeSpecular community of sighted, who respond with a voice or text message.
- Response time is within minutes.

ViaOpta Hello (iOS) (Android) (Windows)

- Face recognition and environment description; identifies people, items, and scenes
- Available in 12 languages (English, German, French, Spanish, Arabic, Japanese, Chinese, Greek, Portuguese, Dutch, Italian, and Hungarian).

Navilens (Android, iOS)

- QR code reader and creator. Create QR codes for placing on objects.

Be My Eyes (iOS) (Android)

- Free app that connects blind and low vision people with sighted volunteers and company representatives for visual assistance through a live video call

Cinema, TV

Audio description

- This is a form of narration that supplements movies and TV. Descriptions are spoken between dialog and pertinent sound effects, providing content of on-screen action, facial expressions, and other relevant visual elements. Ideally, it can enable a totally blind person to understand the overall story as well as individual moments.

- Netflix and Amazon include audio descriptions on all original programs, as does DirectTV. Every movie theater now has descriptive audio headsets.

Greta (iOS, Android)

- Enables people with sight or hearing loss to experience fully accessible cinema (including foreign language subtitles and audio). It whispers audio descriptions or plays subtitles.

Navigation

Microsoft Soundscape (iOS)

- A research project exploring the use of audio-based technology
- As the user walks, it automatically calls out key points of interest, including roads and intersections being passed.
- An audio beacon can be placed on a point of interest that the user would like to track (eg, the destination, a point to return to, a familiar landmark).
- It is designed to live in the background and provide the user with ambient awareness and can be used in conjunction with other apps.

BlindSquare (iOS)

- A GPS app developed for the blind and visually impaired that describes the environment and announces points of interest and street intersections during travel

Intersection Explorer (Android)

- Speaks the layout of streets and intersections in neighborhoods by touching and dragging finger around a map to create an understanding of an area before and during walking

Arianna Navigation (iOS, Android)

- Navigation for indoor environments (eg, airports, museums, hospitals) and outdoors. High precision localization services against a simple and cheap infrastructure. Through special vibrational signals the user receives feedback for correcting their direction.

Lazzus (iOS, Android)

- Creates an auditory field of vision in real time, pointing out pedestrian crossings, street intersections, stairs, and businesses
- Sources Google Places and Open Street Map and searches within a 100-meter radius, highlighting information on things that are near to the user
- Converts text to speech

Deep Learning/Artificial Intelligence

Anthony Khawaja MBBS

Introduction

Machine learning has been an established technique for many years, and research applying it to ophthalmology and glaucoma is not new. A PubMed search identifies papers on artificial intelligence (AI) and glaucoma from as early as 1985. However, it was the development of a type of machine learning called “deep learning” that provided a step change in the performance of AI algorithms. In particular, deep learning excels at image classification, and it first outperformed humans in 2015. Early deep learning successes in medicine were for classification of skin lesion images as benign or malignant and classification of diabetic retinopathy status from fundus photos. In last few years, the number of deep learning studies in ophthalmology and glaucoma has risen exponentially, opening up possibilities for improved and more efficient care of our patients.

How Might AI Transform Glaucoma Care?

There are many potential uses for AI across the spectrum of glaucoma management, from community to specialist care. Given the irreversible nature of glaucoma, early detection is important for preventing blindness, yet in most health systems, general population screening for glaucoma is not recommended. This is in part due to the poor performance of tests when applied to populations with a relatively low disease prevalence (too many false positives).

AI may help identify a high-risk subset of the general population who should be screened through automated image analysis, or help refine or triage referrals to reduce false positives and specialist service burden. AI may also help with specialist monitoring of low-risk glaucoma patients. With the aging population, the number of glaucoma patients is growing rapidly and many are low-risk, diverting attention/resources from those who need it most. In the future, AI may in part automate or support follow-up decisions for low-risk patients and help risk stratify patients.

Highlights of AI Successes in Glaucoma

Given the large volume of recent high-quality glaucoma-related AI research, I will present a nonexhaustive selection that aims to highlight the breadth of progress. There has been notable success in AI algorithms that can accurately classify fundus/disc photos for “referrable glaucoma” (this term is used because a firm diagnosis cannot be made from photographs alone in the majority of cases). For example, an AI algorithm trained and validated by Google Health performed extremely well in independent datasets where the ground truth of “referrable glaucoma” was graded by multiple glaucoma experts. In fact, the AI algorithm outperformed any single glaucoma specialist, suggesting it can perform at a level approaching a consensus expert decision. Of course, this is an unfair contest, given that physicians usually have much more information before making a diagnosis, including history, fields, and other imaging.

There have also been successful demonstrations of classifying visual field and OCT data for glaucoma, though many of these studies are smaller and the validation was not done in a completely independent population. Notable studies include demonstration of superior diagnostic accuracy of an AI algorithm with an unsegmented circumpapillary OCT image as input compared to global segmented indices, and the ability to predict OCT indices from a standard fundus photo. Multimodal algorithms that incorporate multiple different forms of input data to create one improved classification output are emerging and may ultimately be a useful approach for diagnosing glaucoma. Studies have also been conducted to automatically classify angle closure from anterior segment OCTs.

Another class of machine learning is a generative adversarial network (GAN). GANs have been trained to predict spectral domain OCT images from time-domain OCT images, suggesting future possibilities to extract more meaningful information from noisy data that was not previously possible. A particularly striking finding in the ophthalmic AI literature is not directly glaucoma related: the ability to predict biological sex from just a fundus photograph with a very high degree of accuracy (AUROC 97%). The fact that humans collectively are unable to do this task opens up the possibility of AI algorithms detecting other human-imperceivable patterns that are glaucoma-relevant and can help us better manage our patients' care.

Challenges in AI Research

There will be multiple challenges to translating AI research findings into deployable tools with proven clinical utility. It is extremely important that algorithms are trained on datasets that are as diverse as possible, so that the algorithm generalizes well and works in a variety of populations. For example, an algorithm largely trained on people of European descent may not work well in non-Europeans, limiting its equitable impact.

Another issue facing the ophthalmic research community is a lack of open standards among imaging device manufacturers, limiting the large-scale analysis required to train AI algorithms. The American Academy of Ophthalmology has recently published a statement, supported by other organizations such as the UK Royal College of Ophthalmologists, calling for device manufacturers to become compliant with Digital Imaging and Communications in Medicine standards.

Selected Readings

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James C Liu MD

NOTES

Clinical Trial Update for Bimatoprost Implant

Felipe A Medeiros MD

I. Background on the Bimatoprost Implant

- A. The bimatoprost implant is a biodegradable implant that is administered intracamerally with a single-use applicator and releases bimatoprost at a steady rate for 3-4 months.
- B. The implant dose strength containing 10 µg bimatoprost is approved by the USFDA for single administration to lower IOP in patients with open-angle glaucoma (OAG) and ocular hypertension (OHT).
- C. In vitro assays, aqueous samples taken when the implant was removed from human eyes, and pharmacokinetics studies using dogs predict drug release and intraocular drug bioavailability for 3-4 months after implant administration.¹
- D. Drug distribution studies in dogs have shown that the implant provides 4400-fold higher concentrations of bimatoprost in outflow tissues compared with topical dosing, while minimizing ocular surface and periocular tissue drug exposure.²

II. Two identically designed, 20-month, Phase 3 studies compared 10- and 15-µg bimatoprost implants, administered on Day 1, Week 16, and Week 32, to twice-daily timolol eye drops in patients with OAG and OHT.

