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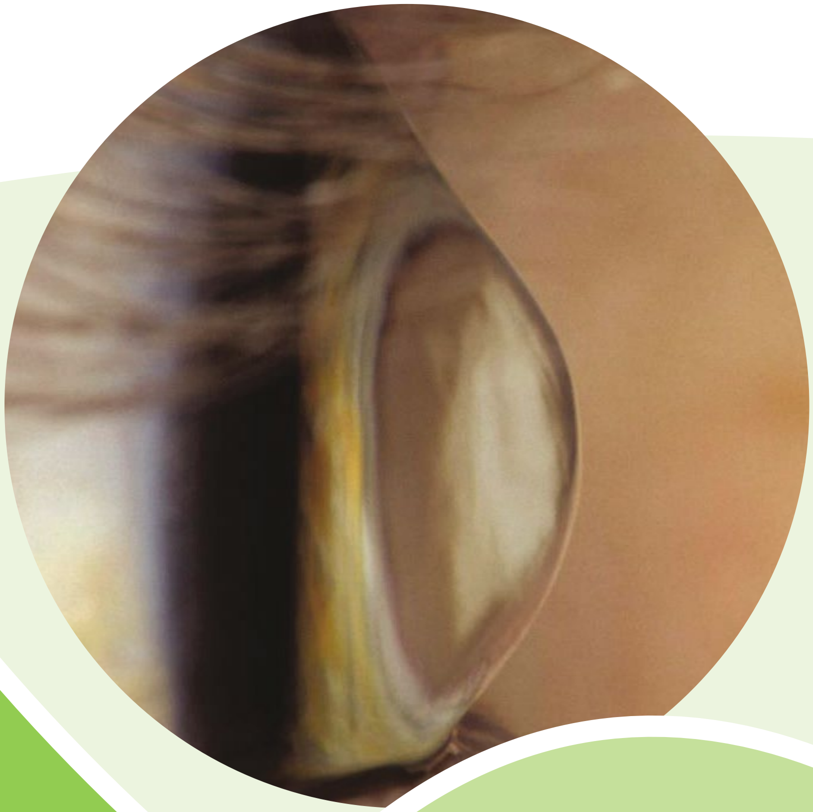

Refractive Surgery 2023

Refractive GPT2023

Subspecialty Day | AAO 2023

San Francisco | Nov 3

Protecting Sight. Empowering Lives.®

6795

Refractive Surgery 2023

Refractive GPT2023

Program Directors
Jodhbir S Mehta MBBS PhD
Nicole R Fram MD

In conjunction with the
International Society of Refractive Surgery

Moscone Center
San Francisco, California
Friday, Nov. 3, 2023

Presented by:
The American Academy of Ophthalmology

AMERICAN ACADEMY
OF OPHTHALMOLOGY®
Protecting Sight. Empowering Lives.

Refractive Surgery 2023 Planning Group
Jodhbir S Mehta MBBS PhD
Program Director

Nicole R Fram MD
Program Director

Renato Ambrósio Jr MD
Deepinder K Dhaliwal MD
Sonia H Yoo MD

Subspecialty Day 2023 Advisory Committee
R Michael Siatkowski MD
Associate Secretary

Julie Falardeau MD
Jennifer Irene Lim MD
Shahzad I Mian MD
Jody R Piltz MD
Sonia H Yoo MD

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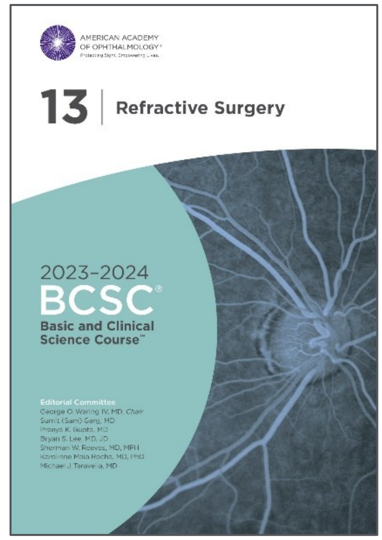
Basic and Clinical Science Course:
An Ongoing Commitment to Education



Covering all subspecialties, the BCSC books are an invaluable resource not just for residents but also for practicing ophthalmologists.

The BCSC books are authored and revised by expert ophthalmic subspecialists, ensuring that the information presented is accurate, up-to-date, and authoritative. Please join us in thanking these volunteers for their hard work and commitment to education.

Faculty for BCSC Section 13 *Refractive Surgery*

Michael J. Taravella, MD
Chair
Aurora, Colorado

Sumit (Sam) Garg, MD
Irvine, California

Preeya K. Gupta, MD
Durham, North Carolina

Elizabeth M. Hofmeister, MD
San Diego, California

Bryan S. Lee, MD, JD
Los Altos, California

Beeran B. Meghpara, MD
Philadelphia, Pennsylvania

Karolinne Maia Rocha, MD, PhD
Charleston, South Carolina

All Ophthalmologists are Invited to Help

The BCSC is created by ophthalmologists for ophthalmologists. As such, the writing committees are always looking for and considering new members. No previous experience necessary. As part of BCSC's commitment to diversity, we seek individuals who are good at writing and editing, and represent all aspects of the AAO's diverse membership, including gender, ethnicity, geography, and private versus academic practice. If you are interested in volunteering for a BCSC writing committee, please submit a CV and indicate your area of interest to: aaovolunteer@aao.org.

Refractive Surgery Subspecialty Day 2023 Program Planning Group

On behalf of the American Academy of Ophthalmology and the International Society of Refractive Surgery (ISRS), it is our pleasure to welcome you to **San Francisco and Refractive Surgery Subspecialty Day 2023: Refractive GPT2023.**

Jodhbir S Mehta MBBS PhD
Program Director

ACEVision: SO
BMRC (Singapore): S
Carl Zeiss: L
CordLife: P
Leica: L
Moria: L
Network Medical: P
NMRC (Singapore): S
Santen: L
Trefoil Therapeutics: SO
Ziemer: L

Nicole Fram MD
Program Director

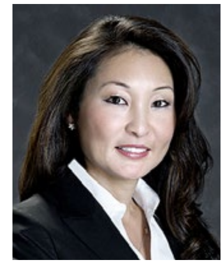
Alcon Laboratories, Inc.: C
Aurion: C | Avellino Labs: C
Beaver-Visitec International, Inc.: L
Carl Zeiss Meditec: C,L,S
CorneaGen: C,L,S,O
Glaukos Corp.: L
Johnson & Johnson Vision: L,C
Lensar: C | Ocular Science: SO,C
Ocular Therapeutix: S
Orasis Pharmaceuticals: C,SO
RxSight: L,C
Vital Tears: L

Program Planning Group

Renato Ambrósio Jr MD
Allergan: L | BrAIN Cornea: PS
Carl Zeiss, Inc.: L
Essilor Instruments: L
Genome Systems, Inc: C,L
Mediphacos: L
Oculus, Inc.: C
RA Masterclass: EO

Deepinder K Dhaliwal MD
Allergan, Inc.: C | Glaukos: S
Haag-Streit Group: C
Johnson & Johnson: C
Kowa American Corp.: S
Lenz Therapeutics: C
Novartis: C,S | Noveome: S
OysterPoint: C | Staar Surgical: C
TearSolutions: C | Trefoil: C

J Bradley Randleman MD
None



Sonia H Yoo MD
Carl Zeiss Meditec: C
Dermavant: C
Oyster Point Pharma: C

Subspecialty Day 2023 Advisory Committee

R Michael Siatkowski MD, Associate Secretary (Pediatric Ophthalmology)
None

Bennie H Jeng MD (Secretary for Annual Meeting)
GlaxoSmithKline: C
Kiora: US

Julie Falardeau MD (Neuro-Ophthalmology)
Medpace: S

Jennifer Irene Lim MD (Retina)
Adverum Biotechnologies: S
Alderya Therapeutics, Inc.: S
Allergan, Inc.: C
Aura Biosciences, Inc.: C
Chengdu Kanghong: S
Cognition Therapeutics: C
Eyenuk, Inc.: C
Genentech: C,S,L
Greybug: S | Iveric Bio: C
JAMA Network: C
Janssen Pharmaceuticals, Inc.: S
Luxa: C | NGM: S
Novartis Pharma AG: C
Opthea: C
Quark Pharmaceuticals: C
Regeneron Pharmaceuticals, Inc.: C,S
Santen, Inc.: C
Spring Vision: S
Stealth Biotherapeutics: S
Taylor & Francis (CRC Press): P
Unity: C | Viridian: C

Shahzad I Mian MD (Cornea)
Kowa American Corp.: S
Novartis: S | VisionCare, Inc.: S

Jody R Piltz MD (Glaucoma)
Aerie Pharmaceuticals, Inc.: C,L
Alcon Laboratories, Inc.: C,L
Nanoscope Therapeutics: C

Sonia H Yoo MD (Refractive Surgery)
Carl Zeiss Meditec: C
Dermavant: C
Oyster Point Pharma: C

AAO Staff

Mecca Boutte
None

Ann L'Estrange
None

Melanie Rafaty
None

Debra Rosencrance
None

Beth Wilson
None

Refractive Surgery 2023 Contents

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.

Refractive Surgery Subspecialty Day 2023 Learning Objectives

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

- Evaluate the latest techniques and technologies in refractive surgery
- Identify the current status and future of femtosecond laser, excimer laser, phakic IOL, and IOL refractive surgery
- Compare the pros and cons of various lens- and corneal-based modalities, including presbyopic and toric IOLs
- Describe the increasing importance of refractive surgery in any ophthalmology practice and the reasons to consider this subspecialty to improve patient care
- Practice complication avoidance, identification, and management in cornea- and lens-based surgery
- Highlight new innovations in the field

Refractive Surgery Subspecialty Day 2023 Target Audience

The intended audience for this program is comprehensive ophthalmologists; refractive, cataract, and corneal surgeons; and allied health personnel who are performing or assisting in refractive surgery.

Teaching at a Live Activity

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

Scientific Integrity and Disclosure of Conflicts of Interest

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

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 acknowledgment is made in a similar way in other Academy CME activities. Though coauthors are acknowledged, they do not have control of the CME content, and their disclosures are not published or resolved.

Subspecialty Day 2023 CME Credit

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

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

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

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

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

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

Attendance Verification for CME Reporting

Before processing your requests for CME credit, the Academy must verify your attendance at AAO 2023 and/or Subspecialty Day. Badges are no longer mailed before the meeting. Picking up your badge onsite will verify your attendance.

How to Claim CME

Attendees can claim credits online.

For AAO 2023, you can claim CME credit multiple times, up to the 50-credit maximum, through March 29, 2024. You can claim some in 2023 and some in 2024, or all in the same year.

For Subspecialty Day 2023, you can claim CME credit multiple times, up to the 12-credit maximum per day, through March 29, 2024. You can claim some in 2023 and some in 2024, 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.

You can view content in the virtual meeting through March 1, 2024.

Academy Members

CME transcripts that include AAOE Half-Day Coding Sessions, Subspecialty Day, and/or AAO 2023 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 2023.

Nonmembers

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

Proof of Attendance

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

Academy Members

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

Nonmembers

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

CME Questions

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

2023 Award Winners

Jose I Barraquer Lecture and Award

The Jose I Barraquer Lecture and Award honors a physician who has made significant contributions in the field of refractive surgery during his or her career. This individual exemplifies the character and scientific dedication of Jose I Barraquer MD—one of the founding fathers of refractive surgery.

Jose I Barraquer Lecture and Award—Roberto Pineda II MD

Roberto Pineda II MD

A native of Minneapolis, Minnesota, Dr. Roberto Pineda completed his medical degree at the University of Minnesota Medical School and was admitted to the Howard Hughes NIH-HHMI Research Scholars Program. He went on to complete his residency in ophthalmology at the Massachusetts Eye and Ear Infirmary (MEEI), Harvard Medical School, where he served as chief resident and director of the Trauma Service for an additional year. As a Heed Fellow recipient, he completed his cornea and refractive surgery fellowship at MEEI. Currently, he is the Thomas Y and Clara W Butler Chair in Ophthalmology and an associate professor of ophthalmology at Harvard Medical School on the Cornea and Refractive Surgery Service at MEEI.

Dr. Pineda has published over 80 peer-reviewed papers and coauthored 5 books, including the award-winning *Massachusetts Eye and Ear Infirmary Illustrated Manual of Ophthalmology* (5th ed.). He has received both the American Academy of Ophthalmology Achievement and Senior Achievement Awards and has served on the Academy's Practicing Ophthalmology Committee in Cataract, the Ethics Committee, and the Preferred Practice Patterns Committee, Adult Cataract. Additionally, he was inducted into the International Intraocular Implant Club (IIIC) in 2016. He regularly participates in global ophthalmology programs such as Orbis, Lifeline Express, and SightLife's Surgical Skill Transfer Program, in addition to his own programs in Uganda and Sudan. He has served on the International Council of Ophthalmology Fellowship Committee, regularly sponsoring award recipients since 2005. Currently, he sits on the board of KeraLink International, working to reduce corneal blindness through advancements in novel low-resource technologies.

Casebeer Award

The Casebeer Award recognizes an individual for his or her outstanding contributions to refractive surgery through nontraditional research and development activities.

Casebeer Award—Karolinne Maia Rocha MD PhD

Karolinne Maia Rocha MD PhD

Karolinne Maia Rocha MD PhD is a professor of ophthalmology and the director of Cornea & Refractive Surgery at the Medical University of South Carolina, Storm Eye Institute in Charleston, South Carolina. She also serves as program director of the Cornea & Refractive Surgery fellowship program and as associate program director for the Storm Eye Institute Residency Program.

Dr. Rocha received her medical degree from the State University of Londrina (UEL), Brazil, in 2002, followed by residency training in ophthalmology at Federal University of São Paulo (UNIFESP-EPM), and she was certified by the Brazilian Council of Ophthalmology in 2005. Subsequently, she completed her fellowship and PhD thesis, also at UNIFESP. She completed her second ophthalmology residency at the Cleveland Clinic Foundation, Cole Eye Institute, in Cleveland, Ohio. Dr. Rocha completed her postdoctoral fellowship in Cornea & Refractive Surgery at the Cleveland Clinic in 2009. She then pursued a second postdoctoral fellowship in Cornea & Refractive Surgery at Emory University in 2010. Her research continues to focus on IOLs, aberrations, ectasia, pseudoaccommodation, and presbyopia.

Dr. Rocha serves on the program committee for the American Academy of Ophthalmology Refractive Surgery Basic and Clinical Science Course (BCSC) and the American Society of Cataract and Refractive Surgery Cornea Clinical Committee. She is active in teaching at national and international conferences and has served as a course instructor at the American Academy of Ophthalmology Laser Refractive Skills Transfer Course since 2009, as well as teaching courses on optics, presbyopia, corneal topography, and complex cataract surgery. Dr. Rocha is an associate editor for the *Journal of Refractive Surgery (JRS)* and the *Journal of Refractive Surgery Case Reports (JRSCR)*.

Dr. Rocha has received awards and distinctions for excellence in ophthalmology, including the American Academy of Ophthalmology's Senior Achievement Award in 2019, the Pierre Gautier Jenkins teaching award in 2021, the International Society of Refractive Surgery Waring Memorial Award in 2016, and the Cleveland Clinic Lerner College of Medicine Teaching Excellence Recognition Award in 2013.

Founders' Award

The Founders' Award recognizes the vision and spirit of the Society's founders by honoring an ISRS member who has made extraordinary contributions to the growth and advancement of the Society and its mission.

Founders' Award—Deepinder K Dhaliwal MD LAc

Deepinder K Dhaliwal MD LAc

Deepinder K Dhaliwal MD LAc is a professor of ophthalmology at the University of Pittsburgh School of Medicine, chief of Refractive Surgery, and vice chair of the department of ophthalmology for wellness and communications. Dr. Dhaliwal also serves as the director of the UPMC Laser Vision Center, the associate medical director of the Campbell Ophthalmic Microbiology Laboratory, and the clinical codirector of the Corneal Regeneration Laboratory at the University of Pittsburgh.

Dr. Dhaliwal earned her medical degree from Northwestern University in the Honors Program in Medical Education, where she was selected to be a member of the prestigious Alpha Omega Alpha Honor Society. She completed her residency in ophthalmology at the University of Pittsburgh Medical Center, where she was selected as chief resident her final year. She then pursued fellowship training in cornea and refractive surgery at the University of Utah. She became a licensed acupuncturist in 2006 and founded the Center for Integrative Eye Care at the University of Pittsburgh to research integrative treatments for eye disease.

Dr. Dhaliwal holds leadership positions in the Cornea Society, the International Society of Refractive Surgery of the American Academy of Ophthalmology, and the Eye and Contact Lens Association/CLAO. Dr. Dhaliwal is a recognized expert in her field and teaches corneal and refractive surgical techniques to other ophthalmologists globally. In addition to teaching and research activities, she has authored several book chapters, numerous journal articles, and serves on the editorial board of several ophthalmology journals. In recognition of her clinical and surgical skills, she has been selected as a "Top Doctor" by her peers every year since 2006. In 20 she was selected to be on the Power List 100 in *The Ophthalmologist* ("Top 100 most influential people in the world of ophthalmology"), and she received the International Society of Refractive Surgery Casebeer Award for outstanding contribution to research and development of refractive surgery.

Kritzinger Memorial Award

The Kritzinger Memorial Award recognizes an individual who embodies the clinical, educational, and investigative qualities of Dr. Michiel Kritzinger, who advanced the international practice of refractive surgery.

Kritzinger Memorial Award—Maria A Henriquez MD

Maria A Henriquez MD

Dr. Maria A Henriquez is from Venezuela. She completed her medical schooling at the Universidad de los Andes, Venezuela, graduating magna cum laude and first of her class in 2004. She specialized in ophthalmology at the Universidad Federico Villareal in Lima, Peru, and completed her fellowship in cornea and refractive surgery at Oftalmosalud, Peru, and a fellowship in ocular ultrasound and ocular surface at Universidad Federal de São Paulo in Brazil.

Dr. Henriquez obtained her master's degree at Universidad de Salta in Argentina in 2008 and her PhD at the Universidad San Martin de Porras, in Lima in 2012. Then she completed the Global Clinical Scholars Research Training Program at Harvard Medical School, in Boston, Massachusetts, in 2014-2015.

She is the founder of the Research Department at Oftalmosalud, which she directs to the present day. Dr. Henriquez has published, so far, over 53 articles in peer-reviewed journals. She has published over 10 book chapters and has recently edited the book *Keratoconus: Diagnosis and Management* (Elsevier).

Dr. Henriquez has received more than 22 awards related to research in ophthalmology. Among them, the Tyson Award, in 2009, granted by the Pan-American Association of Ophthalmology; the Joseph Colin Keratoconus Award, in 2019, for the best article published by the *International Journal of Keratoconus and Ectatic Corneal Diseases*; and the Cornea Society Troutman Prize Award for the best article published in the *Journal of Cornea*, in 2020. She has been the recipient of the National Award for Medical and Ophthalmological Research in Peru on more than seven occasions. She is currently the editor-in-chief of the *Peruvian Journal of Ophthalmology* and integrates the editorial board of the Pancornea Society, besides being a reviewer for more than 12 peer-reviewed journals.

Dr. Henriquez is a well-known researcher and speaker at the national and international level, mainly in the field of keratoconus diagnosis, corneal collagen crosslinking, and refractive surgery, as well as being a surgeon and a postgraduate professor.

Lans Distinguished Lecturer Award

The Lans Distinguished Lecturer Award honors Dr. Leendert J Lans. Given annually, the award recognizes individuals who have made innovative contributions in the field of refractive surgery, especially in the correction of astigmatism.

Lans Distinguished Lecturer Award—
J Bradley Randleman MD

J Bradley Randleman MD

J Bradley Randleman MD is a professor in the Department of Ophthalmology at Cleveland Clinic Lerner College of Medicine of Case Western Reserve University and codirector of the Refractive Surgery Service at the Cleveland Clinic Cole Eye Institute in Cleveland, Ohio. He is a widely respected refractive surgeon whose areas of expertise include laser vision correction and lens-based surgery, IOL complications after cataract surgery, and the management of corneal ectatic disorders. His primary research focuses on corneal biomechanics and the identification and management of corneal ectatic diseases, including keratoconus and postoperative ectasia after LASIK. He has been awarded multiple research grants, including an R01 from the National Institutes of Health to evaluate corneal biomechanical analysis using Brillouin microscopy.

Dr. Randleman has been awarded the Claus Dohlman Fellow Award; the inaugural Binkhorst Young Ophthalmologist Award from the American Society of Cataract and Refractive Surgery; the Kritzinger Memorial Award, Founder's Award, and the Inaugural Recognition Award from the International Society of Refractive Surgery; and the Secretariat Award, Achievement Award, and Senior Achievement Award from the American Academy of Ophthalmology.

Dr. Randleman has served as editor-in-chief for the *Journal of Refractive Surgery* since 2011. He has delivered more than 300 lectures at ophthalmic meetings on 6 continents and trained more than 30 cornea fellows and 100 ophthalmology residents. He has authored more than 185 peer-reviewed publications in leading ophthalmology journals, in addition to 5 textbooks and more than 40 book chapters on refractive surgery evaluation, corneal crosslinking, and management of complications with IOLs.

Lifetime Achievement Award

The Lifetime Achievement Award honors an ISRS member who has made significant and internationally recognized contributions to the advancement of refractive surgery over his or her career.

Lifetime Achievement Award—
Renato Ambrósio Jr MD PhD FWCRS

Renato Ambrósio Jr MD PhD FWCRS

Prof. Ambrósio is the first son of the late Renato Ambrósio MD, who pioneered the field of refractive surgery in Brazil in the early 1980s, and Vera Martins Ambrósio MD, a resilient and dedicated ophthalmologist who upheld the family practice after the premature decease of her husband in January 1994.

Prof. Ambrósio is in private practice in Rio de Janeiro with his younger brother, Rodrigo Martins Ambrósio MD, a talented retina surgeon, and his beautiful wife, Renata Siqueira da Silva MD, a well-trained and competent glaucoma and contact lens specialist.

He concluded his residency in opthalmology at the Instituto de Oftalmologia Tadeu Cvintal (São Paulo) in 1999 and a fellowship program in refractive surgery and cornea at the University of Washington (Seattle) in October 2002 under the supervision of Steven E Wilson MD. He defended his doctorate in sciences at the University of São Paulo in May 2004.

He served as a president of the Brazilian Society of Administration in Ophthalmology from 2006 until 2010, and president of the Brazilian Society of Refractive Surgery from 2012 until 2014, before the incorporation with the Brazilian Society of Cataract and Implants for the creation of the Brazilian Association of Cataract and Refractive Surgery (BRASCRS). He was the vice president of the Brazilian Council of Ophthalmology (2013-2015) and was elected president of the International Society of Refractive Surgery (ISRS) in 2020, staying in this position until its spinoff from the American Academy of Ophthalmology (Academy) in 2024. He is also the current president of the Refractive Surgery Alliance (RSA; 2023-2024).

Prof. Ambrósio founded the Rio de Janeiro Corneal Tomography and Biomechanics Study Group in 2007 and BrAIN (Brazilian Artificial Intelligence Networking in Medicine) in 2010, from which over 200 publications originated. He is an affiliate professor of the postdoc program in ophthalmology at the Pontific Catholic University of Rio de Janeiro (*lato sensu*) and the Federal University of São Paulo (*stricto sensu*) and an adjunct professor in ophthalmology at the Federal University of the State of Rio de Janeiro (UNIRIO).

He published an invited thesis for the American Ophthalmological Society (AOS) in the *American Journal of Ophthalmology* in July 2023, with the title "Optimized Artificial Intelligence for Enhanced Ectasia Detection Using Scheimpflug-Based Corneal Tomography and Biomechanical Data."

Professor Ambrósio is a fellow of the World College of Refractive Surgery (FWCRS) and a world-class refractive surgeon-scientist. His research philosophy encompasses his original algorithm $(A^2I)^2$ – applying ancient intelligence (the why's) and applied artificial intelligence (the how). His primary interests are corneal/refractive multimodal diagnostics, beyond and not over corneal tomography and biomechanics. His practice includes customized laser vision correction (LVC), phakic IOLs, refractive cataract surgery, dry eye, and therapeutic procedures for ectatic corneal diseases.

He is a devoted family man with 2 lovely daughters, Giovanna and Rafaella. He is a second-degree black-belt Jiujitsu practitioner and lives embracing the challenge of finding balance among his busy and proactive academic appointments, his private practice at Instituto de Olhos Renato Ambrósio and Rio Vision Hospital in Rio de Janeiro, and Centro Brasileiro de Cirurgia de Olhos in Goiania.

Miradas Award

Miradas, which means "glances," is a contest in which artists from Spain, Latin America, and the United States participate with artworks dealing with the topic of sight and the prevention of blindness. It was created by Jorge Alió in 1998 with the intention of using artistic sensibility to bring society's attention to the phenomenon of sight, vision, and blindness. Selected paintings from the contest are featured on the cover page of the *Journal of Refractive Surgery.*

Miradas Award—Ewa Koziór

Ewa Koziór

Please recognize the recipient of the Miradas Award—Ewa Koziór, from Poland, with the artwork entitled *Fotozmysł* ("Photo Sense").

Presidential Recognition Award

The Presidential Recognition Award is a special award that honors the recipient's dedication and contributions to the field of refractive surgery and to the ISRS.

Presidential Recognition Award—Steven E Wilson MD

Steven E Wilson MD

Dr. Wilson received a BA in biology from California State University–Fullerton in 1974, an MS in molecular biology and biochemistry from the University of California–Irvine in 1977, and his MD from the University of California–San Diego in 1984. He completed his ophthalmology residency at the Mayo Clinic in Rochester, Minnesota, in 1988 and was a fellow in cornea and refractive surgery at Louisiana State University Eye Center in New Orleans from 1988 to 1990. Dr. Wilson was assistant/associate professor at the University of Texas Southwestern in Dallas from 1990 to 1995. He was professor and medical director of refractive surgery at the Cleveland Clinic in Cleveland from 1995 to 1998. From 1998 to 2003, he was chair of ophthalmology at the University of Washington in Seattle. Since 2003, he has been professor of ophthalmology at the Cleveland Clinic.

Dr. Wilson's laboratory is focused on cellular and molecular interactions involved in wound healing in the cornea, especially growth factors and receptors in the cornea, basement membranes, and fibrosis. He has been funded by the National Eye Institute of the National Institutes of Health from 1992 to 2021 and by the Department of Defense from 2019 to 2025. He has authored more than 280 peer-reviewed publications. He has received numerous awards, including the ARVO Gold Fellowship in 2009, the Richard L Lindstrom CLAO Award Lectureship at the American Society of Cataract and Refractive Surgery annual meeting in 2013, the Barraquer Award from the International Society of Refractive Surgery–American Academy of Ophthalmology (ISRS-AAO) in 2020, and the ISRS-AAO Presidential Recognition Award in 2023.

Dr. Wilson has published 4 adventure-thriller novels, most recently *The Benghazi Affair* in 2018, and the nonfiction book *The Making, Breaking and Renewal of a Surgeon-Scientist* in 2019, which was a Benjamin Franklin Award finalist for Audiobook of the Year for 2020 in nonfiction.

Presidential Recognition Award

The Presidential Recognition Award is a special award that honors the recipient's dedication and contributions to the field of refractive surgery and to the ISRS.

Presidential Recognition Award—Ana María Torres COMT

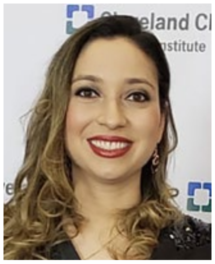
Ana María Torres COMT

Mrs. Ana María Torres is a distinguished leader in ophthalmology, recognized for exceptional contributions that have transformed eye care in Latin America and beyond. As the cofounder and executive director of the Asociación Pan Americana de Bancos de Ojos (APABO; Pan-American Association of Eye Banks) she helped establish over 40 eye banks in Latin America and collaborated in corneal donation legislation in several countries on the continent. Her impact on ophthalmology also includes training ophthalmologists in eye banking, developing the Technical and Scientific Course of Eye Banks, and empowering professionals to meet the growing demand for quality corneal tissue and transplantation services.

32nd Annual Richard C Troutman MD DSc (Hon) Prize

The Troutman Prize recognizes the scientific merit of a young author publishing in the Journal of Refractive Surgery. This prize honors Richard C Troutman MD DSc (Hon).

Richard C Troutman MD DSc (Hon) Prize—
Lycia Pedral Sampaio MD



Lycia Maria Martins Pinho Pedral Sampaio MD

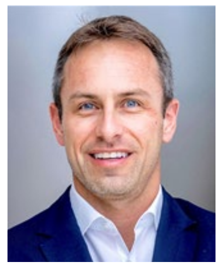
Lycia Maria Martins Pinho Pedral Sampaio's current professional roles include the following:

- Ophthalmology resident and cornea, cataract, and refractive surgery fellow at the Sorocaba Eye Bank and Hospital (BOS) in São Paulo, Brazil
- Cornea and refractive surgery postdoctoral research fellow at the Cole Eye Institute, Cleveland Clinic, in Cleveland, Ohio, USA
- PhD candidate at the University of São Paulo (USP) in São Paulo, Brazil
- Researcher at Refractive RiO (Research in Ophthalmology) Group
- Cornea and cataract attending at Sorocaba Eye Bank and Hospital in São Paulo, Brazil

Waring Memorial Award for a Young Ophthalmologist

The Waring Memorial Award for a Young Ophthalmologist recognizes an ISRS member early in his/her career who has demonstrated a commitment to ISRS, as well as a commitment to the promulgation of knowledge and the practice of refractive surgery. This award honors George O Waring III MD for his commitment to the profession and to ISRS.

Waring Memorial Award—
Emilio A Torres-Netto MD PhD FWCRS



Emilio A Torres-Netto MD PhD FWCRS

Emilio A Torres-Netto MD PhD FWCRS is a cornea, cataract, and refractive surgeon educated in multiple centers in Brazil, the United States, France, and Switzerland, who is engaged in the development of innovative approaches for keratoconus, crosslinking, corneal biomechanics, and refractive surgery at the ELZA Institute and University of Zurich, Switzerland.

Dr. Torres-Netto has received 17 national and international awards from the largest societies in ophthalmology. Among others, in 2018, he was unanimously chosen as the inaugural World Winner of the International Council of Ophthalmology Award with the topic on factors influencing corneal biomechanics, and in 2022, he was awarded with the José Ignácio Barraquer Medal by the Brazilian Association of Cataract and Refractive Surgery for his contribution to the field of cornea and refractive surgery. In addition, he was named among the 50 global key opinion leaders in ophthalmology by Media Mice in 2021 and 2023.

He is reviewer for several international peer-reviewed journals, serves on the editorial board of the *Journal of Refractive Surgery Case Reports* (USA), *Oftalmologia em Foco* (Brazil), and *Ophta* (Switzerland), and serves as a member of the European Regional Advisory Committee of the World College of Refractive Surgery and Visual Sciences.

Dr. Torres-Netto is the author of 50 articles in peer-reviewed journals, 51 publications/interviews, and 15 book chapters, and in the last few years, he has delivered more than 300 talks and presentations internationally.