- A. Results of the ARTEMIS 1 study have been reported:¹
 1. Bimatoprost implant was noninferior to topical timolol in IOP lowering over 12 weeks.
 2. Efficacy of the implant was demonstrated in patients regardless of prior treatment with a topical prostaglandin analog or selective laser trabeculoplasty (SLT).
 3. An extended duration of IOP-lowering effect was observed in the majority of patients after 3 implant administrations, and most patients required no additional (rescue) IOP-lowering treatment for 1 year after the third administration.
- B. The ARTEMIS 2 study was completed more recently; the results were consistent with and corroborated those of the ARTEMIS 1 study.
- C. In Cox regression analysis to identify factors potentially associated with a longer-term IOP response in the pooled ARTEMIS studies, baseline IOP ≤25 mmHg, IOP lowering of >5 mmHg from baseline at the last measurement before the third administration, no history of SLT, female gender, and phakic lens status were significantly associated with a

longer time to rescue after the third administration of the 10-µg bimatoprost implant.³

III. A 24-month ongoing extension study enrolled OAG/OHT patients after their completion of a bimatoprost implant Phase 3 trial.

- A. An interim analysis using all data available as of February 2021 evaluated IOP and use of added (rescue) IOP-lowering treatment for patients who were treated with 10- or 15-µg bimatoprost implant in ARTEMIS 1 or 2.
 1. Of 200 patients enrolled in the extension study, 69 were unrescued at screening, 54 remained unrescued for ≥2 years, and 18 remained unrescued for ≥3 years after their last bimatoprost implant administration.
 2. The mean IOP in these patients remained controlled for 2 and 3 years after the last implant administration (17.3 and 16.6 mmHg, respectively).
- B. These results suggested that some patients can maintain controlled IOP without additional treatment for up to 2-3 years after their last bimatoprost implant administration in a Phase 3 trial.

IV. The proposed mechanism for the long duration of response is matrix metalloproteinase (MMP)-mediated durable remodeling of aqueous outflow pathways.⁴

- A. The mechanism of IOP lowering with prostaglandin analogs such as bimatoprost involves upregulation of MMPs and MMP-mediated turnover of the extracellular matrix, leading to decreased resistance to aqueous outflow.
- B. Studies using cell cultures have shown that the upregulation of MMPs by bimatoprost is concentration dependent.
- C. The higher concentrations of bimatoprost produced in target tissues by the implant are proposed to cause enhanced upregulation of MMPs, resulting in more durable tissue remodeling and sustained IOP lowering.

V. In safety evaluations in the ARTEMIS studies, the bimatoprost implant was usually well tolerated; however, corneal adverse events (AEs), mostly corneal endothelial cell loss (CECL) and edema, were reported more frequently in study eyes treated with the implant than in study eyes treated with topical timolol.

- A. The corneal AEs generally occurred after repeated administration and were more common with the 15-µg implant, which is 50% larger than the 10-µg implant.

- B. The rate of implant biodegradation is slow, and with the 4-month fixed interval administration used in the ARTEMIS studies, as many as 3 implants were present in the angle at the same time. Clinically significant implant biodegradation (to $\leq 25\%$ of the initial size) was observed in the majority of patients by 12 months after administration.⁵
- C. The corneal AEs are believed to result from physical interaction between the implant material and the cornea, and so are more likely to occur when multiple implants that have not yet biodegraded to $\leq 25\%$ of their initial size are present.
- VI. A single administration of 10- μ g implant is FDA approved because no eyes in the ARTEMIS studies or in a previous Phase 1/2 study⁶ had $\geq 20\%$ CECL after a single administration.
- VII. Ongoing studies are evaluating the safety and efficacy of as-needed administration of the implant with longer administration intervals.

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Potential Scientific Basis for Sustained Response to Implant

Douglas J Rhee MD

NOTES

[illegible]

Synthesizing the Clinical and Basic Science Information for This Patient

Qi N Cui MD

Summary: This is the last in a series of talks centered on the bimatoprost implant. It will closely tie-in with the data presented earlier in the same section. Briefly, the presentation will synthesize available scientific and clinical trials data on the bimatoprost intraocular implant to arrive at an informed treatment decision for the patient in the case presentation.

- I. Summary of Scientific Mechanisms-of-Action Relevant to the Case Presentation
- II. Summary of Clinical Trials Data Relevant to the Case Presentation
- III. Patient Factors Relevant to Treatment
- IV. Recommended Treatment Course
- V. Discussion of Pitfalls and Alternatives

Best of AGS: Surgery in the Advanced Angle-Closure Patient

Sarah H Van Tassel MD

We all have patients in our practices with chronic angle closure and severe structural and functional loss. The decision about appropriate treatment may differ, depending on whether the patient is phakic with cataract, phakic without cataract, or already pseudophakic.

I. Phakic With Cataract

- A. Cataract surgery in the angle-closure patient: In eyes with visually significant cataract and chronic angle-closure glaucoma, the decision to pursue cataract surgery is easy, but these cases can be among the toughest. Prepare for challenges:
 1. Posterior synechiae: Lift gently rather than sweeping to avoid tearing iris root.
 2. Posterior pressure: Pretreatment with acetazolamide, osmotics, or a Honan balloon can decompress the vitreous and choroid and lessen the posterior pressure.
 3. Malyugin ring, iris hooks, or similar for small pupils; keep the iris away from the wounds.
 4. Avoid iris prolapse: Longer incision, gentle hydrodissection
 5. Avoid chamber shallowing with the help of continuous irrigation and viscoelastic devices.
 6. Look out for zonular issues, which are common in angle closure.
 7. Review axial length: Some angle-closure eyes are microphthalmic and nanophthalmic, and in a study of such eyes, shorter axial length and IOP 22 or higher were independent risk factors for complications, with the odds of complications rising quickly as axial length shortened.¹
- B. Real-world IOP lowering from cataract extraction (CE) IOL: Cataract surgery alone can have a substantial IOP-lowering effect. For example, Wang and colleagues² extracted data from EHRs and demonstrated that narrow- and closed-angle eyes experienced a mean decrease in IOP of about 2 mmHg. However, we're often targeting a far greater IOP reduction from surgery, and the question arises, "What else should I do at the time of cataract surgery?"
- C. What else should I do at the time of cataract surgery?
 1. Synechialysis: Mixed results in the literature; synechialysis has been mostly eclipsed by enthusiasm for minimally invasive glaucoma surgery (MIGS) and can be combined with MIGS.
 2. MIGS: Histopathologic work has demonstrated that persistent trabecular-iris contact plays a causal role in the progressive process of Schlemm canal endothelial damage, Schlemm canal occlusion, and trabecular cell damage and that gonioscopic evaluation of the extent of peripheral anterior synechiae may not truly reflect the extent of trabecular damage. Therefore, it's very intellectually satisfying to pursue excision or cleaving of the trabecular meshwork or dilation of Schlemm canal as strategies targeted at this diseased tissue. While these advanced angle-closure eyes can be exquisitely sensitive to angle surgery, there is little high-quality evidence to demonstrate whether this approach is superior to cataract surgery alone.
 3. Endoscopic cyclophotocoagulation (ECP): Targets inflow rather than outflow
 4. Traditional surgery: Combining incisional glaucoma surgery with cataract extraction in advanced angle-closure eyes is also an option. Studies investigating this pathway have shown greater angle opening and anterior chamber deepening in cataract surgery alone compared with combined cataract and trabeculectomy.³ Additionally, cataract surgery combined with trabeculectomy has been shown to have more postoperative complications and mixed results as to whether there is a clear IOP or medication advantage.^{4,5} While I am generally a proponent of combined cataract and glaucoma surgery when appropriate, I find that angle-closure glaucoma is often an exception. These eyes can be exquisitely sensitive to cataract surgery/MIGS even in advanced disease.
 5. Important considerations include your access to, comfort with, and results from these surgeries. With ECP in particular, give consideration to the patient's risk of postoperative inflammation. Consider combining surgical approaches. In some of these eyes, you'll end up returning to the OR for incisional surgery and discussing that possibility with the patient, as well as understanding that the ease of that in your environment is important. Finally, more research is needed to enhance our knowledge in this area to determine a more accurate prediction formula for the surgical outcome rather than relying on a best guess.