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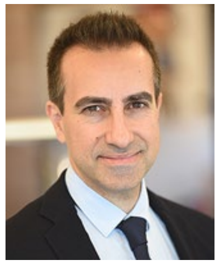

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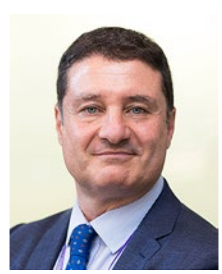

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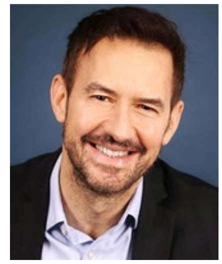

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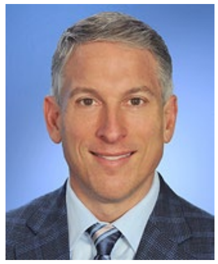

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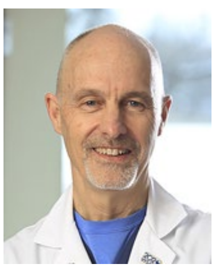

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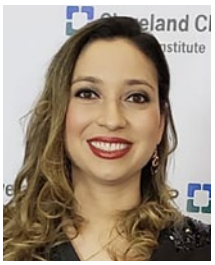

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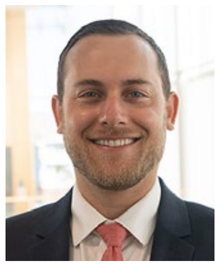

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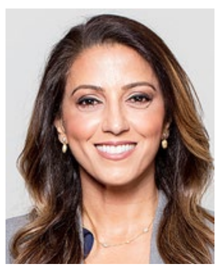

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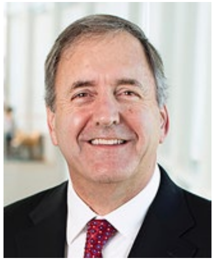

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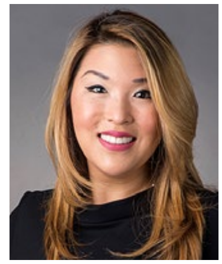

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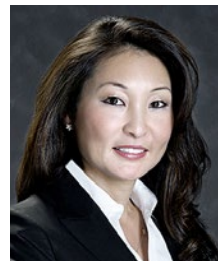

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Dagny C Zhu MD
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Tanya Trinh MBBS
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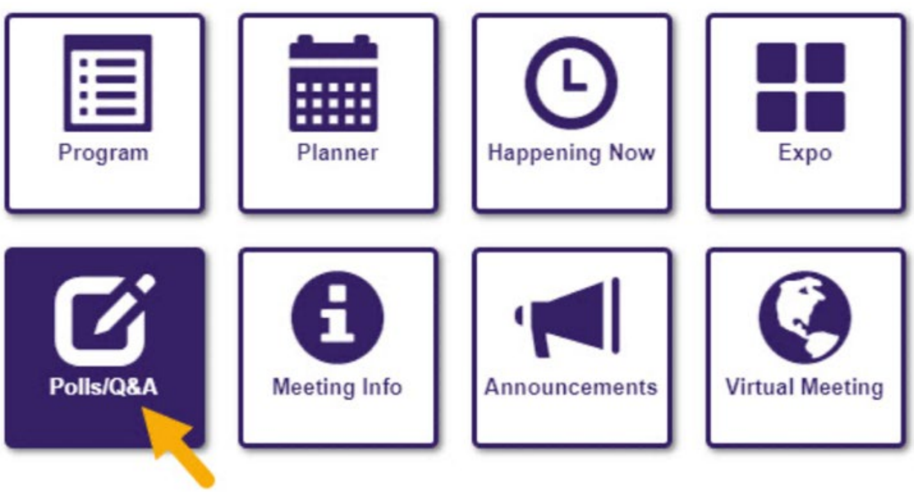
- Choose "Ask a Question"



Refractive Surgery Subspecialty Day 2023: Refractive GPT2023

FRIDAY, NOV. 3, 2023

8:00 AM	Welcome and Introductions	Jodhbir S Mehta MBBS PhD Nicole R Fram MD	

Section I: What I'm Doing This Year That I Didn't Do Last Year—What's New in 2023

Moderators: George O Waring IV MD and Soosan Jacob MBBS FRCS

Panelists: Angela M Gutierrez MD, Namrata Sharma MD MBBS, Rohit Shetty MBBS, and Darren Shu Jeng Ting PhD FRCOphth

8:05 AM	Artificial Intelligence for Ectasia Risk Assessment	Renato Ambrósio Jr MD	1
8:11 AM	Crosslinking at the Slit Lamp	Farhad Hafezi FARVO MD PhD	2
8:17 AM	Corneal Allogenic Intrastromal Rings for Keratoconus	Alain Saad MD	4
8:23 AM	What New Presbyopia IOLs Am I Using This Year?	Francesco Carones MD	5
8:29 AM	Discussion		

Section II: Simple Explanation On . . . Overview of Topic and Understand Basics

Moderators: Renato Ambrósio Jr MD and Cynthia Roberts PhD

Panelists: Marcus Ang MBBS PhD, Preeya K Gupta MD

8:39 AM	New Tomographers /Imaging Devices	Renato Ambrósio Jr MD	6
8:45 AM	Epithelial Thickness Mapping	Karolinne M Rocha MD	8
8:51 AM	Biomechanics in Cornea Refractive Surgery	Cynthia Roberts PhD	9
8:57 AM	Difference in Trifocal Lenses	Julie M Schallhorn MD	10
9:03 AM	Innovations in Femtosecond Laser for Corneal Refractive Surgery	Ronald R Krueger MD	11
9:09 AM	Therapeutic Refractive Surgery	Simon P Holland MD	12
9:15 AM	Understanding Aberrations	Kashif Baig MD MBA	13
9:21 AM	Discussion		
9:31 AM	United for Sight: A Vision for Effective Advocacy	Vineet (Nick) Batra MD	14

ISRS Awards

9:36 AM	ISRS Awards	Renato Ambrósio Jr MD	
9:46 AM	REFRESHMENT BREAK		

Section III: Video-Based Master Complications

Moderators: Nicole R Fram MD and Elizabeth Yeu MD

Panelists: Brandon Ayres MD, Rosa Braga-Mele MD, and Karolinne M Rocha MD

10:27 AM	Femtosecond Complications (LASIK/SMILE)	Audrey R Talley Rostov MD	17
10:32 AM	Corneal Ring Complications	Shady T Awwad MD	18
10:37 AM	Encountering the IOL Exchange!	J Morgan Micheletti MD	19
10:42 AM	Epithelial Ingrowth	Kathryn Masselam Hatch MD	20
10:47 AM	Misadventures With Phakic IOLs	Ashvin Agarwal MD	21
10:52 AM	Toric IOL Placement in the Setting of Capsule Tears	Soon-Phaik Chee MD	22
10:57 AM	Discussion		

Section IV: Show Me the Evidence—Point-Counterpoint

Moderators: Nicole R Fram MD and William B Trattler MD

Panelists: Kendall E Donaldson MD, Sumitra S Khandelwal MD, Cathleen McCabe MD, and Michael E Snyder MD

11:07 AM	Lens Exchange vs. Piggyback for Moderate Refractive Miss: Take It Out!	Zaina N Al-Mohtaseb MD	23
11:11 AM	Lens Exchange vs. Piggyback for Moderate Refractive Miss: Piggyback It Up!	William F Wiley MD	24
11:15 AM	Simultaneous Bilateral Cataract Surgery (SBCS) vs. Sequential Surgery: SBCS Adds Efficiency	Rupert Michael Menapace MD	25
11:19 AM	Simultaneous Bilateral Cataract Surgery (SBCS) vs. Sequential Surgery: Sequential Surgery Is Safer and More Accurate	Samuel Masket MD	27
11:23 AM	Trifocal vs. EDOF for Presbyopia Correction: Trifocal IOLs Are the Only Way to Satisfy	Damien Gatinel MD	29
11:27 AM	Trifocal vs. EDOF for Presbyopia Correction: EDOF IOLs Are the Best Options for Most	Douglas D Koch MD	31
11:31 AM	Lenticle Extraction vs. LASIK in High Myopia: Lenticle Extraction Offers Accuracy and Stability	John So-Min Chang MD	32
11:35 AM	Lenticle Extraction vs. LASIK in High Myopia: LASIK Offers Faster Recovery	Edward E Manche MD	33
11:39 AM	Implantable Contact Lens (ICL) vs. Laser Vision Correction for Low Myopia: ICLs Are Safe Thanks to New Technology	Gregory D Parkhurst MD	34
11:43 AM	Implantable Contact Lens vs. Laser Vision Correction for Low Myopia: Is This a Serious Question?	Neda Shamie MD	35
11:47 AM	Discussion		

Keynote Lecture

12:00 PM	Introduction	Nicole R Fram MD	
12:01 PM	How Clinical Trials Have Shaped My Refractive Surgical Experience	Vance Michael Thompson MD	36
12:11 PM	LUNCH/ISRS Member Lunch		

Section V: Cutting-Edge Translational Research From the Next Generation

Moderators: Jodhbir S Mehta MBBS PhD and Tanya Trinh MBBS

Panelists: Saama Sabeti MD, Brian M Shafer MD, and Dagny C Zhu MD

1:41 PM	What's New in Corneal Scarring Treatment	Lycia Maria Martins Pinho Pedral Sampaio MD	37
1:47 PM	Corneal Nerve Regeneration and Neuropathic Pain Following Refractive Surgery	Yu-Chi Liu MD MD PhD	38
1:53 PM	Innovations in Collagen Crosslinking	Theo Guenter Seiler MD	39
1:59 PM	Corneal Stromal Regeneration	Larissa Gouvea MD	40
2:05 PM	Tear Biomarkers in Clinical Practice	Pooja Khamar MBBS MS	41
2:11 PM	Corneal Biomechanics: Practical Tips	Riccardo Vinciguerra MD	42
2:17 PM	Discussion		

Section VI: ESCRS Symposium

Moderators: Burkhard Dick MD and Oliver Findl MD

Panelists: Burkhard Dick MD, Oliver Findl MD,
Thomas Kohnen MD PhD FEBO, and Rudy Nuijts MD

2:22 PM	Artificial Intelligence for Optimizing Refractive Outcomes	Oliver Findl MD	47
2:27 PM	The Influence of Artificial Intelligence in IOL Calculation	Thomas Kohnen MD PhD FEBO	48
2:32 PM	Development of Machine Learning Models to Predict Posterior Capsule Rupture Based on the European Registry of Quality Outcomes for Cataract and Refractive Surgery	Rudy Nuijts MD	50
2:37 PM	Innovations in Digital Refractive Cataract Surgery	Burkhard Dick MD	53
2:42 PM	Discussion		

Section VII: Wellness

Moderators: Deepinder K Dhaliwal MD and Audrey R Talley Rostov MD

Panelists: Sabrina Mukhtar MD, Rohit Om Parkash MBBS MS,
and Michelle K Rhee MD

2:52 PM	Creating "High-Performance" Surgeons	Samuel Masket MD	54
2:58 PM	Mind Over Matter	Kavita K Mishra MD MPH	55
3:04 PM	Eating for a Longer Life	Scott M MacRae MD	56
3:10 PM	Discussion		

Section VIII: JRS—Hot Hotter Hottest Late Breaking News

Moderator: J Bradley Randleman MD

3:20 PM	Introduction of the 2023 Troutman Prize Lecturer	J Bradley Randleman MD	
3:21 PM	2023 Troutman Prize Lecture: Losartan Inhibition of Myofibroblast Generation and Late Haze (Scarring Fibrosis) After PRK in Rabbits	Lycia Maria Martins Pinho Pedral Sampaio MD	58
3:36 PM	Ectasia Risk Model: A Novel Method Without Cut-off Point Based on Artificial Intelligence Improves Detection of Higher-Risk Eyes	Marcony R Santhiago MD	59

3:41 PM	Sequential Custom Therapeutic Keratectomy for the Treatment of Granular Corneal Dystrophy Type 1: A Long-term Study	Fabrizio I Camesasca MD	59
3:46 PM	Posterior Corneal Astigmatism Does Not Influence Manifest-Treated Topography-Guided LASIK Outcomes	Avi Wallerstein MD	59
3:51 PM	The Most Cited Articles and Authors in Refractive Surgery	J Bradley Randleman MD	59
3:56 PM	Discussion		
4:06 PM	REFRESHMENT BREAK		

Section IX: Innovation (not eligible for CME credit)

Moderators: Sheraz M Daya MD and Sonia H Yoo MD

Panelists: Dimitri T Azar MD, Stephen S Lane MD, Rajesh K Rajpal MD, and Dirk Muehlhoff

4:36 PM	Brillouin Imaging/Spectroscopy and Biomechanics	Julian D Stevens DO	60
4:42 PM	Drug-Eluting IOLs	Kenneth J Mandell MD PhD	61
4:48 PM	Artificial Intelligence for Refractive Surgery	Dimitri T Azar MD	62
4:54 PM	Telemedicine in Cataract and Refractive Surgery	Giselle C Ricur MD	63
5:00 PM	Myopia Control: Light Therapy vs. Drops/Lenses	Mingguang He MD PhD	64
5:06 PM	Discussion		
5:26 PM	Closing Remarks	Jodhbir S Mehta MBBS PhD Nicole R Fram MD	
5:27 PM	Adjourn		

Artificial Intelligence for Ectasia Risk Assessment

Renato Ambrósio Jr MD

NOTES

Crosslinking at the Slit Lamp

Farhad Hafezi FARVO MD PhD

Introduction

Office-based corneal crosslinking (CXL) at the slit lamp represents a convenient alternative to the traditional operating room (OR) environment for performing this procedure—and reflects a bigger-picture move of procedures like intravitreal injections[1] or cataract surgery[2] from the OR to procedure rooms or even the doctor's office. The potential advantages of slit lamp CXL are reduced cost and added convenience, as OR-based CXL involves staff and operational costs and requires booking a time slot.[3] This has the potential to increase accessibility to the procedure, as not only are cost barriers reduced but the requirement for a hospital with an OR is also eliminated.[3] This may be of particular significance in low-to-middle income countries where populations tend to be predominantly rural but hospitals are located only in large conurbations. Slit-lamp CXL also permits the entire spectrum of modern CXL protocols and techniques to be performed, like sub400 ultrathin cornea CXL and phototherapeutic keratectomy (PTK)-assisted customized epi-on crosslinking (PACE).

Background Observations

However, the shift from the conventional sterile OR environment to the slit lamp has raised some concerns, at least in theory. These include questions about the sterility of the procedure, patient comfort during potentially lengthy irradiation times when sitting upright at the slit lamp, and the influence of gravity on the distribution of riboflavin within the stroma after its application. This presentation will explore these concerns in detail, with insights drawn from recent research in the field. The intention is to provide a balanced and comprehensive understanding of slit-lamp CXL in the context of modern corneal crosslinking procedures.

Addressing Concerns

CXL has a direct pathogen killing effect. The absorption of ultraviolet (UV) photon energy by riboflavin generates reactive oxygen species (ROS). The desired effect of these ROS in CXL for ectasia is to create covalent bonds between molecules within the essentially acellular stroma, thereby strengthening it and slowing or halting ectasia progression. But these ROS also directly attack and damage the cell membranes and nucleic acids of pathogens, resulting in a direct, pathogen-agnostic killing effect—to such an extent that CXL can be used as a direct, and even stand-alone, treatment for infectious keratitis, known as photoactivated chromophore for keratitis-CXL (PACK-CXL).[4,5] Given that antimicrobial prophylaxis and bandage contact lenses are administered immediately on completion, the risk of postoperative infection is almost completely related to how carefully the case is managed after the procedure (ie, patient adherence to postoperative prophylactic drug regimens), not the setting in which the procedure was performed.[3]

Traditionally, CXL has been an "epi-off" procedure, in that the corneal epithelium that protects the cornea from the environment also represents a barrier to riboflavin (and to some extent, oxygen and also UV light) penetration into the stroma.[6] Its removal facilitates stromal riboflavin saturation, but its regrowth typically takes several days, during which antimicrobial prophylaxes are vital and pain management is essential. However, "epi-on" CXL—where the epithelium is left intact and riboflavin is delivered to the stroma with either penetration enhancers or via iontophoresis—should eliminate or at least significantly mitigate these issues.[7] Unfortunately, historic epi-on techniques have failed to strengthen the cornea as effectively as epi-off procedures, and several additional elements have been implemented to try and increase its stiffening efficacy, such as supplemental oxygen. Today, using second-generation penetration enhancers, atmospheric air, and a unique pulsed, slow irradiation, high-fluence crosslinking protocol, epi-on CXL can now be implemented without requiring additional oxygen or iontophoresis.[8] This approach provides additional patient comfort and further reduces the risk of infection, especially in the postoperative period, and adds to the appeal of office-based slit-lamp CXL.

Regarding concerns that the 30-minute irradiation period might cause patients discomfort, it is now clear that accelerated CXL protocols (where UV intensity is increased and duration is reduced accordingly) can produce the desired ectasia-halting efficacy. We had previously shown that accelerated CXL protocols deliver a reduced stiffening effect, thanks to the faster depletion of oxygen—a rate-limiting component of the reaction that may make accelerated protocols less attractive in cases where the full strengthening effect is desired (such as in aggressive pediatric cases). However, we have recently published a 10 J/cm^2-fluence accelerated epi-off protocol that delivers the same robust efficacy as the Dresden Protocol but with only 9 minutes and 15 seconds of 18 mW/cm^2 UV irradiation.[9] If one spends a minute to ensure that the patient is comfortable in a chair and the slit-lamp height is correctly adjusted, almost any patient can sit comfortably for 10 minutes.

Finally, it has been suggested that the simple effect of gravity could cause riboflavin to settle in the inferior cornea if the patient is sitting upright for an extended period. This has been evaluated experimentally: no sedimentation or significant alteration in riboflavin concentration in the corneal stroma occurs, even after an experiment subject had sat upright for 1 hour (twice the duration of the Dresden Protocol).[10]

Conclusion

CXL at the slit lamp should be as safe and effective as CXL performed in an OR. There should be no sterility or comfort disadvantage to the patient, and riboflavin settling is not an issue. Slit-lamp CXL therefore represents a significant advancement in terms of accessibility and affordability.

References

1. Veritti D, Sarao V, Chhablani J, et al. The ideal intravitreal injection setting: office, ambulatory surgery room or operating theatre? A narrative review and international survey. *Graefes Arch Clin Exp Ophthalmol*. Epub ahead of print 2023 May 18. doi: 10.1007/s00417-023006108-y.
2. Ianchulev T, Litoff D, Ellinger D, et al. Office-based cataract surgery: population health outcomes study of more than 21 000 cases in the United States. *Ophthalmology* 2016; 123(4):723-728.
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4. Hafezi F, Hosny M, Shetty R, et al. PACK-CXL vs. antimicrobial therapy for bacterial, fungal, and mixed infectious keratitis: a prospective randomized Phase 3 trial. *Eye Vis (Lond)*. 2022; 9(1):2.
5. Hafezi F, Randleman JB. PACK-CXL: defining CXL for infectious keratitis. *J Refract Surg*. 2014; 30(7):438-439.
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10. Salmon B, Richoz O, Tabibian D, et al. CXL at the slit lamp: no clinically relevant changes in corneal riboflavin distribution during upright UV irradiation. *J Refract Surg*. 2017; 33(4):281.

Corneal Allogenic Intrastromal Rings for Keratoconus

Alain Saad MD, Nicole Mechleb MD, and Damien Gatinel MD

I. Corneal Allogenic Intrastromal Rings (CAIRS) Preparation

   A. Manual preparation: Jacob trephine

   B. Femtosecond laser (FSL)-assisted preparation

      1. Artificial chamber pressurized (ACP): pressure selection

      2. WaveLight FS200 nomogram

      3. Other FSLs (LDV Z8, iFS)

II. CAIRS Implantation

   A. FSL corneal tunnel parameters: width, optical zone diameter and depth

   B. Surgical technique: tips and tricks

      1. Double FSL cut and 2 opposite incisions

      2. Preoperative dehydration

   3. Epithelial marking

III. Surgical Results

   A. Visual and refractive results

   B. Topographic modifications

   C. Aberrometric modifications

What New Presbyopia IOLs Am I Using This Year?

Francesco Carones MD

Introduction

Presbyopia-correcting IOLs have become widely available in recent years to assist patients in achieving spectacle independence after having their crystalline lens replaced for refractive- or cataract-related reasons. These lenses vary in terms of the range of vision they offer as well as any potential compromises they may cause, particularly with regard to night dysphotopsia and decreased contrast sensitivity.

Background and Observations

Presbyopia-correcting IOLs perform differently, according to their optics. In general, diffractive optics offer a full range of vision (from infinity to close range), but at the expense of dysphotopsia or other vision quality. Nondiffractive optics, on the other hand, are more tolerant of compromises while providing a wider range of vision (from infinity to intermediate distance, where close range vision is functional). Presbyopia can be partially mitigated by the most recent generation of enhanced monofocal IOLs, which offer some additional depth of focus. This is especially true when implanted bilaterally with any micro/mini-monovision aim outcome.

The New IOLs

A new, nondiffractive, increased range of vision IOL with an add power between 1.50 and 2.00 D is called PureSee (Johnson & Johnson Vision). The depth of focus is lengthened and extended by a linear aspheric profile in the optics design. The induced night vision symptoms are negligible and equivalent to those of an enhanced monofocal IOL, thanks to the patented design. When implanted bilaterally, the profile for spectacle independence is quite good, especially when intending a residual quantity of mild myopia (–0.50 D or less) in either eye.

The Impress (Hoya Surgical Optics) is an enhanced monofocal IOL that extends the depth of focus by 0.75 to 1.0 D thanks to its nonlinear, nondiffractive optics design. This lens is not labeled as correcting presbyopia, but when implanted bilaterally and planned to leave some residual myopia (–0.75 to –1.00 D) in the nondominant eye, the lens can mitigate it and lessen spectacle dependence for intermediate vision as well as allowing some functional close vision. The Impress dysphotopsia profile is identical to that of a conventional monofocal IOL, and it can safely be used to replace conventional monofocal IOLs.

Considerations

These 2 novel IOLs give the surgeon performing lens replacements more alternatives for treating presbyopia. Regarding the range of vision they offer, nondiffractive technologies still fall short of diffractive ones. They do, however, present a wide enough range of vision to target for independence from spectacles, especially when implanted bilaterally in a mini-monovision way. With better profiles related to reduced contrast sensitivity and night dysphotopsia, these IOLs may be more appropriate for those patients who are concerned about these issues.

New Tomographers/Imaging Devices

Renato Ambrósio Jr MD

The beginning of wisdom is to call things by their proper name.
—Confucius

I. The What's: Defining Multimodal Refractive Imaging[1]—Basic Nomenclature for Corneal Imaging

A. Corneal topography: characterization of the front surface of the cornea

1. Placido disk corneal topography[2]
2. Reflection-based systems[3]

B. Corneal pachymetry: assessing corneal thickness from a single point at the center and/or paracentral points, typically with ultrasound A-scan[2]

C. Corneal tomography: 3-D corneal characterization, depicting front and back elevation and thickness mapping[3]

1. Scheimpflug tomography (rotating, horizontal or vertical)
2. OCT
3. Digital very high-frequency ultrasound

D. Segmental or layered corneal tomography: assessing corneal layers

1. Epithelial thickness mapping[4]
   a. Ultrahigh-resolution Scheimpflug tomography
   b. OCT[5,6]
   c. Digital very high-frequency ultrasound[7,8]
2. Bowman layer thickness and regularity[9]
   a. Ultrahigh-resolution OCT
3. Descemet membrane/endothelium thickness[10]
   a. Scheimpflug tomography
   b. Ultrahigh-resolution OCT

E. Corneal biopsy ultrahigh-resolution OCT[11]

Also, besides assessing corneal geometry and shape, we should consider assessing biomechanical properties, corneal cells, and tear film.

He who has a why to live for can bear almost any how.
—Friedrich Nietzsche

II. The Why's: Purpose and Goals for Diagnostics and Imaging for Refractive Surgery

A. Understand the overall needs and expectations of the patient

1. Determine if it is elective or therapeutical
2. Patient education about risks, limitations, and refractive aging

B. Comprehensive ophthalmological assessment

C. Assess refractive error and optical/vision quality

D. Assess corneal shape/structure

E. Diagnosis of keratoconus and ectatic corneal diseases[12]

1. Screening for ectasia risk
2. Confirming the diagnosis
3. Classification of ectatic corneal disease
4. Staging
5. Prognosis
6. Treatment and follow-up

F. Diagnosis of Fuchs endothelial corneal dystrophy and corneal edema

1. Characterizing corneal guttata
2. Detecting subclinical corneal edema

G. Assess crystalline lens function (clarity and accommodation)

H. Customize the most appropriate refractive procedure (optimize efficiency and safety)

1. Decide if corneal laser vision correction, phakic IOL, or refractive cataract surgery
2. If corneal laser vision correction: PRK (ASA), SMILE, or LASIK
3. Other

I. Customize treatment plan

J. Postoperative evaluation for monitoring outcomes and refractive efficiency

K. Proactive detection of potential complications and proper management

III. The Role of Artificial Intelligence (AI)

A. The plethora of generated data from multimodal refractive imaging

B. The need for objective and accurate approach considering the variability of subjective interpretation even by fellowship-trained experts[13]

C. Multidimensional assessment power by AI for supporting clinical decision-making[14-17]

D. The algorithm $(A^2I)^2$ applied ancient intelligence (or philosophy—the Why's) and applied AI (the How's).

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Epithelial Thickness Mapping

Karolinne M Rocha MD

NOTES

Biomechanics in Cornea Refractive Surgery

Cynthia J Roberts PhD

I. Clinical Assessment of Biomechanical Response
   A. Ocular Response Analyzer (ORA; Reichert Technologies; Depew, NY)
      1. Viscoelastic response
      2. Corneal hysteresis
   B. Corvis ST (Oculus; Wetzlar, Germany)
      1. Elastic response
      2. Stiffness

II. What Influences Biomechanical Effect on Refractive Outcomes?
   A. Amount of tissue removed
      1. Depth of tissue removal
      2. Width of tissue removal: Optical zone vs. ablation zone, which includes transition zone
   B. Residual stromal bed

III. Biomechanics of Surface Ablation vs. LASIK vs. SMILE
   A. Biomechanics of surface vs. flap vs. cap
   B. Residual stromal bed

IV. IOP Measurement Error
   A. Applanation tonometry is not accurate following refractive surgery, with potentially large errors.
      1. Mean decrease of IOP in large population studies of myopic procedures
         a. Individually measured IOP may be increased or decreased: not predictable.
         b. Assumptions in Goldmann equation are violated, so no longer valid.
   B. Which tonometer should be used?
      1. Corneal compensated IOP from ORA
      2. Biomechanically corrected IOP from Corvis ST

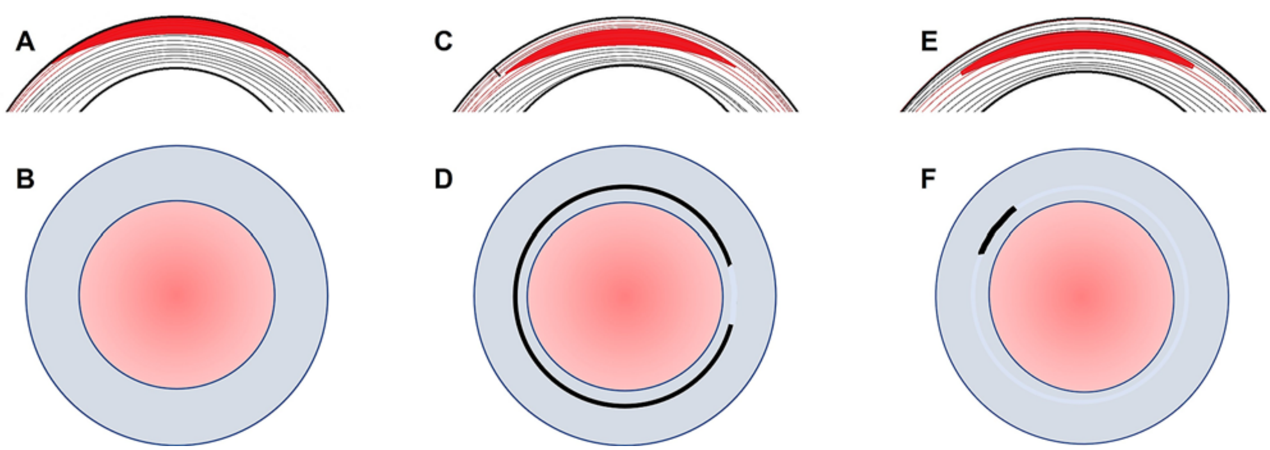

Figure 1. (A) Central profile of tissue removal (red) for a myopic surface ablation with anterior peripheral lamellae no longer in tension. (B) Top view of surface ablation without a flap or a cap. (C) Central profile of tissue ablated (red) in myopic LASIK with a flap overlying the ablated region and contiguous peripheral lamellae without tension. Severed lamellae in anterior flap region can no longer bear tension. (D) Top view of LASIK with near circumferential severing of lamellae in flap region with the presence of a hinge, often nasal. (E) Central profile of lenticule creation for tissue removal in myopic SMILE with a cap overlying the lenticule and lamelle in region of cap under reduced tension than preoperatively due to longer arclength on posterior cap than anterior residual stromal bed. (F) Top view of SMILE with small side cut for lenticule removal, often superotemporal. Reprinted with permission from: Yuhas PT, Roberts CJ. Clinical ocular biomechanics: Where are we after 20 years of progress? *Curr Eye Res.* 2023; 48:89-104.

Difference in Trifocal Lenses

Julie M Schallhorn MD

NOTES

Innovations in Femtosecond Laser for Corneal Refractive Surgery

Ronald Krueger MD

NOTES

Therapeutic Refractive Surgery

Simon P Holland MD, David T C Lin MD FRCSC,
Greg Moloney MBBS BSCMed MMed FRCSC, Derek Chan BSc, and Parham Elmi BSc

I. Applications of Laser Refractive Surgery for Therapeutic Indications: A Developing Area of Ophthalmology

II. Laser Technology

III. High-Speed Laser

IV. Multidirectional High-Speed Tracker: Variations Between Laser Platforms Transepithelial Mode (TE PRK)

V. Technique: Predominantly Surface Ablation

VI. Alternatives
   A. LASIK
   B. SMILE
   C. Ring segments
   D. Corneal allogenic intrastromal ring segments

VII. Indications
   A. Irregular astigmatism
      1. Keratoconus (with crosslinking)
      2. Post-LASIK ectasia
      3. Post keratoplasty
      4. Post radial keratotomy
      5. Previous laser eye surgery
      6. Correction of corneal scarring
   B. Difficulties with laser refractive surgery
      1. Contact lens intolerance
      2. SMILE complications
      3. Poor image capture with wavefront
      4. Post cataract refractive error
      5. Optical zone expansion
      6. Flap trauma
      7. Retreatment/enhancement for previous refractive surgery

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Understanding Aberrations

Kashif Baig MD MBA

Clinical Aberrations

I. What Are They?

II. How Are They Measured?

III. Key Aberrations to Understand

IV. Clinical Management of Common Aberrations

Selected Readings

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United for Sight: A Vision for Effective Advocacy

Refractive Surgery Subspecialty Day 2023

Vineet (Nick) Batra MD

Action Requested: *Donate to strengthen ophthalmology's legislative voice and protect patients and your profession*

Please respond to your Academy colleagues and join the community that advocates for ophthalmology: OPHTHPAC, the Surgical Scope Fund, and your State Eye PAC. Ensure you and your patients are heard by our nation's lawmakers by giving to each of these funds.

Where and How to Contribute

During AAO 2023 in San Francisco, please contribute to OPHTHPAC® and Surgical Scope Fund at one of our two convention center booths or online. You may also donate via phone to both funds by sending two texts:

- Text **MDEYE** to **41444** for OPHTHPAC
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We also encourage you to support our congressional champions by making a personal investment via OPHTHPAC Direct, a unique and award-winning program that lets *you decide* who receives your political support.

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

Why Should You Contribute?

Member support of the Academy's advocacy funds—OPHTHPAC and the Surgical Scope Fund—powers our advocacy efforts at the federal and state levels. When you give to OPHTHPAC, you give ophthalmology a voice on Capitol Hill on critical issues like Medicare payment, optometry's scope expansion efforts in the VA, and prior authorization and step therapy burdens. When you give to the Surgical Scope Fund, you're funding our efforts to fight dangerous optometric surgery initiatives at the state level, whenever and wherever they arise. And finally, when you give to your state Eye PAC, you help elect officials in your state who will support the interests of you and your patients. Giving to *each* of these three funds is essential to helping protect sight and empower lives.