II. Phakic, No Cataract

Controversy arises when the lens is relatively clear without visually significant cataract. Important considerations in these eyes include noting whether the patient still accommodates, which may motivate one to leave them phakic. Deciding whether to perform a tube or a trab can be challenging because studies like the Primary Tube vs. Trabeculectomy study excluded eyes with narrow angles.

If you opt for a tube, ensure there is space in the anterior chamber for the tube to be distanced from the endothelium. Paying attention to the lens thickness and vault in a particular patient may provide insight into the role of the lens in that person's disease and further guide decision making. In patients with combined exfoliation and angle-closure glaucoma, I have a strong preference for early cataract extraction because the zonulopathy can be tremendously challenging in the dense cataracts that often follow incisional surgery.

III. Already Pseudophakic

- A. All of the options discussed thus far remain viable, and I typically move forward with incisional surgery in the setting of the advanced disease eye.
- B. Tube considerations: We now have high-quality evidence demonstrating that sulcus tube placement is better for the corneal endothelium than anterior chamber placement. Sulcus placement in angle closure is also nice because it prevents you from getting tangled in high peripheral anterior synechiae as you attempt optimal tube placement.

IV. Summary

The best surgical strategy for advanced angle-closure glaucoma is not clearly defined. If appropriate, remove cataract. Consider nonincisional surgery (ie, ECP, MIGS, synechialysis) options for lowering IOP at time of CE IOL, even in advanced cases. Proceed with incisional surgery as indicated. Consider sulcus tube placement.

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Best of AGS: Surgery in the Advanced Uveitic Glaucoma Patient

Keith Barton MBBCh

Intraocular pressure (IOP) elevation is a common complication of uveitis, affecting roughly 20% of uveitics. IOP elevation may result from any or several of the following mechanisms: inflammation, corticosteroid treatment, chronic synechial angle closure, pupil block from a secluded pupil, or forward movement of the lens-iris diaphragm. The IOP in uveitis may swing widely, from extremely high to very low levels, as a result of reduced aqueous production by a compromised ciliary body in the presence of outflow resistance that is elevated as a result of the above mechanisms. In general, the role of the glaucoma specialist is to take IOP out of the equation in order to permit the uveitis specialist to treat the patient's inflammatory disease to an appropriate degree to prevent further inflammatory damage to the eye without risk of IOP elevation from corticosteroid usage.

While there are many surgical options for the control of IOP—most of which may not be specifically licensed for use in patients with uveitis but nevertheless may have some utility in patients with uveitis—patients with advanced uveitic glaucoma, like advanced glaucoma of any type, require definitive IOP control as the risk of severe visual loss is high, should any progression of optic neuropathy occur. For that reason, many of the newer procedures, the IOP-lowering benefits of which are largely modest, are not appropriate for patients with advanced uveitic glaucoma, and it is usually necessary to fall back on the more definitive conventional procedures, such as trabeculectomy with mitomycin C and aqueous shunt implants.

Basic Points

- I. Control inflammation in preference to withholding steroids to minimize IOP elevation.
- II. Identify the patient with advanced glaucoma who is at risk of severe visual loss.
 - A. Advanced field loss
 - B. Paracentral field loss
- III. Identify mechanism(s) of IOP elevation.
 - A. Corticosteroid response
 - B. Inflammation
 - C. Angle closure
- IV. If angle closure, identify type.
 - A. Pupil block vs.
 - B. Chronic peripheral anterior synechial closure vs.
 - C. Forward movement of the lens-iris diaphragm

Also look for other angle abnormalities, such as neovascularization and inflammatory nodules.
- V. Management
 - A. Correct pupil block if present.

1. Uveitic pupil block is fundamentally different from pupil block in primary angle closure (PACG).
 - a. Absolute (uveitis) vs. relative (PACG)
 - b. Iris reversibly adherent to trabecular meshwork due to fibrin and sticky aqueous (uveitis) vs. iris falls away from trabecular meshwork immediately on laser iridotomy (PACG)
 2. Laser iridotomy is often ineffective at reversing pupil block in uveitis due to:
 - a. Loculation of aqueous behind iris, thick iris with adhesions to lens
 - b. Even if pupil block is relieved by iridotomy, iris remains adherent to trabecular meshwork and even peripheral cornea.
 - B. Chronic synechial closure is not specifically treated, as angle surgery is ineffective.
 1. Patients are treated similarly to those with secondary open-angle glaucoma.
 2. Chronic synechial closure is a predictor of a long-term IOP problem that is unlikely to resolve on steroid withdrawal.
 - C. Identify the likely IOP level required: In the Advanced Glaucoma Intervention Study, a mean IOP of 12 mmHg resulted in a 13% risk of progression over 8 years.
- VI. Surgical Management of IOP Elevation in Association With Uveitis
- A. When to consider surgery?
 1. Acute angle closure with pupil block and a secluded pupil: Surgical iridectomy with viscosynechiolysis
 2. Acute angle closure from forward movement of the lens-iris diaphragm: Treat the cause—posterior scleritis, Vogt-Koyanagi-Harada syndrome, iatrogenic after retinal surgery, aqueous misdirection, phacomorphic.
 3. Uncontrolled chronic secondary synechial angle closure: In advanced glaucoma, trabeculectomy vs. aqueous shunt
 4. Uncontrolled secondary open-angle glaucoma: In advanced glaucoma, trabeculectomy vs. aqueous shunt
 - B. The role of MIGS/angle surgery in advanced uveitic glaucoma

First System for Robot-Assisted Ab-Interno Gonio-Intervention: From Stent Implantation to Trabeculotomy

Tsontcho Ianchulev MD

NOTES

Status of the CMS Bundling for MIGS and How We Got There

Leon W Herndon Jr MD

NOTES

Lens-Related Glaucoma and Considerations for Surgical Management

Glaucoma and the Native Lens

Thomas W Samuelson MD

I. Introduction

The native lens plays a pivotal role in the pathogenesis and management of many adult-onset glaucomas. While the importance of the lens has been long recognized in many forms of glaucoma—including phacomorphic narrow- and closed-angle glaucoma; pupillary block glaucomas, including microspherophakia and ectopia lentis; and various lens-related secondary glaucomas, such as phacolytic and phacoantigenic glaucoma—there is a growing body of empiric evidence that the native lens may play an important role in adult-onset open-angle glaucoma. While the role of the lens is especially important in the surgical management of phakic glaucoma, there is growing circumstantial evidence that the native lens may have important implications in the pathogenesis of some forms of primary open-angle glaucoma (POAG).