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

OPHTHPAC for Federal Advocacy

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

- **Improving** the Medicare payment system, so ophthalmologists are fairly compensated for their services, and working to prevent impending payment cuts of 3.36% scheduled to take effect in 2024
- **Securing** payment equity for postoperative visits, which will increase global surgical payments
- **Stopping** optometry from obtaining surgical laser privileges in the veterans' health-care system
- **Increasing** patient access to treatment and care by reducing prior authorization and step therapy burdens

Academy member support of OPHTHPAC makes all this possible. Your support provides OPHTHPAC with the resources needed to engage and educate Congress on our issues, helping advance ophthalmology's federal priorities. Your support also ensures that we have a voice in helping shape the policies and regulations governing the care we provide. Academy member support of OPHTHPAC is the driving factor behind our advocacy push, and we ask that you get engaged to help strengthen our efforts and make sure that the ophthalmology specialty has a seat at the table for the critical decisions being made that affect our ability to care for our patients.

At the Academy's annual Mid-Year Forum, the Academy and the American Society of Cataract and Refractive Surgery (ASCRS) ensure a strong presence of refractive surgeons to support ophthalmology's priorities. The ASCRS is a crucial partner with the Academy in its ongoing federal and state advocacy initiatives.

Surgical Scope Fund (SSF) for State Advocacy

The Surgical Scope Fund works in partnership with state ophthalmic societies to protect patient safety from dangerous optometric surgery proposals through advocacy. The Fund's mission is to ensure surgery by surgeons, and since its inception, it has helped 43 state/territorial ophthalmology societies reject optometric scope-of-practice expansions into surgery.

Support for the Surgical Scope Fund from ophthalmic interest societies like the American Society of Cataract and Refractive Surgery makes our advocacy efforts possible. These efforts include research, lobbyists, political organization, polling, advertising, social media, digital communications, and grassroots mobilization. However, the number of states facing aggressive optometric surgery legislation each year has grown exponentially. And with organized optometry's vast wealth

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 *No* funds may be used for campaign contributions or PACs.	Campaign contributions, legislative education	Campaign contributions, legislative education
Contributions: Unlimited Individual, practice, corporate, and organization	Contributions: Personal contributions are limited to $5,000. Corporate contributions are confidential.	Contribution limits vary based on state regulations.
Contributions are 100% confidential.	Personal contributions of $199 or less and all corporate contributions are confidential. Personal contributions of $200 and above are public record.	Contributions are on the public record depending upon state statutes.

of resources, these advocacy initiatives are becoming more intense—and more expensive. That's why ophthalmologists must join together and donate to the Surgical Scope Fund to fight for patient safety.

The Academy's Secretariat for State Affairs thanks ASCRS for its past support of the Surgical Scope Fund and looks forward to its 2023 contributions. The ASCRS' support for the Surgical Scope Fund is essential to fighting for patient safety and quality eye care!

State Eye PAC

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

Support Your Colleagues Who Are Working on Your Behalf

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

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NOTES

Femtosecond Complications (LASIK/SMILE)

SMILE Complications

Audrey Rostov MD

I. Suction Loss
  A. Early vs. late
  B. Redock
  C. Convert
  D. PRK
II. Difficult Lenticle Extraction
  A. Check for posterior dissection
  B. Energy management
  C. Opaque bubble layer
III. Retained Lenticle
  A. Check with slit beam at end of case
  B. Intraoperative vs. postoperative management
IV. Diffuse Lamellar Keratitis
  A. Mild
  B. Moderate
  C. Severe
V. Interface Fluid Syndrome
  A. Recognition
  B. Management
VI. Epi Ingrowth/Implantation
  A. Removal/manual
  B. YAG laser

Corneal Ring Complications

Shady Awwad MD

I. Intraoperative

   Perforation into the anterior chamber

II. Postoperative

   A. Early postoperative

      1. Infection
      2. Epithelial ingrowth
      3. Glare and haloes

   B. Late postoperative

      1. Anterior stromal necrosis/melt
         a. Percentage
         b. Appearance
            i. slit lamp
            ii. imaging
         c. Natural course
         d. Treatment
            i. removal
            ii. exchange with corneal allogenic intrastromal ring segments
      2. Intrusion into the anterior chamber
         a. Percentage
         b. Natural course
         c. Treatment
      3. Neovessels
      4. Minor side effects
         a. Crystal deposits
         b. Iron lines

Encountering the IOL Exchange!

J Morgan Micheletti MD

This presentation provides a concise overview of IOL exchange, beginning with the "when" and "why" before segueing into a few scenarios that necessitate IOL exchanges. Attendees will be introduced to useful tips and techniques, and potential challenges or complications will be discussed. The aim is to enhance surgical proficiency and foster a deeper understanding of the dynamic landscape of IOL exchange.

Epithelial Ingrowth

Kathryn Masselam Hatch MD

NOTES

Misadventures With Phakic IOLs

Ashvin Agarwal MD

Introduction

Phakic ICL is the premium technology for refractive error correction. A lens, usually customized, is placed in a phakic eye to act as an additional optical surface in order to reduce the refractive error of that eye. Many different types of phakic IOLs are available on the market. In this presentation, I wish to highlight some of the ICL misadventures I have faced in my career, ranging from preoperative sizing issues to intraoperative and postoperative complications that need to be resolved.

Video Description

The presentation will demonstrate the most common misadventures I have personally faced and how we can address them—both from an immediate treatment and from a prevention perspective—as we build our careers as premium refractive surgeons. The presentation will showcase sizing issues, high vault/low vault, explantation of ICL and all its indications (cataract, damaged ICL, etc.), inverted phakic ICL, and more.

Selected Readings

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Toric IOL Placement in the Setting of Capsule Tears

Soon-Phaik Chee MD

I. Introduction

A. Correction of astigmatism during cataract surgery makes for the happiest patients.

B. Encountering an intraoperative complication that prevents the surgeon from implanting a toric IOL as planned is one of the greatest fears many surgeons have.

C. When the capsule is compromised, achieving placement of the toric IOL in the appropriate meridian and maintaining rotational stability can be challenging.

D. With every 1 degree of misalignment, the toric IOL loses 3% of its cylinder-correcting power, and with 30 degrees of misalignment, the toric power is neutralized.

II. Pearls for Maintaining IOL Rotational Stability

A. Complete capsulorrhexis overlap of optic

B. Complete removal of ophthalmic viscoelastic device from behind the IOL

C. Tap IOL against the posterior capsule.

D. Leave eye with a little lower IOP, thus preventing overinflation of bag.

E. Maintain supine position for first hour postoperatively to avoid IOL rotation.

III. What to Do When There Is a Posterior Capsule Tear With No Loss of Posterior Capsule

A. Place the IOL in the capsular bag along intended meridian.

B. If the IOL is unstable because of the meridian of the intended axis, consider reverse optic capture by bringing the optic anteriorly through the capsulorrhexis using 2 Sinskey hooks.

IV. What to Do When There Is a Posterior Capsule Tear With Capsular Defect

A. Insert the IOL into the anterior chamber, and rotate the IOL to the intended meridian using a Sinskey hook. Grasp the IOL with lens micrograsping forceps, and flex the IOL haptics into the capsular bag using a Sinskey hook at the appropriate meridian.

B. Release the optic so that it lies anterior to the capsulorrhexis rim (reverse optic capture).

V. What to Do When the Capsulorrhexis Runs Out but Is Brought Back Eventually, Leading to a Hugely Oversized Capsulorrhexis Resulting in IOL Rotational Instability?

A. Create a centered, round posterior capsulorrhexis around 1.5 mm smaller than the optic.

B. Insert the IOL into the capsular bag, and buttonhole the optic through the defect at the intended meridian using a Sinskey hook.

VI. What to Do When There Is an Anterior Capsule Tear Extending Posteriorly to Involve the Posterior Capsule

A. Place the IOL in the capsular bag along the intended meridian

B. If the IOL is unstable, rotate the IOL to nearest axis achieving stability. Some degree of toric power correction will be lost with this, but it is unavoidable in this scenario.

VII. Important to Note

A. In all cases, check for the presence of vitreous before IOL insertion. Visualization of vitreous may be enhanced by the use of diluted triamcinolone acetonide.

B. The IOL may first be introduced into the anterior chamber filled with viscoelastic and rotated to the appropriate meridian before the haptic is maneuvered, one by one, into the capsular bag using a Sinskey hook while being supported by an IOL micrograsper.

C. Predominantly classic subfoveal choroidal neovascularization (CNV) secondary to AMD

D. Subfoveal CNV secondary to pathologic myopia (VIP-PM Trial)

E. Subfoveal CNV secondary to ocular histoplasmosis syndrome; safety and efficacy study

Selected Reading

1. Inoue Y, Takehara H, Oshika T. Axis misalignment of toric intraocular lens: placement error and postoperative rotation. *Ophthalmology* 2017; 124(9):1424-1425.

Lens Exchange vs. Piggyback for Moderate Refractive Miss: Take It Out!

Zaina N Al-Mohtaseb MD

NOTES

Lens Exchange vs. Piggyback for Moderate Refractive Miss: Piggyback It Up!

William F Wiley MD

I. Introduction

Traditional IOL formulas have dramatically decreased the incidence of refractive misses. However, they still occur and require appropriate attention. The "piggyback" secondary lens is an effective tool.

II. Alternatives and Considerations for Refractive Miss

When presented with a refractive miss, there various considerations.

A. LASIK

B. IOL exchange

C. Piggyback

III. Considerations

A. What is the magnitude of the refractive miss?

B. Has the patient had a YAG capsulotomy?

C. What is the residual refractive error?

1. Myopic: Consider LASIK, IOL exchange, or piggyback.
2. Hyperopic: Strongly consider IOL exchange or piggyback IOL.
3. Astigmatism: Consider IOL exchange or corneal refractive surgery.

D. Other pathology

1. Ocular surface considerations
2. Narrow angles/glaucoma
3. Zonule support
4. Dysphotopsias

IV. IOL Calculations

A. Astigmatismfix.com

B. Holiday IOL calculation software

V. Potential Complications

A. IOL subluxation

B. Pigment dispersion

C. Interlenticular opacification

VI. Lens Material: Acrylic vs. Silicone

VII. Other Considerations

A. Phakic IOLs

B. Light-adjustable IOLs

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Simultaneous Bilateral Cataract Surgery (SBCS) vs. Sequential Surgery: SBCS Adds Efficiency

Rupert M Menapace MD

Immediate simultaneous bilateral cataract surgery (ISBCS) is gaining attention in an environment of escalating health-care costs and rapidly growing numbers of cataract patients, while evidence of its noninferiority regarding safety and outcomes is accumulating.

Advantages of ISBCS

Medical

ISBCS avoids repeated physical and psychological stress for the mostly elderly patients and halves personal contacts and thus risk for infection during epidemics (COVID, flu). It accelerates binocular visual rehabilitation and reduces risk of falls until second eye surgery, especially with higher anisometropia. And it improves surgical outcome in the second eye because of surgeon's fresh experience with the mostly mirror-image anatomy of the first eye (eg, rhexis size and centration).

Socioeconomic

ISBCS can save 50% of hospital costs, or around 1000 Canadian dollars per patient. It halves time and costs for transportation (for the United States, additional distances of 450 miles per patient were calculated for second eye cataract surgery) and after-care (drug instillation, visits to ophthalmologist and optician) by professionals and relatives, especially with immobile or remote living patients. It increases patient throughput in surgical units and reduces waiting time. When taking the 0.06% rate of the European Society of Cataract and Refractive Surgeons study published in 2006 as a basis, additional costs of 3 billion dollars would accumulate with sequential surgery versus ISBCS until the first bilateral endophthalmitis (BE) statistically occurs.

Prerequisites for ISBCS

- Strict aseptic measures, every single eye treated fully separate (washing, draping)
- Highest sterilization standards, elimination of any linkage factors for instruments, consumables, and implants by using different batches and lots
- Particular attention to flawless wound construction (posterior-limbal square incision)
- Intracameral antibiotic prophylaxis and combined cortisone and NSAID as postop regimen
- Meticulous patient instruction regarding early signs of endophthalmitis and 24/7 availability for consultation, diagnostic workup, and treatment (“red telephone”)
- Exclusion of patients with active macular or retinal diseases, uveitis, risk for cystoid macular edema (CME), risk for corneal decompensation, or odd eyes with divergent IOL power predictions

Concerns and Drawbacks of ISBCS

Fear of bilateral endophthalmitis (BE) and toxic anterior segment syndrome (TASS) and their legal consequences

Actual calculated risk is 1 case per 4-12 million patients; risk of fatal car accident is far higher than that of bilateral blinding with ISBCS (U.S. Census Bureau). In all 4 cases of BE published, guidelines were blatantly violated. Blinding by endophthalmitis can often be avoided when diagnosed at its onset and immediately treated.

Fear of bilateral CME

Typical onset of 4-10 weeks postop would require similar offset of second eye surgery, which is not the usual practice. Prophylactic measures do not exclude CME in the second eye.

Fear of bilateral refractive surprise

This fear stems from the lack of opportunity for second eye power adjustment. However, statistical spread and outliers have been greatly reduced with modern measuring and calculation methods, and the usual 2-7 day delay of second eye surgery may be too short for reliable power adjustment.

Personal Experience With ISBCS

I adopted routine ISBCS at my academic hospital particularly for bilateral comparison study patients in 2007. Until 2021, 3600 of my own patients have profited from it.

Every eye was meticulously disinfected and separately draped, and different infusion and ophthalmic viscosurgical device lots or products were used. A longer-than-wide internally funneled 2.2-mm posterior-limbal incision was created temporally with a special (“arrow”) knife (KAI; Japan), and the incision was checked for spontaneous sealing and deformation stability at the end of surgery before hydration. Cefuroxime was applied intracamerally. Before dismission, globe pressurization was ensured by inferior scleral globe palpation when looking upward. The patient had to wear protective goggles for the rest of the day.

No case of endophthalmitis occurred in the 7200 eyes. One case of clinically significant bilateral CME was successfully treated by topical and systemic cortisone. Three lenses were exchanged for a refractive surprise, 2 of them because of an erroneously set target refraction. Patient feedback was excellent, resulting in a difficult-to-satisfy demand.

Along with improved day-clinic and OR workflow, ISBCS increased the surgical throughput significantly, as well as the financial savings: For the 3600 ISBCS patients I operated between 2007 and 2021, estimated savings amounted to 3 million dollars and 1.5-2 months of OR utilization time when assuming 8 hours on 5 weekdays.

Conclusion

ISBCS has been widely adopted in sparsely populated countries like Scandinavia and Canada for decades and is officially classified by the Spanish health authorities as equally effective and safe as delayed sequential cataract surgery. BE or refractive surprises are not issues when strictly following the guidelines. Though particularly profitable for immobile and remote living patients, ISBCS has great potential to gain widespread acceptance, as it saves money, time, and effort, as well as carbon. Rather than the concern of BE and refractive surprises, reimbursement appears to be the main obstacle: Health authorities and insurances must be convinced that surgeons ready to adopt ISBCS as their routine should rather be financially rewarded than punished and supported in the optimization of their surgical skills and settings, thus saving enormous amounts of public expense, relieving society and environment by halving expenditures for patient transportation and care, and supporting struggling health systems to cope with the rapidly growing demand for cataract surgeries.

Simultaneous Bilateral Cataract Surgery (SBCS) vs. Sequential Surgery: Sequential Surgery Is Safer and More Accurate

Samuel Masket MD

There are 3 arms to medical care delivery: the patient, the provider, and the payer. As I view the paradigm, what best suits the patient is paramount. To my sense, immediate sequential bilateral cataract surgery (ISBCS) represents an economic model that benefits payers to a great extent, providers to a lesser extent in time savings and efficiency modelling, and patients, in my estimation, little, if at all. However, on that note, U.S. providers (surgeons and facilities) of ISBCS under traditional Medicare are at a financial disincentive in that second eye surgery is reimbursed at only 50%. Patient advantage can be measured only in fewer visits for surgery and postoperative care, potentially saving time and freeing family members or other supportive individuals. However, a strategy that offers surgery on one day with a follow-up exam and surgery 2 days later for the fellow eye can greatly reduce extra visits while allowing the benefits of delayed bilateral cataract surgery (DBCS).[1] Although there is little published evidence for major bilateral complications after ISBCS, and a recent retrospective investigation employing "big data" failed to find an increased incidence of bilateral endophthalmitis with ISBCS, one remaining concern is that serious complications tend to be underreported.[2] In fact, within the past year I have reviewed 2 literature submissions of bilateral postop endophthalmitis that have not yet been published. Moreover, early adapters may be more diligent regarding safety protocols than might be the rank and file of practitioners.