II. Lens-Related Glaucoma

A. Pupillary block

1. Primary phacomorphic narrow-angle glaucoma
2. Microspherophakia
3. Ectopia lentis

B. Lens-related secondary glaucomas

1. Associated with hypermature or Morgagnian cataract with leakage of lens proteins through an intact capsule. Generally associated with an open angle and variable inflammatory anterior chamber reaction. Treatment includes anti-inflammatory medications, IOP-lowering medications, and ultimately surgical removal of the native lens.

2. Lens particle glaucoma

Similar to phacolytic glaucoma in presentation and management, but an important differentiating feature is a disrupted lens capsule, which makes surgical intervention more complex. Identifiable lens material is often visible in the anterior chamber.

3. Phacoantigenic (aka phacoanaphylactic)

Not a true allergic reaction to lens material but rather an immune-mediated inflammatory response to residual lens material. Definitive diagnosis is made with aqueous aspirate and identification of polymorphonuclear leukocytes, but this is rarely needed as removal of the residual lens material is generally the recommended treatment.

C. POAG?

A provocative question to consider . . . Does phacomorphic open-angle glaucoma exist? The evidence is mostly circumstantial. Consider that POAG and cataract often coexist, the incidence of each condition being more common with aging.

In addition, there is extensive level-one evidence that cataract removal lowers IOP when the baseline IOP is higher than physiological and that this reduction is sustained for at least 4-5 years. Thus, if cataract removal lowers IOP, one must consider that the reverse may be true as well. Specifically, that the native lens may play a causal role in the elevation of IOP in some individuals. The native lens thickness increases with normal aging, and the anteroposterior diameter is directly related to age. In one study, the thickness of the cataractous lens was directly proportional to age, with a mean of 3.78 (± 0.21) mm in the 3rd decade and a mean of 5.03 (± 0.46) mm in the 10th decade. It is quite plausible that the increased anteroposterior diameter of the native lens results in forward rotation of the ciliary muscle-scleral spur complex, resulting in relative compression of the trabecular meshwork and reduction of conventional outflow, even if the angle remains open. A typical IOL is 1 mm in thickness. Accordingly, cataract removal with placement of an IOL widens the iridocorneal angle, which may favorably influence physiologic outflow by relaxing lens-induced compression of the trabecular meshwork.

III. Management of Coincident Cataract and Glaucoma

A. Phacoemulsification alone

B. Combined phacoemulsification and canal-based glaucoma surgery

1. Trabecular microbypass with device
2. Incisional goniotomy
3. Excisional goniotomy
4. Viscodilation of Schlemm canal

C. Combined phacoemulsification and transscleral (bleb forming) surgery

1. Gel stenting surgery
2. Traditional trabeculectomy
3. Traditional aqueous drainage devices

- D. Combined phacoemulsification and cyclophotocoagulation (CPC)
 - 1. Transscleral diode CPC
 - 2. Transscleral micropulse CPC
 - 3. Endoscopic cyclophotocoagulation

Selected Readings

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3. Samuelson TW, Chang DF, Marquis R, et al.; HORIZON Investigators. A Schlemm canal microstent for intraocular pressure reduction in primary open-angle glaucoma and cataract: the HORIZON study. *Ophthalmology* 2019; 126(1):29-37.
4. Ahmed IK. 5-year results from the Horizon Trial: long term safety and effectiveness of combined phacoemulsification and minimally invasive glaucoma surgery with the Hydrus microstent. American Glaucoma Society Virtual Annual Meeting; Mar. 4-7, 2021.

Aphakic Glaucoma

David S Walton MD

NOTES

Uveitis-Glaucoma-Hyphema Syndrome

Iqbal K Ahmed MD

NOTES

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Premium and Toric Lenses in Glaucoma Patients

John P Berdahl MD

- I. Understanding Patient Visual Goals
- II. Understanding IOL Options
 - A. Presbyopic
 - B. Toric
 - C. Light-adjustable lens
- III. Special Considerations for Glaucoma Patients
 - A. Contrast sensitivity
 - B. Ocular surface disease
 - C. Zonular stability
 - D. Progression of glaucoma
- IV. Summary

Fix It With an Anterior Chamber IOL

AC-IOLs in Cases That Lack Capsular Support

Kendall Donaldson MD

- I. Indications: Choosing the Right Patient and Situation
 - A. Age
 - B. Comorbid conditions
 - C. Situation
 - 1. Planned
 - 2. Unplanned
- II. Recommended Preoperative Testing for Planned AC-IOL
 - A. Specular microscopy
 - B. Measurement of AC depth: Pentacam, ultrasound, or anterior segment OCT
- III. Technique
 - A. IOL calculations
 - B. Surgical technique
- IV. Postoperative Course and Recommended Follow-up
 - A. Drops
 - B. Specular microscopy or pachymetry and macular OCT
- V. Outcomes: The Literature
 - A. Visual outcomes
 - B. Complications
 - C. Comparisons with other options for lack of capsular support

Fix It With an Iris-Sutured Lens

Garry P Condon MD

Simplified Scleral Fixation for Late In-Bag IOL Subluxation

The vast majority of these cases can be managed with scleral fixation of the bag/IOL complex regardless of whether or not a capsular tension ring (CTR) is present. There are various well-described techniques for placing 2 scleral lasso sutures 180 degrees apart that incorporate needle passage through the capsular bag. Most are ab-externo and require only microincisions that minimize intraoperative risks. In my experience, with even the most dramatic subluxation or dislocation, the existing IOL can be retained while avoiding more invasive IOL exchange.¹ Microforceps and small-gauge vitrectomy instrumentation make this all the more possible.

I have found, however, that even with a CTR in the bag, it is easier and more secure to pass the suture through the bag between the optic and the haptic close to what I call the IOL “armpit.” The bag is often thin and fragile more peripherally, risking tearing along the ring when the suture is barely tensioned. The capsule is generally more robust centrally, and a square-edge haptic fibrosed in the bag affords great support for the suture near this haptic/IOL junction. Rotating the bag/IOL complex to the favored orientation is fairly easy in these pseudoexfoliation cases with minimal residual intact zonule. A poorly dilating pupil makes the more central portion of the bag/IOL complex easier to visualize and work on, as opposed to the more peripheral ring.