Another separate and parallel issue is patient adaptation to the implanted IOL, particularly in the case of diffractive optic IOLs, as it is impossible to ascertain tolerance prior to surgery. A given number of patients will be dissatisfied with IOLs of that design despite emmetropia, absence of complications, and no ocular comorbidities.[3] Indeed, in one randomized trial comparing monofocal to multifocal satisfaction, 5.7% of multifocal IOLs required exchange, whereas that was true for none of the monofocal implants.[4] The same concern may occur with regard to positive or negative dysphotopsia. Hence, in my view, potential optical side effects of cataract/IOL surgery represent a key drawback to ISBCS, as the patient may require bilateral IOL exchange if highly symptomatic. Moreover, the refractive results of surgery for the first eye remain unknown when performing bilateral surgery, another negative in my estimation. Indeed, a recent investigation employing the same "big data" referenced above revealed a statistically significant second eye optical error when comparing ISBCS to DBCS.[5] This may be obviated with IOLs that allow for postoperative adjustment of the optical outcome of surgery, albeit at sizable expense to the patient for such technology.

It appears and appeals to my sensibility that the patient should be the final arbiter in the decision to have one or both eyes operated for cataract on the same day.[6] Certainly, ISBCS might be acceptable and perhaps preferable on occasion,but not in my view on a routine basis.

I am curious to know when, how, and why we as a society or as a profession moved away from the interests of the individual patient and toward the "bottom line" of economics? A possible answer lies in our changing demographics. As can be noted in Figure 1, the U.S. Census Bureau confirms a "greying" of our society, with a roughly 50% increase in the over-65 population between 2016 and 2030. Given that cataract is, in general, a disease of aging, the "cataract burden" will only increase with time, and as a result, efficiency in the delivery of care will be paramount. "Greying" also applies to ophthalmologists. In the United States we currently train approximately 450 ophthalmologists annually, but more are retiring in the same time frame, setting up a potential workforce deficit.

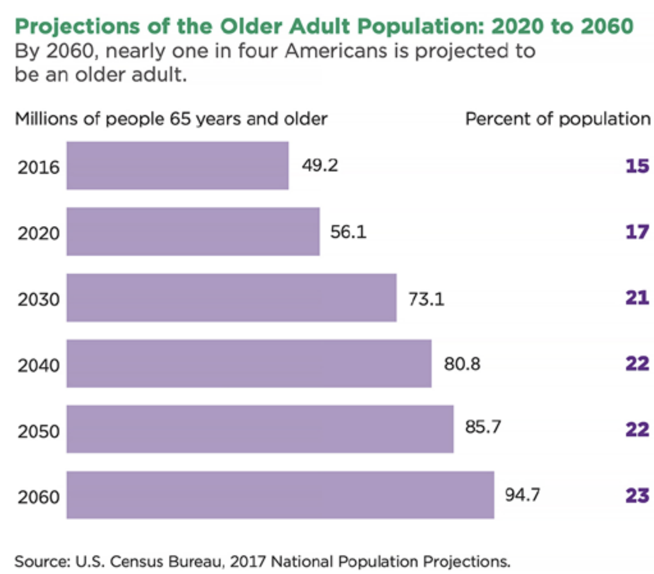

Figure 1. Projected demographic changes in U.S. population over time.

In some settings, freestanding outpatient eye surgery centers may be limited. This mandates that ophthalmologists perform surgery in hospital, competing with other disciplines for OR time and challenging the ophthalmologist to "cram in" a high volume in a limited time. As health-care delivery systems vary greatly from setting to setting, it is interesting to note that in the "managed care" and national health service environments, the use of ISBCS is greater than with traditional fee-for-service programs. It will be interesting to observe surgeon preferences and practices should reimbursement programs change to allow for full second eye fees with ISBCS in the United States.

Finally, the COVID-19 pandemic added additional impetus to reduce patient visits to the office, hospital, and surgery center. While in the current environment all of these factors combine to promote ISBCS, one wonders how many ophthalmologists would themselves opt for same-day bilateral cataract surgery.

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Trifocal vs. EDOF for Presbyopia Correction: Trifocal IOLs Are the Only Way to Satisfy

Damien Gatinel MD

While trifocal IOLs are the most predominantly used presbyopia-correcting lenses, pure extended depth of focus (EDOF) IOLs have recently gained attention. These enhance the depth of focus by creating an elongated focal point.

EDOF lenses can be challenging to use for several reasons:

Lack of Standardized Definition

There is no universally agreed-upon definition or standard for what constitutes an EDOF lens. This lack of a standardized definition can lead to confusion and difficulty in describing and comparing these lenses and can create disproportionate expectations on the part of patients or even the surgeons who use them.

Innovative Design and Functioning but Some Light Is Still Defocused

EDOF lenses use advanced optical technology to create a single elongated focus, which helps to provide a range of vision, from distance to intermediate and potentially near vision. This contrasts with the operation of traditional multifocal lenses, which create separate, distinct focal points for different distances. The innovative mechanism of EDOF lenses might be challenging to explain without an in-depth understanding of optics. In addition, the notion of an elongated focus can be misleading by suggesting the absence of defocused light, which is not the case.

Variability in Visual Outcomes

The visual outcome with EDOF lenses can vary from patient to patient. While some patients may experience an excellent range of vision (from distance to near), others may achieve different results. This variability is due to several factors, including the individual's ocular health and geometry, the surgical technique used, and the process of neuroadaptation, or the brain's adjustment to the new way of seeing. We studied the impact of certain parameters, such as pupillary diameter and degree of asphericity, on an optical bench; these parameters have a major impact on the aspect of the defocus curves of EDOF implants, depending on the principles used by these lenses to induce the increase in depth of field. These simulations suggest that eyes implanted with EDOF IOLs can have a reduced depth of focus compared to eyes with monofocal lenses when the cornea's and the IOL's spherical aberration cancel each other out. On the other hand, trifocal IOLs can exhibit an "EDOF behavior" when the pupil diameter is small.

Confusion with Multifocal Concepts

Often more clarity is needed to distinguish between EDOF and multifocal lenses. While both aim to provide a range of vision (from distance to near), they achieve this differently. Multifocal lenses create multiple distinct focal points, while EDOF lenses create a single elongated focus. However, these differences can be nuanced and may need clarification or simplification. The first EDOF implant was a bifocal diffractive implant with an addition corresponding to intermediate vision, whose step height was designed to compensate in part for chromatic aberration of corneal origin. It achieved its effects predominantly through multifocality rather than an elongated focal point. The study on the optical bench of the defocus curves of some EDOF implants can reveal a bifocal behavior (2 peaks) for certain pupillary diameters and/or corneal asphericities. Trifocal IOLs are more robust to variations of these features.

Subjective Experience and Visual Phenomena

EDOF lenses can cause visual phenomena such as glare, halo, and starbursts. These experiences are highly subjective and can differ from one individual to another. Consequently, accurately describing the potential visual experiences with EDOF lenses can take time and effort. Systematic review and meta-analysis aim to provide the most current evidence in support of selecting appropriate IOLs for patients. Studies of post-implantation clinical outcomes of trifocal IOLs and hybrid multifocal EDOF IOLs, including visual acuity (VA) data, presented trifocal IOLs as superior to EDOF IOLs for uncorrected near visual acuity and corrected near VA. However, the EDOF IOLs outperformed the trifocal IOLs in terms of uncorrected intermediate VA. Trifocal patients were more likely to achieve spectacle independence at near distances but were also more prone to developing photic effects like halos and glares.

The Performance of Trifocal IOLs and Hybrid Multifocal-EDOF IOLs

Trifocal IOLs have been developed with various technologies designed to compensate for the vision impairment of monofocal IOLs at near and intermediate distances without compromising distance vision. Both IOL groups offered satisfactory vision across all distances, but meta-analysis revealed that the hybrid multifocal EDOF IOL outperformed trifocal IOLs at intermediate distances. Conversely, the trifocal group presented superior uncorrected and corrected near VAs over the hybrid multifocal EDOF group. It is important to note that the variations in the types of trifocal IOLs could be a source of discrepancies in these outcomes.

Refractive Outcomes and Stability Over Time

Residual ametropia following IOL implantation can lead to reduced vision and patient dissatisfaction. A slightly larger but insignificant spherical equivalent has been demonstrated in diffractive EDOF IOLs, but this deviation did not negatively impact VA or patient satisfaction. Future studies with longer follow-up must assess stability and possible complications.

Subjective benefits and spectacle independence are significant factors driving patient expectations. More patients achieved spectacle independence at a near distance in the trifocal group, which aligns with their better near VAs. However, the trifocal group also demonstrated a higher incidence of halos.

In conclusion, while EDOF lenses hold promise for improving patients' range of vision, their complex design, the variability in visual outcomes, and the lack of a standardized definition make them challenging to describe accurately and comprehensively. Trifocal IOLs remain the gold standard for presbyopia-correcting IOLs.

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Trifocal vs. EDOF for Presbyopia Correction: EDOF IOLs Are the Best Options for Most

Douglas D Koch MD

I. Introduction

There are a large number of presbyopia-correcting IOLs for patients. So-called "multifocals" are best for distance and near. Trifocals provide all functional vision at all 3 distances. Extended depth of focus (EDOF) IOLs are best for distance and intermediate.

II. Types

There are several types of EDOF IOLs:

A. Diffractive IOLs, which provide outstanding distance and intermediate vision

B. Refractive IOLs, which have an excellent glare profile but lower visual quality

C. Spherical aberration modulation IOLs, which also have a reasonable glare profile

D. Small-aperture optic IOLs, which provide excellent acuity for distance and intermediate but can reduce night vision

III. The math is simple.

The more you divide the light, the less sharp the vision. Diffractive EDOF IOLs provide superior distance vision and comparable or superior intermediate vision compared to trifocal IOLs.

IV. Patient Needs

What are the needs of most patients? Excellent distance and intermediate vision and ability to read electronic devices. EDOFs provide this while providing distance vision nearly comparable (or in some instance superior to) that of monofocal IOLs.

V. What will happen to patients' eyes over time?

A. Change in astigmatism

B. Possible decline in ocular health, especially macular degeneration

C. IOLs that provide the highest quality of vision will best preserve functional vision in the face of these changes.

VI. Conclusion

For most patients, EDOF IOLs provide the needed range of vision while maximizing quality vision for the patients' lifetime.

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Lenticle Extraction vs. LASIK in High Myopia: Lenticle Extraction Offers Accuracy and Stability

John So Min Chang MD

Both LASIK and SMILE have been gaining popularity among individuals seeking spectacle independence in recent years. LASIK was generally thought to yield visual outcomes superior to those of SMIL E, particularly in high myopes. However, recent literature suggested that in high myopes, SMILE offered similar or even better outcomes when compared to LASIK.[1-3] In this presentation, I will present our own comparative findings between LASIK and SMILE in high myopes.

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Lenticle Extraction vs. LASIK in High Myopia: LASIK Offers Faster Recovery

Edward E Manche MD

I. FDA-Approved Indications for LASIK
   A. Wavefront-guided LASIK outcomes
   B. Topography-guided LASIK outcomes
   C. Wavefront-optimized LASIK outcomes

II. FDA-Approved Indications for SMILE
   A. SMILE outcomes

III. Other Lenticule Extraction Procedures (Not FDA Approved)
   A. Smooth incision lenticule keratomileusis (SILK)
   B. Corneal lenticule extraction for advanced refractive correction (CLEAR)

IV. Prospective Randomized Clinical Studies
   A. Wavefront-guided LASIK vs. SMILE
   B. Topography-guided LASIK vs. SMILE
   C. Wavefront-optimized LASIK vs. SMILE

V. Conclusion

   LASIK offers faster visual recovery than SMILE in high myopia.

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Implantable Contact Lens (ICL) vs. Laser Vision Correction for Low Myopia: Implantable Contact Lenses Are Safe Thanks to New Technology

Gregory D Parkhurst MD

NOTES

Implantable Contact Lens vs. Laser Vision Correction for Low Myopia: Is This a Serious Question?

Neda Shamie MD

NOTES

How Clinical Trials Have Shaped My Refractive Surgical Experience

Vance Thompson MD

I. Introduction

A. In July of 1990 I started clinical research as a fellow, and it lit a flame that I immediately carried with me into practice. That flame has shaped my professional journey, practice growth, and personal joy and fulfillment. I am honored to share my story with you in a way that may help you see a path for starting clinical research in your practice.

B. My focus has been comprehensive refractive surgery of the cornea, lens, and phakic IOL in the device and drug arena.

C. Having partners who are attracted to and supportive of clinical research is of great help.

II. Rewards

A. Staff is proud to be part of a practice performing quality research.

B. Research has been a cultural positive.

C. It is exciting to be a part of the approval process/journey.

D. The influence of research on industry relationships has been amazing.

E. The experience has enhanced my understanding of how industry looks at new technology.

F. Fellow investigator relationships globally have become deep.

G. Clinical research provides a peek into the future.

III. Challenges

A. Significant responsibility

B. A lot of work

C. An understanding of the risk if human research is not done properly

IV. The Impact Research Has Had on My Refractive Surgery Journey

A. Research: A unique calling

B. How research changed my mindset

C. A respect for the FDA process

D. A review of what quality clinical research entails

E. How data drove me deeper into the eye in refractive surgery and enhanced my clinical knowledge and experience . . . and how this has improved my patient care.

What's New in Corneal Scarring Treatment

Lycia Pedral Sampaio MD

I. The Importance of Corneal Transparence and Vision

II. Conditions Leading to Corneal Stromal Damage and Scarring

III. Corneal Wound Healing/Corneal Stromal Repair and Regeneration Mechanisms

IV. New Treatments for Corneal Scarring

V. Clinical Applications: Challenges, Limitations, and Outcomes

VI. Conclusion

Corneal Nerve Regeneration and Neuropathic Pain Following Refractive Surgery

Yu-Chi Liu MD MD PhD

The cornea is a highly sensitive structure, innervated by the ophthalmic division of the trigeminal nerve. Any kind of refractive surgery has impacts on corneal nerve fibers to a variable degree. In LASIK, the corneal nerves are cut throughout the extension of the flap cut, and the deeper nerves are disrupted by the photoablation. In SMILE, the corneal nerves are transected only at the small incision. The nerves outside the lenticule area remain undisrupted. (See Figure 1.) Results from in vivo confocal microscopy scans show that corneal denervation is more prominent in LASIK and PRK than in SMILE. SMILE has better preservation of nerves and faster nerve restoration postoperatively. In SMILE, high myopia treatment is associated with greater corneal denervation and neuroinflammation.[1]

The impact on corneal nerves following refractive surgery is long-lasting. A long-term study has shown that in neither SMILE nor LASIK did the nerve status recover to normal levels, even 5 years after surgery.[2] The consequences of corneal denervation and regeneration may be seen clinically on the ocular surface, including changes in corneal sensitivity, tear break-up time, and dry eye symptoms. Overall, ocular symptoms are seen in 20%-55% of patients after refractive surgery. Of note, clinical symptoms may not always correlate very well with nerve changes.

Although there is no consensus on the diagnostic criteria for neuropathic corneal pain (NCP), patients typically present with[3] (1) pain or pain-like symptoms, such as irritation, discomfort, aching, allodynia, burning, dryness, grittiness, or hyperalgesia, (2) abnormal nerve findings on in vivo confocal microscopy, including decreased nerve density, microneuromas, tortuous nerves, and beadings, and (3) minimal or no staining on the cornea.

NCP occurs in approximately 10.5%-13.3% of patients following refractive surgery.[4,5] Reported risk factors associated with postoperative NCP include (1) ocular pain before surgery, (2) symptom report of depression before surgery, (3) the use of oral antiallergy medication before surgery,[4] (4) high myopia treatment in SMILE, and (5) low corneal nerve metrics before surgery in LASIK.[5]

Management for post–refractive surgery NCP is similar to that of NCP caused by other etiologies: lubricants, topical steroids/immunosuppressants, blood-derived products, bandage contact lens/scleral lens, and oral neuromodulators (eg, gabapentin, pregabalin, carbamazepine, anti-depressants, etc.).