Rhexis-to-Iris Fixation for Late In-Bag IOL Subluxation

While a number of techniques have been described utilizing a lasso technique to fixate an in-the-bag IOL to the sclera,²⁻⁴ I suggest considering a modified McCannel suture to fix the superior capsulorrhexis margin to the posterior aspect of the superior iris. Using only a clear corneal approach, this simple form of fixation can be effective for managing early IOL subluxation associated with exfoliation.⁵

Preoperative tropicamide 1% typically produces a mid-dilated pupil in these pseudoexfoliation patients. Under topical tetracaine and intracameral nonpreserved lidocaine, paracentesis tracks are made in clear cornea at about the 10:00 and 2:00 meridians. A cohesive viscoelastic is injected into the anterior chamber and behind upper iris to stabilize the anterior chamber, create space behind the superior iris, and tamponade the vitreous face where the zonule is likely deficient. The fibrotic and phimotic capsulorrhexis edge is key in applying this technique. A small-gauge microforceps is placed through the nasal paracentesis. The edge of the capsulorrhexis is grasped while

a 10-0 polypropylene suture on a long curved needle is guided through the temporal paracentesis and directed down through midperipheral iris a clock hour or two away from the 12:00 meridian. Once the iris is pierced, the tip of the needle is rotated and passed through the capsular bag just underneath the edge of the capsulorrhexis while the bag is stabilized with the microforceps (Figure 1). The capsulorrhexis edge is then released from the forceps, and the needle is turned back superiorly so the tip of the needle passes over the same edge of the capsulorrhexis (Figure 2) and is then directed up through mid-peripheral iris 2 or 3 clock hours nasal to the first iris entry point. Once the needle passes up through this location in iris, it is pushed out through clear cornea (Figure 3). The result is a suture pass that extends through superotemporal clear cornea, down through mid-peripheral iris, through capsular bag beneath the fibrotic capsulorrhexis edge, back around and over the capsulorrhexis edge, up through superonasal midperipheral iris, and out through clear cornea.

A sliding Siepser knot technique is used to gently secure the edge of the capsulorrhexis to the posterior aspect of the iris. The sliding knot is initiated by retrieving a loop of the distal suture segment and bringing it out through the superotemporal entry paracentesis. This suture typically produces slight peaking of the pupillary margin (Figure 4). The viscoelastic is gently irrigated from the chamber. In these cases, I recommend a small peripheral iridectomy to avoid postoperative pupillary block.

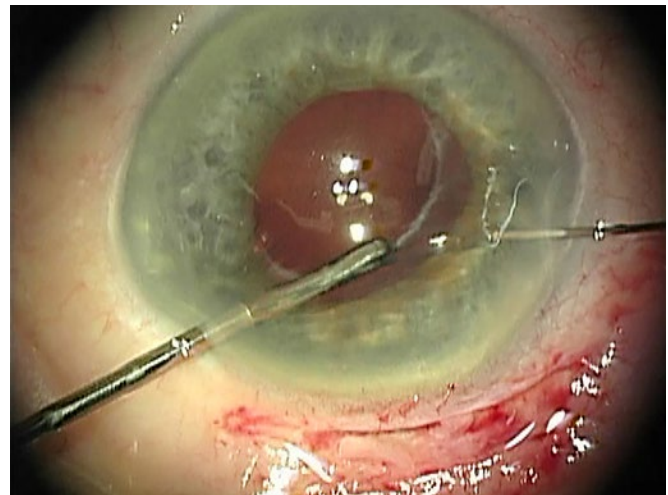


Figure 1. The needle is passed through cornea, mid iris, and the edge of the capsulorrhexis, which is held with a microforceps.

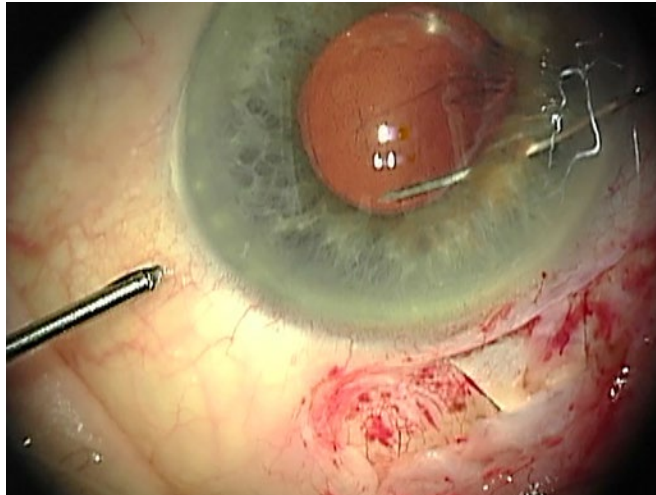


Figure 2. Once through the edge of the capsulorhexis, the needle is rotated back superiorly under the nasal iris.

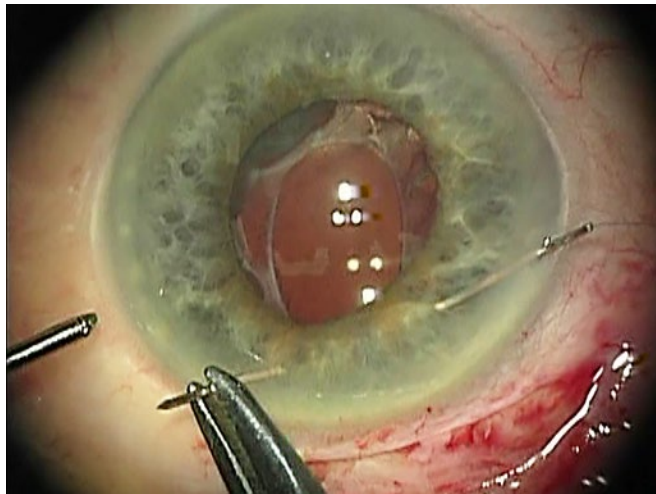


Figure 3. Passing the needle up through the nasal iris and out through adjacent cornea completes the suture pass.

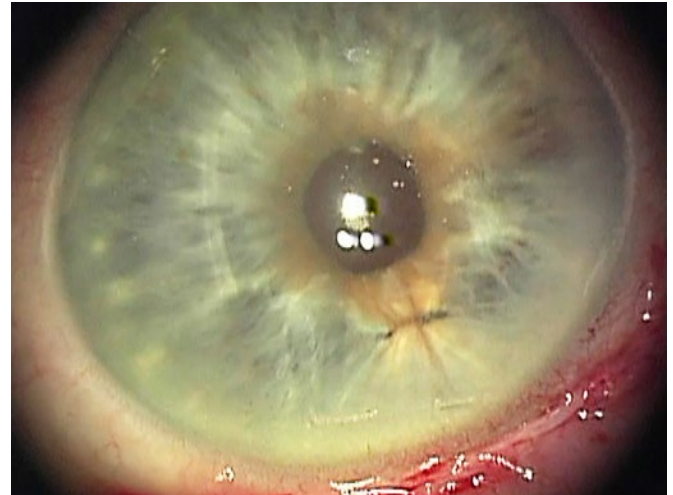


Figure 4. The finished suture fixes the capsulorhexis edge to the posterior surface of the iris.

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1. Kirk TQ, Condon GP. Simplified ab externo scleral fixation for late in-the-bag intraocular lens dislocation. *J Cataract Refract Surg.* 2012; 38:1711-1715 (erratum, 2013; 39:489).
2. Chan C, Crandall A, Ahmed IK. Ab externo scleral suture loop fixation for posterior chamber intraocular lens decentration: clinical results. *J Cataract Refract Surg.* 2006; 32:121.
3. Hoffman RS, Fine IH, Packer M. Scleral fixation without conjunctival dissection. *J Cataract Refract Surg.* 2006; 32:1907-1912.
4. Kirk TQ, Condon GP. Simplified ab externo scleral fixation for late in-the-bag intraocular lens dislocation. *J Cataract Refract Surg.* 2012; 38:1711-1715 (erratum, 2013; 39:489).
5. Siegal MJ, Condon GP. Single suture iris-to-capsulorhexis fixation for in-the-bag intraocular lens subluxation. *J Cataract Refract Surg.* 2015; 41:2347-52.