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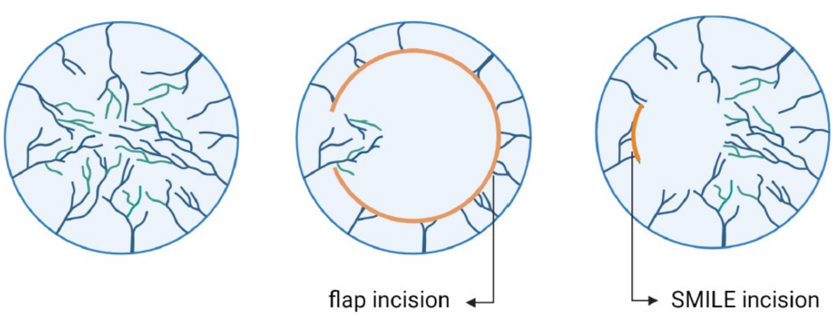


Figure 1

Innovations in Collagen Crosslinking

Theo Guenter Seiler MD

NOTES

Corneal Stromal Regeneration

Larissa Gouvea MD

I. Role of Stroma in Maintaining Corneal Transparence

A. Conditions leading to corneal stromal damage

B. Significance of regenerating the corneal stroma

II. Introduction to Corneal Stromal Regeneration as a Treatment Approach

III. Current Approaches to Corneal Stromal Regeneration

A. Traditional treatments

B. New treatments

IV. Advances in Regenerative Medicine

Stem cell therapy in corneal regeneration

V. Clinical Applications and Outcomes

Challenges and limitations

VI. Conclusion

Tear Biomarkers in Clinical Practice

Pooja Khamar MBBS MS

Introduction

Dry eye disease (DED) is a global health concern, affecting approximately 344 million individuals, with its prevalence on the rise, as reported by the American Academy of Ophthalmology. DED not only impacts productivity but also significantly diminishes quality of life. Astonishingly, an estimated 50%-60% of DED cases remain undiagnosed. Despite the availability of various treatment options, there is a perplexing variability in patient responses to therapy; some patients find relief with minimal intervention, while others remain dissatisfied even after undergoing multiple therapies. This underscores the imperative need for standardized DED therapy, achievable through the precise identification of causative factors and the subsequent application of targeted treatments. The following explores this issue in detail.

Conversely, keratoconus (KC) is traditionally characterized as a progressive inflammatory condition that leads to corneal thinning and steepening. Recent studies have shed light on the significant roles played by proteolytic enzymes, cytokines, and free radicals in the development and progression of KC. In light of these findings, we raise the question: Can we design a point-of-care diagnostic kit to detect subclinical inflammation, particularly in our clinical settings?

In response to this question, we have developed a customized biomarker kit, the Bio-M Pathfinder, which empowers us to analyze tear biomarkers within our clinical facilities, allowing us to assess 8 key biomarkers in a mere 90 minutes. This point-of-care testing approach bridges the gaps present in conventional multiplex strategies, revolutionizing our ability to diagnose and manage ocular surface diseases effectively.

Point-of-Care Diagnostics Workflow

The workflow of point-of-care diagnostics is as follows: Tear samples are collected using Schirmer strips, with tears subsequently eluted from the strips by adding 300 µl of phosphate-buffered saline to the tubes. This is followed by a 5-minute period of shaking the Eppendorf tubes. Following this, 50 µl of the resulting extract is added to each sample well, and the cartridges are loaded into the analyzer system. The system then generates a report detailing the levels of 8 biomarkers: IL-6, IL-1b, IL-17A, MMP-9, ICAM-1, TNF-a, IL-10, and VEGF-A.

Rationale for Biomarker Selection

The selection of these specific inflammatory biomarkers is rooted in their established associations with disease pathology and severity, as extensively documented in prior research. Notably, pre-existing targeted therapies for these inflammatory markers are readily available on the market or are currently undergoing clinical trials. Furthermore, the inclusion of the anti-inflammatory marker IL-10 aims to strike a balance between pro-inflammatory and anti-inflammatory factors, providing a comprehensive approach to ocular surface disease management.

In summary, Bio-M Pathfinder, an enzyme-linked immunosorbent (ELISA)–based biomarker assay, represents a promising technology for the assessment of tear biomarkers related to inflammation and the tailoring of therapy. Targeted therapy guided by biomarker profiles can enhance treatment compliance and accelerate recovery. This technology assists in the identification and stratification of clinically healthy eyes with unusually high levels of inflammation, enabling early intervention to prevent disease deterioration. Additionally, it contributes to achieving optimal surgical outcomes by addressing inflammation prior to procedures. The Bio-M Pathfinder kit has also proven its value in monitoring disease progression and evaluating treatment responses in various ocular surface diseases.

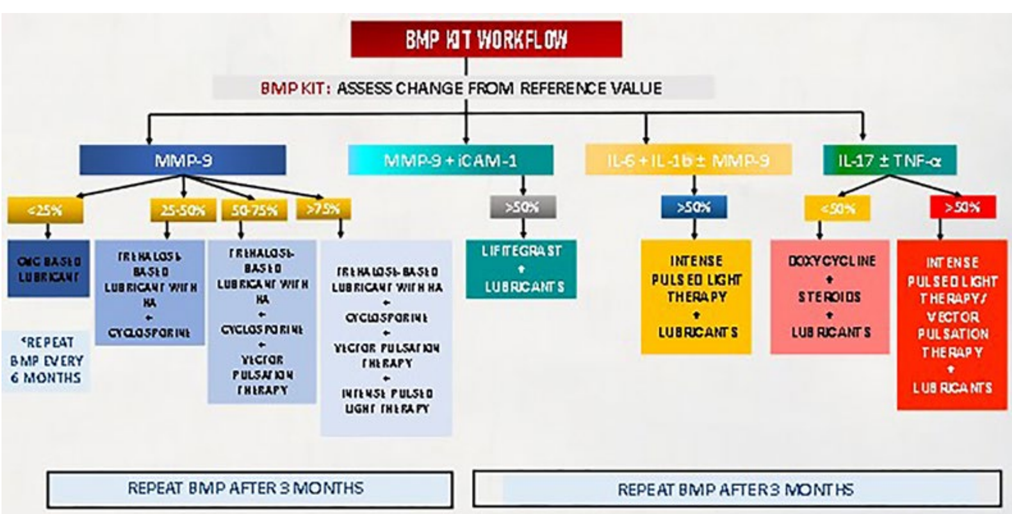


Figure 1. Algorithmic treatment approach for ocular surface diseases using the Bio-M Pathfinder kit. (*This is purely based on literature.)

Corneal Biomechanics: Practical Tips

Riccardo Vinciguerra MD

Introduction

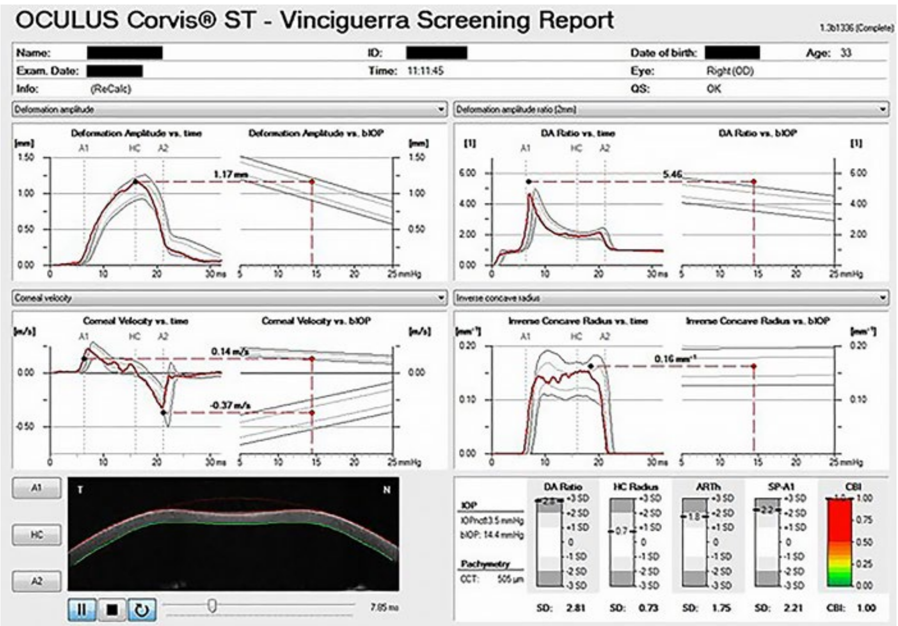
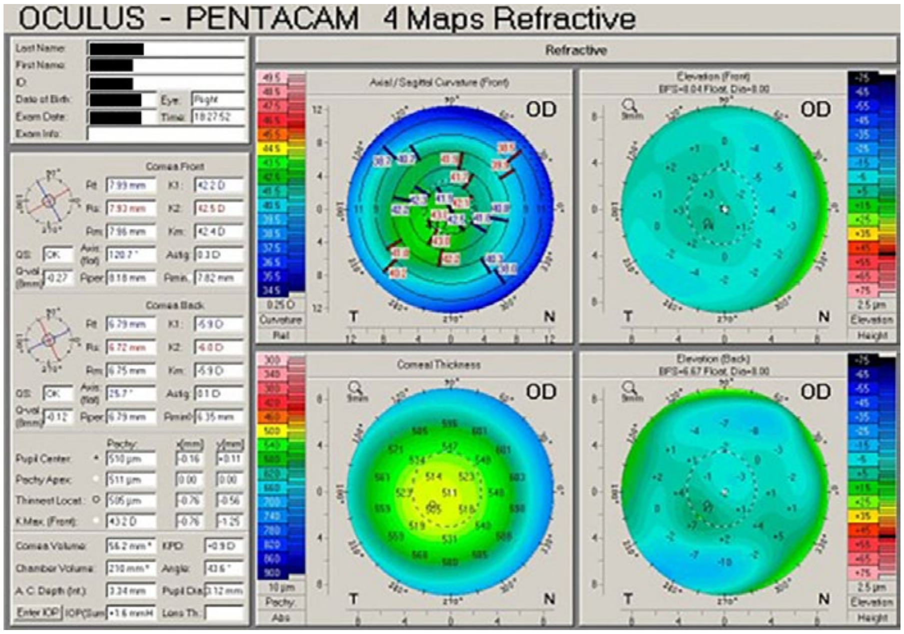
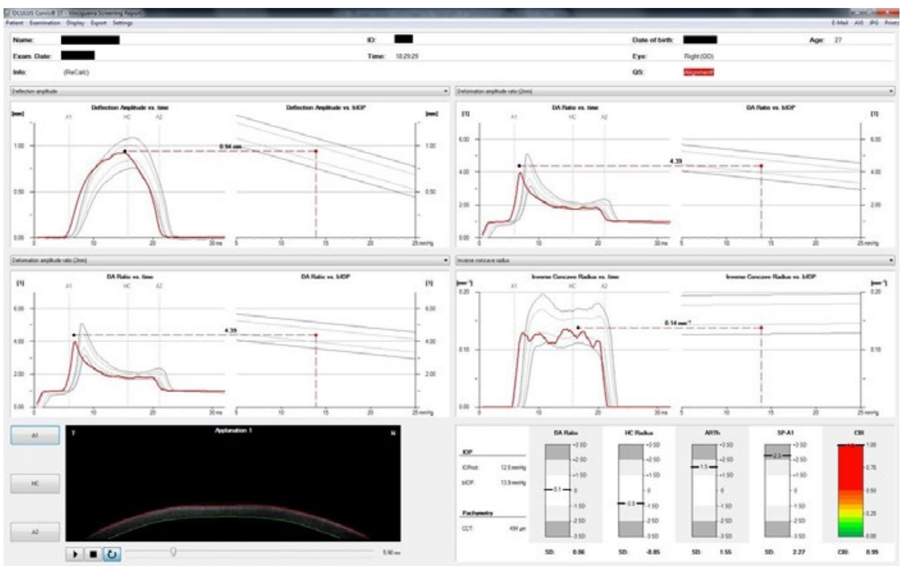


Figure 1. Keratoconus.



A



B

Figure 2. Very asymmetric ectasia.

Summary With a Case

- 49-year-old female referred for decreased vision and monolateral keratoconus
- Considered corneal crosslinking as vision loss significant (no previous topographies)