Fix It With a Scleral-Fixated Lens

Zaina Al-Mohtaseb MD

IOL Placement in Absence of Capsular Support: Scleral fixation is the way to go.

Secondary IOLs are implanted during IOL exchange surgery or to treat aphakia. The most common indications include IOL dislocation, uveitis-glaucoma-hyphema (UGH) syndrome, incorrect IOL power, IOL opacification, and dissatisfaction with a multifocal IOL. The ideal position for placement of a secondary IOL is in the capsular bag; however, patients requiring a secondary IOL often have a history of trauma, previous complicated surgery, or other ocular comorbidity resulting in inadequate capsule support. Alternate positions including scleral fixation present distinct challenges and advantages. I will be discussing scleral fixation in absence of capsular support and concentrate on the Yamane technique specifically. I will discuss the details of the procedure, the necessary instrumentation, refractive outcomes, potential complications, and combination procedures.

Challenges With Tubes: Conj Tricks, Tube Tricks

Ronald Leigh Fellman MD OCS

Most short-term problems with nonvalved devices are related to ligatures, rip cords, and managing postoperative IOP. The hypertensive phase is a problem with all devices, especially valved devices. Most long-term complications of all glaucoma drainage devices (GDDs) are caused by either tube erosion or location. Once tube erosion is repaired primarily, it may recur in 40% of cases. Tube erosion may lead to endophthalmitis. Many re-erosions are due to scarring or a shortage of conjunctiva. The use of a pedicle flap is emphasized. Special management of the Tenon capsule during GDD surgery may decrease exposure problems.

1. Tube Length, 1

Usually a valved device is used for neovascular glaucoma (NVG); leave the tube considerably longer in the anterior chamber (AC) with NVG. This will help prevent blockage of the tip of the tube by a blood clot that is universally seen on postoperative day 1. Also, leave the tube slightly longer in the AC with secondary glaucomas, iridocorneal endothelial syndromes, and epithelial downgrowth to prevent occult blockage.

2. Tube Length, 2

Leave extra length of tube (which should also be covered with a patch graft) on the surface of the eye (eg, a curve in tube sutured to sclera), in pediatric glaucomas, for as the eye grows, the tube length in the AC becomes less and less and may reach a critical point. Easier to revise if extra tube length on surface of eye to work with than using a tube extender.

3. Separate Closure of Tenon Capsule by Advancement (Sclerolimb Tenoncapsulopexy)

Gently separate underlying Tenon capsule from conjunctiva at edge of fornix-based incision for 3-4 mm posteriorly. Advance Tenon separately over the plate and tube and secure near the limbus on both sides of the patch (sclerolimb tenoncapsulopexy), especially when the overlying conjunctiva needs to be stretched to cover the hardware.

4. Closure of Conjunctiva

Suture the radial wings together as usual but in addition, suture edge of conjunctiva to limbus (limbal conjunctivopexy – horizontal mattress suture \times 2). This reduces retraction of conjunctiva and decreases likelihood of bacteria reaching the plate.

5. Tube Erosion

When faced with a tube erosion, use a cotton swab to assess the mobility of conjunctiva over an exposed tube in order to decide on revision technique. (1% to 4% per year is rate of primary erosion.)

6. Tube Re-erosion

Re-erosion rate after primary repair, up to 40%, definitive management of tube erosion when there is a shortage of conjunctiva (prior buckle, prior mitomycin C trabeculectomy, etc.) interpolated fornical-conjunctival pedicle flap, likelihood of re-erosion is less than 5%.

7. Double Patch Graft

Initially, double patch all tubes in eyes receiving bevacizumab for AMD.

8. Check Flow to Plate

When repositioning a tube at a later date, always check flow to plate before reinserting tube. Blue dye is very helpful in order to make sure there is flow to plate and to identify location of plate.

9. Tube Ligation and Rip Cord

When one must control timing of flow to plate with nonvalved GDD (due to high risk of complications from hypotony), ligate tube with nonabsorbable suture with additional rip cord in tube for optimal control of removing rip cord in clinic.

10. Always suspect occult blockage of any device, tube, or sclerostomy.

Any device or sclerostomy opening in the eye that is a conduit for the exit of aqueous may become visibly blocked by iris, vitreous, or fibrous tissue, or may be blocked by imperceptible (invisible) tissue. Slit-lamp exam looks normal, but tip of tube may be blocked by hidden debris. This may occur decades after tube insertion.

Laser the tip of the GDD with the YAG laser, even if it looks unblocked (capsulotomy settings), especially if it worked for years. As an aside, this also applies to Xen45, Ex-Press shunt, or YAG sclerostomy if prior trabeculectomy (gonioscopy key), or YAG laser to trabeculo-Desemet membrane (TDM) if prior canaloplasty.

11. Consider 2-stage drainage device.

Use a 2-stage GDD approach for aphakic vitrectomized eyes and possibly for high-risk patients on anticoagulants. The plate encapsulates by 6 weeks, and the tube may then be inserted along with viscoelastic. This avoids hypotony but requires 2 separate trips to the operating room.

12. Maintain AC when having to remove tube/plate.

First, before removing tube, ligate tube a couple of mm posterior to limbal insertion site, cut tube posterior to ligature, leave segment of ligated tube in sclerostomy to maintain AC. Remove or replace GDD as needed. Replace the ligated tube stump with new tube if entry site is desirable.

13. Use pericardium to patch abandoned tube entry site to avoid astigmatism.

14. Chronic Hypotony Problem

Consider suture in the tube, but bury the tip of the suture in the wall of the tube near its beveled tip so suture will not fall into AC. This avoids a knot that may change the direction of the tube and avoids removing the tube from the AC to ligate.

15. History of Uveitis

Perform a peripheral iridectomy when there is a history of uveitis and there is an absolute need to avoid uveal tissue contact. Insert the tip of the tube into the iridectomy site, free of uveal tissue.

16. Fibrous Tissue

When fibrous tissue invades the AC and pupillary area, usually secondary to retinal disease, the AC is usually shallow, and tube is encased in fibrous tissue. Remove the IOL and create a uni-chambered eye. At the time of IOL removal, reposition the tube in the vitreous cavity to prevent fibrous tissue from blocking tube (very helpful in eyes with KPro).

17. Secondary glaucomas do best with GDD.

When downgrowth covers the cornea, a penetrating keratoplasty (PK) has a reasonable chance of clarity for years due to contact inhibition of healthy endothelium, which prevents epithelium from growing on it, granted the IOP is controlled with a tube and there is no rejection of PK.

18. Reposition a tube posteriorly when too close to cornea.**19. Cover Tube**

Decide on best tissue or method (scleral flap? long track?) to cover tube (phakic vs. pseudophakic). Cornea, sclera, or pericardium.

20. Tube Insertion

Decide on best method to insert tube into the eye (angle needle?).

21. Aqueous Suppressants

Use aqueous suppressants aggressively postoperatively in valved devices, low IOP decreases hypertensive phase; very early on, even as early as end of first postoperative week, when IOP is 10 mmHg. (Choroidal effusion is rare.)

22. MMC

Consider MMC injection over plate to inhibit hypertensive phase in valved implants: 3 injections, total 75 micrograms (25 plus 25 plus 25).

23. Uveitic Eye or Eye With Aggressive Prior Cyclophotocoagulation

Plan for a smaller plate area to avoid hypotony.

24. Bury plate suture knots.

Always take the time to ensure the knots that are used to secure the plate to the globe are buried below the surface of the device.

25. Postop Diplopia

Is there evidence for less postoperative diplopia with certain GDDs?

26. GDD Exchange

Consider supratenons placement when exchanging a GDD.

27. Failed GDD

Consider angle surgery in patients with failed GDD; surprisingly, it oftentimes works.

28. Smaller Implants

Smaller implants that do not involve muscle isolation (Clear-Path250, FP7, Molteno) may be done with topical anesthesia. A smaller plate size may decrease risk of double vision.

Challenges With Trabs: Conjunctiva, Flaps, Etc.

Paul Palmberg MD PhD

Reconsidering Anatomy in Glaucoma Surgery—Avoiding Leaks and Bleeding

The key information for making a conjunctival-Tenon capsule flap is illustrated with a video and slides, showing how to avoid bleeding into the tissue and how to get a watertight seal at the limbus.

Think of conjunctiva as a thin layer of relatively water-tight cellophane and the Tenon capsule as a sponge. Each has its own blood vessels and attachments at the limbus and posteriorly. The secret to avoiding bleeding into the conjunctival-Tenon flap is to only cut these tissues at their insertions anteriorly, except for an initial radial relaxing incision done straight temporally. This approach allows one to evert the edge of the developing flap and to enter the potential space under the Tenon capsule, allowing one to lift the flap away from the sclera, slide the scissors underneath, slide forward to the limbus, and then with one blade under the flap and one over the cornea to sever the conjunctiva and Tenon capsule at their insertions. In this way bleeding within the sponge of Tenon capsule is avoided, as well as any cutting of the vessels on the surface of the sclera that run radially from the superior rectus to enter the sclera about 3 mm behind the limbus at 12 o'clock. It is *not* important to make a small conjunctiva-Tenon capsule flap; on the contrary, the most scarring will take place where the conjunctiva-Tenon flap tissues were cut and where sclera is cut, as Tenon tissue will attempt to heal to scleral cuts.

The key to a watertight closure is to use “square-wave” bites in the sclera at the limbus. One (1) enters the sclera just anterior to the scleral flap, with the needle passing straight down into the tissue to half depth, (2) turns to be parallel to the limbus, and then (3) attempts to turn the needle as straight back up to the surface as possible, then (4) up through the conjunctiva-Tenon capsule for the same length as the scleral pass, and (5) ties a square knot with the knot brought under the edge of conjunctiva-Tenon capsule by pulling the suture ends away from each other horizontally across the cornea. This results in a buried knot that is not irritating or tugged on by upper lid action. The flap tissue is then pulled firmly toward anchoring sutures at 3 and 9 o'clock, tied with a single throw, the relaxing incision closed with running closure, and then the needle passed back through the apex of the relaxing incision and underneath the closure back to the limbus, where a square knot is tied, pulling the ends of the suture superiorly and inferiorly along the surface of the cornea so that the knot slides under the closure. During this last tying, the superior hand in each case pulls more tightly, so that the knot slides superiorly under the cut edge of the flap. The square wave bites in sclera to avoid gradual tearing of the scleral anchoring that can occur with the use of skimming scleral bites over the first few days after surgery. With skimming scleral bites one may have a water-tight closure on the table, but then find a leakage developing at the limbus after a few days postoperatively as the compression of a loosening suture is lost.

The use of a wide conjunctival flap with an anchoring suture at 12 o'clock and tight closure along the limbus to the 3 and 9 o'clock positions allows one to avoid leaking at the limbus, but

also, very importantly, to avoid any compressing tension over the site of intended filtration, allowing the sponge of Tenon capsule to be fully hydrated by aqueous, inflating like a spinnaker sail, and not to be compressed, which would increase resistance to aqueous flow posteriorly through the Tenon capsule.

Safety-Valve Trabeculectomy—A Technique for Avoiding Hypotony and Flat Chambers

This is the technique I began using in 1988 as a strategy to avoid hypotony when using antimetabolites (5-fluorouracil [5-FU] and later mitomycin C [MMC]) in trabeculectomy. I began using 5-FU on May 11, 1982, with this initial case of its use being suggested by Mark Blumenkranz to Richard Parrish, after tissue culture studies in my laboratory performed for Dr Blumenkranz by Anthony Hajek and studies in rabbits and monkeys performed by Dr Parrish. The initial trabeculectomies were performed with the usual scleral flaps and sutures providing the scleral resistance, and they were performed only in repeat operations in which some conjunctiva-Tenon capsule scarring was already present, so that postoperative hypotony was not common.

However, we heard from Richard Simmons of Boston and others of late hypotony developing when the nylon sutures in scleral flaps would dissolve a few years postoperatively and realized that we needed a new strategy to avoid hypotony. All hypotony cases after trabeculectomy have an insufficient scleral flap resistance (in the absence of choroidal detachment or cyclo-dialysis), so it occurred to me that for primary surgery I needed a new strategy to create some permanent scleral flap resistance through a new valve-like architecture. What I developed was a 3-mm wide scleral and peripheral corneal tunnel incision (about 1 mm of each, for a 2-mm length) with removal of tissue in the anterior base of the tunnel using a Kelly Descemet punch, such that there was a canal that reached within about a half millimeter from the scleral exit that had an opening pressure of about 4-6 mmHg. It is essential to estimate the IOP at equilibrium flow, using a 30-gauge cannula to press on the cornea to be sure that no more than the intended resistance is present before going on to place scleral tunnel mouth sutures to adjust the pressure at equilibrium flow up to the ideal 8-12 mmHg. It probably would be much more difficult to estimate the pressure gradient established with a large scleral flap, as the opening and closing pressures may be quite different, with a resulting intermittent flow. However, with the short tunnel filter the flow is steady at equilibrium, as illustrated in the video. Indeed, the average IOP on the first postoperative day in 212 cases was 10 mmHg, as it also was on day 7 and at 1 month, and the average IOP was 11 mmHg thereafter for more than a decade.

The use of 0.5 mg/mL MMC for 5 minutes had indeed greatly retarded the formation of additional resistance to aqueous flow in the 65% of cases functioning at 10 years, which I presented in the Shaffer Lecture in 2005. All subjects remained in the analysis, even if they required further surgery to revise the procedure, as happened in one-third of cases by a decade, often as part of a subsequent cataract surgery. The results after

2 years and the technique were published;^{1,2} we reported a 4% rate of hypotony maculopathy in primary trabeculectomy, quite low considering the very high dose of MMC used to obtain optimal efficacy. We also reported that nearly all cases of hypotony maculopathy could be reversed, with visual recovery and elimination of metamorphopsia, with the use of 2 sets of sutures.

Transcorneal Needling of Blebs at the Slit Lamp

A 30-gauge half-inch needle mounted on a 1-mm syringe and bent into a bayonet shape can be used at the slit lamp to needle the external scleral flap of a trabeculectomy to lyse adhesions of Tenon capsule to the sclera, the usual site of failure of trabeculectomies. Using a self-sealing entry through cornea (requiring the needle to pass with the bevel parallel to the surface) and passing out the ostium of the trabeculectomy, with some cutting of the scar tissue with the point and then the side of the needle tip, reduces the scleral flap resistance without disturbing the margins of the bleb (so not creating hypotony) and not creating a hole in the conjunctiva (so not risking infection or hypotony). The procedure is best performed at the slit lamp and is preceded by placement of a solid-bladed speculum and applying proparacaine for corneal anesthesia, 5% povidone iodide for antisepsis, 1% apraclonidine for vasoconstriction, and 3.5% xylocaine gel for scleral anesthesia.³

Keys to Successful Surgery With the PreserFlo MicroShunt and the Xen Gel Stent

My observations as a consultant, trainer, and medical monitor for the new microshunts and discussion with those with the most experience in using them have led me to recognize 4 key aspects of the surgery for optimal results:

1. A higher dose of MMC is required to achieve IOPs similar to those achieved with trabeculectomy and optimal for visual field preservation in advanced damage patients. Comparative results find a 1.5-mmHg lower IOP with 0.4 mg/mL for 3 minutes than for 0.2 mg/mL for 2 minutes. Average values of 11-12 mmHg can then be achieved. Injected doses of 60 µg MMC can also achieve such IOPs.

Why is the higher dose of MMC needed, compared to what might be used with a trabeculectomy? At normal aqueous flow, the PreserFlo MicroShunt produces a 4-6 mmHg pressure gradient from the anterior chamber to the subconjunctival-Tenon space. While that greatly reduces the risk of hypotony, it also means that one wishes to strongly inhibit the formation of additional resistance in the conjunctiva-Tenon tissues.

2. The tip of the microshunt must be either under (or over) the Tenon tissue. The ideal location for the PreserFlo is in the potential space under the Tenon capsule. Why does that matter? If the tip is within Tenon tissue, rather than under the Tenon, the mechanical rubbing of the tip can stimulate the fibroblasts to produce a fibrous cap at the tip. MMC-treated fibroblasts are not dead, they just have their DNA crosslinked,

which prevents cell division but does not prevent transcription and production of proteins like collagen. The careful dissection to enter the sub-Tenon space was covered above. Results by those surgeons who use a relaxing incision to reach the sub-Tenon space (ie, Juan Batlle, Ike Ahmed) have been superior to those of surgeons who just blindly open a small conjunctiva-Tenon flap at 12 o'clock, and actually cut *inside* the Tenon, placing the tube tip inside Tenon.

Some have advocated placing the Xen just under the conjunctiva and over Tenon, which can reduce the chance of forming a fibrotic cap at the tube tip; however, that does increase the risk of tube exposure and infection.

3. The tube tip should be placed about 1½ clock hours nasal or temporal to the 12 o'clock position. While it is essential to have the tube tip exit the sclera 3 mm behind the limbus and thus behind the excursion of the superior lid in order to avoid tube exposures (as shown by Felix Gil Carrasco with the Ahmed Implant), the Tenon is thicker at 12 o'clock, and about a 1-mm lower IOP was observed for tubes placed at 10:30 or 1:30 o'clock compared to those placed at 12 o'clock.
4. One must prime the PreserFlo implant *and* check that the IOP at equilibrium flow is about 4-6 mmHg before closing the conjunctiva-Tenon flap. The device is hydrophobic, and the resistance to initial flow is much greater than the resistance once primed. Additionally, when the device is primed with the cannula that fits over the tip outside the eye, one could unintentionally jam the device further into the insertion track, which can result in the tube being pinched and the resistance to flow being increased, resulting in IOPs at equilibrium well above that desired. So it is essential to estimate the IOP at equilibrium flow (as illustrated above for the valve-like trabeculectomy operation) and if the IOP estimated with a 30-gauge cannula pressing on the cornea is above the desired range, pull back slightly on the implant and thus release the pinching effect, and test again. This problem is well illustrated by a case videoed by Ike Ahmed in which he detected and easily corrected the problem.

You may contact me to obtain a copy on Dropbox of any of the videos used.

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Challenges With Cataract Surgery in Angle Closure

Lilian Nguyen MD

- I. IOL Power Calculation in Short Eyes
- II. Dealing With Shallow Anterior Chambers
 - A. Wound construction
 - B. Viscoelastic
 - C. Pupil expansion devices
- III. Complications More Common in Angle Closure Eyes
 - Aqueous misdirection: Irido-zonulo-hyaloidectomy
- IV. Management of Angle-Closure Glaucoma
 - A. Goniosynechialysis ± goniotomy
 - B. Endoscopic cyclophotocoagulation

Complications With Intraoperative Angle Bleeding

Michelle Butler MD

Performing angle-based glaucoma surgery frequently causes a transient hyphema as blood refluxes into the anterior chamber with a lower IOP. The extent of the hyphema is variable but generally minimal with canal stents (Glaukos iStent inject W and Ivantis Hydrus Microstent), slightly more with partial trabecular stripping procedures (New World Medical Kahook Dual Blade, MST TrabEx, or MST Trabectome), and greater with 180-360 degree canal cleavage (GATT or Sight Science OMNI). Postoperatively, these are usually managed conservatively and will resolve without additional intervention. While a small amount of blood reflux may be reassuring as it indicates that the surgeon is working in the correct space, significant intraoperative bleeding can make the surgery much more challenging. This video presentation will review responses to intraoperative hyphemas, including patient positioning, use of viscoelastic and irrigation to wash out the anterior chamber.

Complications With Aqueous Misdirection on the Table; or, Preventing Aqueous Misdirection

Arsham Sheybani MD

NOTES

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Presenter Index

Ahmed*, Iqbal K 45
 Al-Aswad*, Lama A 27
 Al-Mohtaseb*, Zaina N 50
 Arosemena*, Analisa 14
 Barton*, Keith 39
 Bedrood*, Sahar 9
 Berdahl*, John P 46
 Budenz*, Donald L 5, 22
 Butler*, Michelle R 56
 Capitena Young, Cara E 17
 Chaya, Craig J 10
 Chen, Jenny 15
 Condon*, Garry P 48
 Cui*, Qi N 36
 Donaldson*, Kendall 47
 Elam, Angela R 19
 Emanuel*, Matthew E 13
 Fellman*, Ronald Leigh 51
 Gallardo*, Mark J 12
 Gedde, Steven 7
 Herndon*, Leon W 41
 Ianchulev*, Tsontcho 40
 Khawaja*, Anthony P 30
 Lim*, Michele C 24
 Liu, James C 32
 Mansberger*, Steven L 3
 Medeiros*, Felipe A 33
 Nguyen, Lilian 55
 Ou*, Yvonne 26
 Palmberg*, Paul F 53
 Rhee*, Douglas J 35
 Richter*, Grace Marie 4
 Rosdahl*, Jullia A 6
 Ross*, Ahmara V 20
 Samuelson*, Thomas W 42
 Schwartz, Terry L 28
 Seibold*, Leonard K 11
 Sheybani, Arsham 57
 Sola-Del Valle, David A 18
 SooHoo, Jeffrey R 25
 Vajaranant, Thasarat S 1
 Van Tassel*, Sarah 37
 Vinod, Kateki 16
 Walton, David S 44

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