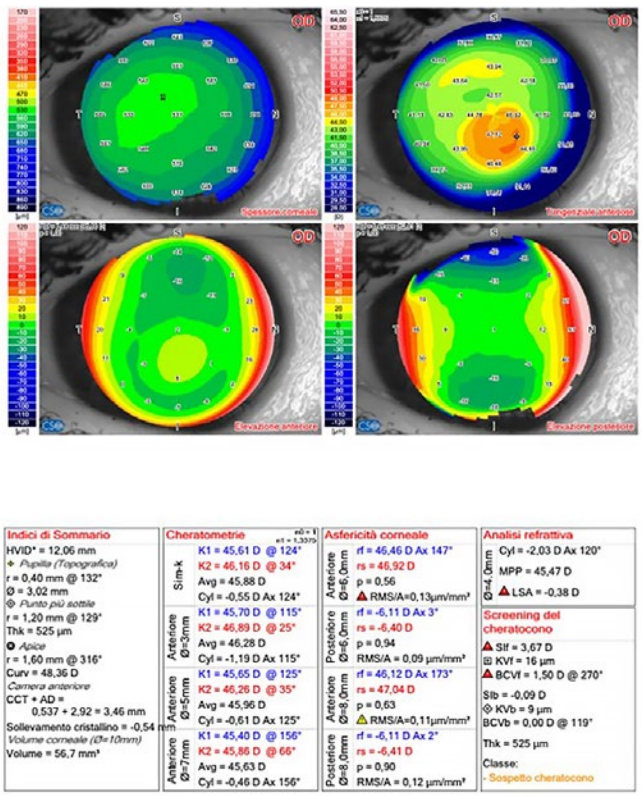


Figure 3

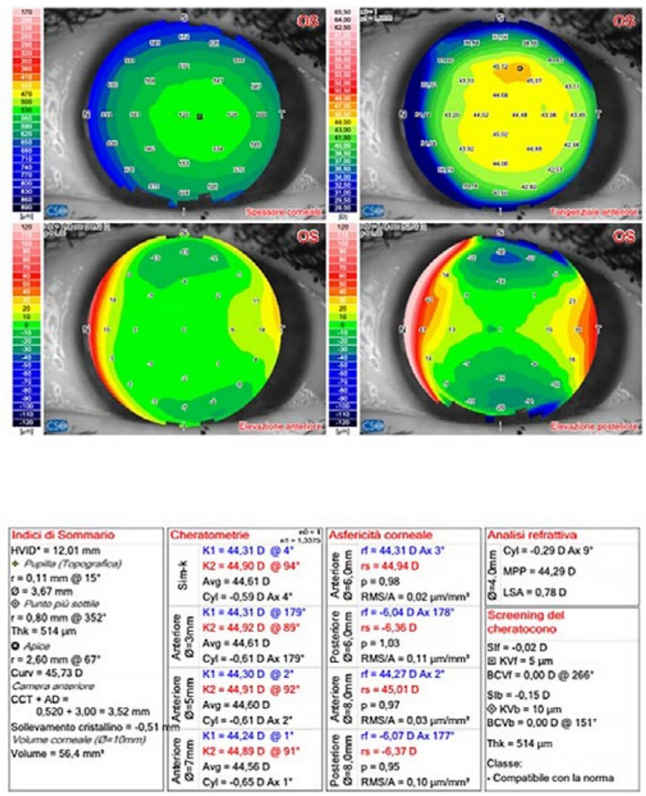


Figure 4

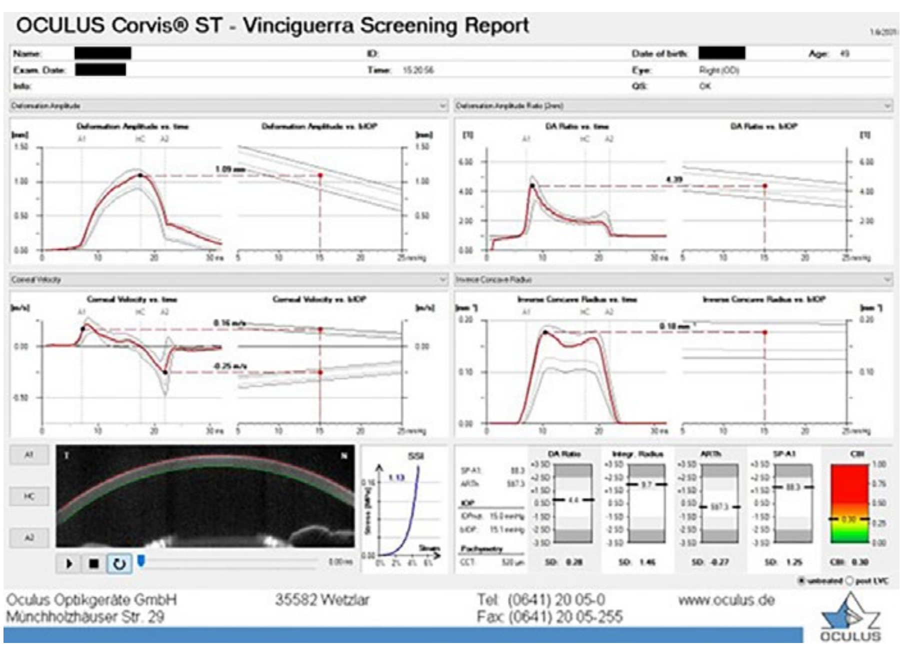


Figure 5

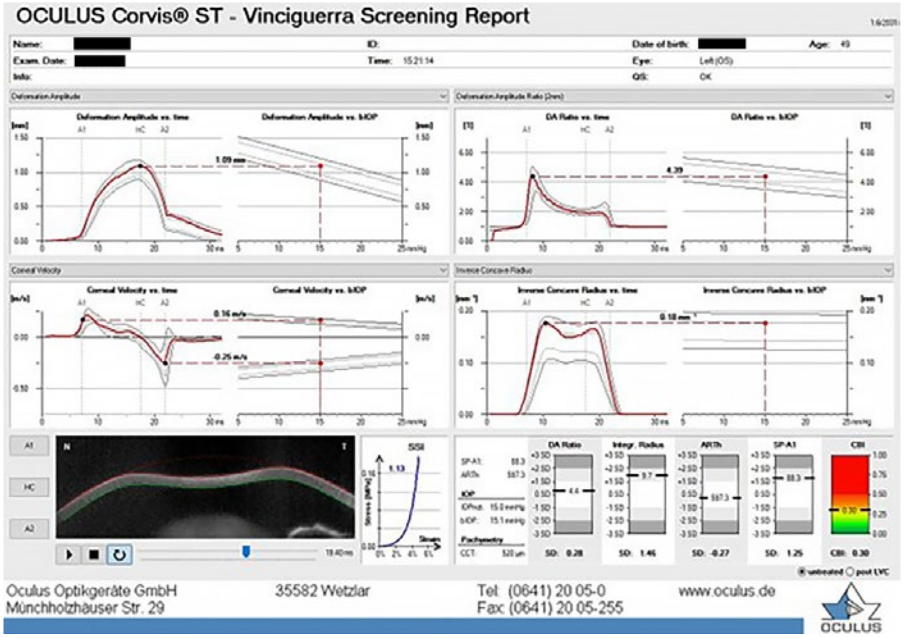


Figure 6

Figure 7

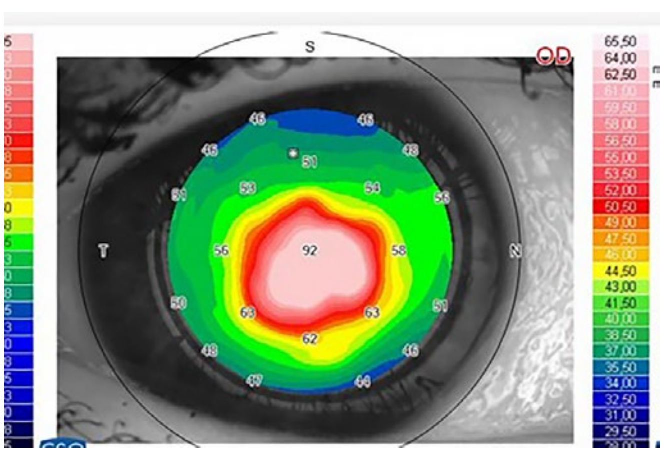


Figure 8

Previous History

- She referred some months before an incident with boiling oil.
- Cristal clear cornea with hyperplastic epithelium
- Suggested alcohol-assisted epithelial removal

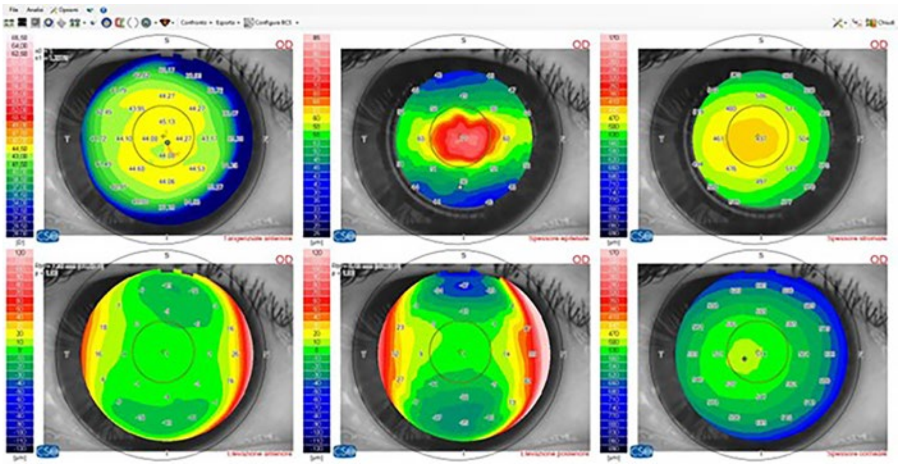


Figure 9. Postop 20/20 unaided.

Artificial Intelligence for Optimizing Refractive Outcomes

Oliver Findl MD

Artificial intelligence (AI) has the potential to revolutionize the field of ophthalmology, specifically in the area of power calculation and prediction of IOLs. Accurate determination of the appropriate IOL power is critical for achieving optimal visual outcomes following cataract surgery. There has already been a significant improvement in existing IOL formulas. For patients with a history of refractive surgery or extreme or atypical biometry, a certain risk of refractive surprise, even with the best formulas, is a given. By implementing the power of AI and the use of advanced algorithms and data analysis techniques, the accuracy of power calculations and patient satisfaction might be improved.

Existing IOL formulas using Gaussian optics rely on the assumption that image vergence consists of object and lens vergence. Therefore, several variables such as corneal power, axial length, effective lens position (ELP), target refraction, and vertex distance were initially used to calculate the IOL power. The ELP is the only variable so far that is still estimated. The number of necessary variables varies, depending on the used formula, from 2 (Holladay 1, SRK/T) to 7 (Holladay 2). Just as the technology of the biometers used has improved, the possible variables for power prediction have also been increased.

With the implementation of AI, modern power prediction formulas (Kane, Hill-RBF, EVO) have the capacity to analyze large datasets comprising patient information, clinical measurements, and surgical outcomes and to try to reduce the estimation in the power prediction to zero. By training on this vast amount of data, AI models can learn complex patterns and correlations, allowing for more accurate and precise power calculations. These algorithms can take into account various biometric parameters, extracted from preoperative biometry and corneal topography, to generate the optimal IOL power prediction. Additionally, depending on the formula used, information like sex, age, and other parameters can be added to the calculation. As AI models continuously learn and improve from new data, they can refine their predictions and adapt to individual patient characteristics, ultimately enhancing the accuracy of power calculations.

One of the key advantages of AI is its ability to continuously learn and adapt based on real-world data. As AI-powered systems are regularly updated with postoperative outcomes, the algorithms can evaluate the accuracy of their predictions and adjust accordingly. Over time, this iterative process enables AI models to refine their predictions, improve the accuracy of power calculations, and account for any biases or trends in the data. This continuous improvement cycle ensures that future patients benefit from the collective knowledge and experience embedded within the AI algorithms. Therefore, regular validation and evaluation of AI algorithms are necessary to ensure their ongoing accuracy and effectiveness.

In summary, AI has the potential to significantly improve the accuracy and predictability of power calculations and predictions for IOLs. By leveraging machine learning algorithms and analyzing vast amounts of patient data, AI can enhance the precision of IOL power calculations and reduce variability in visual outcomes. As AI continues to evolve and mature, it holds great promise for optimizing visual outcomes, improving patient satisfaction, and advancing the field of ophthalmology.

The Influence of Artificial Intelligence in IOL Calculation

Thomas Kohnen MD PhD FEBO

Introduction

Many patients want to be independent from spectacles or contact lenses, and there are different approaches to achieve this. Options include PRK, LASIK, lenticular extraction or phakic IOLs and refractive lens exchange. Refractive surgery has increased significantly in recent years and decades. One crucial part of choosing the right IOL is IOL power calculation. Recently, the use of artificial intelligence (AI) in ophthalmology and IOL calculation has become increasingly popular.

Background

IOL calculation formulas use multiple parameters of the eye (for example, axial length, corneal curvature, anterior chamber depth, or lens thicknes) to approximate a power that most closely achieves the desired target refraction. During the last few decades, classic formulas like Haigis, SRK/T, and Holladay 1/2 were most widely used. But with advances in technology, more sophisticated formulas with elements of AI were published. Examples of these include the Kane and the Ladas Super Formula, the PEARL-DGS, or the RBF calculator, which is completely based on AI.[1]

Current Data

Recent studies have shown good results for AI formulas like the Kane or the PEARL-DGS formula. Up to 79.3% of eyes were within ±0.5 D of target refraction using the Kane formula and up to 52.4% were within ±0.25%. A summary of studies on old and new formulas can be found in Table 1.[2]

Table 1. Refractive Values of Different IOL Calculation Formulas From Recent Studies

Formula	Study	IOL	MAE	SD	MedAE	± 0.25 D	± 0.50 D	± 1.0 D
Kane	Connell [46]	SN60WF	0.329	0.445	0.231	52.4	77.9	96.6
	Darcy [47]	Multidesign*	0.377	0.49	0.302	42.6	72	95.2
	Hipolito [48]	SN60WF	0.324	0.418	0.274	47	79.3	97.7
Olsen	Connell [46]	SN60WF	0.342	0.46	0.264	47.9	77.2	96.1
	Melles [44]	SA60AT	0.337	0.443	0.268	47.1	78	96.7
	Darcy [47]	Multidesign*	0.388	0.501	0.309	41.4	70.6	94.9
Barrett	Connell [46]	SN60WF	0.350	0.469	0.268	47.9	75.2	96.4
	Melles [44]	SA60AT	0.320	0.424	0.252	49.8	80	97.3
	Darcy [47]	Multidesign*	0.390	0.505	0.314	41.7	70.7	94.7
	Hipolito [48]	SN60WF	0.339	0.429	0.291	42.4	77.8	97.2
Holladay 2	Connell [46]	SN60WF	0.357	0.477	0.273	46.8	76.0	95.5
	Melles [44]	SA60AT	0.456	0.456	0.277	46.1	75.3	96.6
	Darcy [47]	Multidesign*	0.390	0.503	0.312	41.2	71	94.4
Holladay 1	Connell [46]	SN60WF	0.358	0.475	0.276	45.1	73.4	96.1
	Melles [44]	SA60AT	0.348	0.453	0.281	45.1	75.9	96.9
	Darcy [47]	Multidesign*	0.397	0.512	0.321	40.2	69.6	94.4
	Hipolito [48]	SN60WF	0.361	0.461	0.299	40.8	74.3	96.1
Haigis	Connell [46]	SN60WF	0.358	0.48	0.271	45.5	75.5	96.1
	Melles [44]	SA60AT	0.345	0.449	0.278	45.3	76.3	96.8
	Darcy [47]	Multidesign*	0.405	0.521	0.327	39.9	69.0	94.0
	Hipolito [48]	SN60WF	0.359	0.459	0.309	40.7	74.5	95.4

(table continues on next page)

Table 1 (continued)

Formula	Study	IOL	MAE	SD	MedAE	± 0.25 D	± 0.50 D	± 1.0 D
SRK/T	Connell [46]	SN60WF	0.369	0.489	0.293	40.3	73.6	95.5
	Melles [44]	SA60AT	0.363	0.471	0.290	43.7	74.1	96
	Darcy [47]	Multidesign*	0.403	0.522	0.323	39.9	69.1	93.6
	Hipolito [48]	SN60WF	0.356	0.454	0.303	42.5	75.1	97.2
Hoffer Q	Connell [46]	SN60WF	0.381	0.499	0.311	40.3	73.6	95.5
	Melles [44]	SA60AT	0.365	0.474	0.292	43.7	73.0	96.3
	Darcy [47]	Multidesign*	0.410	0.527	0.332	39.0	68.1	94.0
	Hipolito [48]	SN60WF	0.383	0.489	0.317	40.6	69.9	95.7
PEARLDGS	Hipolito [48]	SN60WF	0.344	0.436	0.290	42.0	76.9	97.2
EVO 2.0	Hipolito [48]	SN60WF	0.329	0.419	0.282	44.9	78.5	97.6

Abbreviations: MAE, mean absolute prediction error; SD, standard deviation; MedAE, median of the absolute error.

Note: Target of these studies was to minimize the SD of the mean absolute prediction error.

Reprinted by permission from Wendelstein J, Kohnen T, Casazza M, et al. Update Biometrie und Linsenberechnung—ein Review zu Grundlagen und neuen Entwicklungen. *Klin Monbl Augenheilkd*. 2022; 239(08):960-970.

Another study compared different machine learning models to established formulas in 260 eyes. Using measurements and IOL data, the best machine learning model, Karmona, had a standard deviation (SD) of the prediction error of 0.30 D, and 65.38% of eyes within ±0.25 D, compared to a SD of 0.36 and 53.85% of eyes within ±0.25 D with the Haigis formula.[3]

The Grand Picture

AI will not only be crucial for IOL calculation but can also assist in many other steps of cataract surgery,[4] from diagnosis of cataract to intraoperative video analysis. The possibilities for AI applications are almost endless.

Conclusion

AI is a powerfull tool if used right. IOL calculation formulas have shown good refractive outcome in recent studies.

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Development of Machine Learning Models to Predict Posterior Capsule Rupture Based on the European Registry of Quality Outcomes for Cataract and Refractive Surgery

Rudy MMA Nuijts MD, Ron JMA Triepels PhD, Maartje HM Segers MD, Paul Rosen MD, Frank JHM van den Biggelaar PhD, Ype P Henry MD, Ulf Stenevi MD PhD, Marie-José Tassignon MD PhD, David Young PhD, Anders Behndig MD PhD, Mats Lundström MD PhD, and Mor M Dickman MD PhD

Introduction

Cataract surgery has improved over the past decade, with more advanced surgical techniques allowing it to become a minimally invasive surgery with fast visual recovery, good visual outcomes, and few complications. Nonetheless, it has been reported that 0.2% to 1.8% of cataract surgeries are complicated by a posterior capsule rupture (PCR), a potentially sight-threatening complication.[1,2] To mitigate the risks of PCR, surgeons typically assess the probability of PCR before surgery, possibly guided by a scoring system.[3,4] The outcome of the risk assessment can contribute to a better allocation of patients to junior or experienced surgeons and better communication of risks to patients. Although risk assessments have been shown to reduce the occurrence of PCR, clinical judgment is subjective and dependent on the experience of the surgeon and designer of the scoring system.[3]

The application of machine learning may prove helpful in estimating the probability of PCR more reliably and objectively. Instead of manually weighing the severity of known risk factors, a probabilistic classifier can be constructed based on a large dataset of cataract surgeries to predict PCR. Preoperatively, all available data about the patient and surgery can be processed through the classifier to estimate the probability of PCR. When the classifier predicts a high risk for PCR, risk mitigation measures can be taken to minimize the risk and its potential consequences. These measures include, for example, ensuring an experienced surgeon carries out the surgery and that certain equipment, such as a dispersive ophthalmic viscoelastic device, is already available in the operating room.

Three probabilistic classifiers were constructed to estimate the probability of PCR: a Bayesian network (BN), a logistic regression (LR) model, and a multilayer perceptron (MLP) network. The classifiers were trained on 2,853,376 surgeries reported to the European Registry of Quality Outcomes for Cataract and Refractive Surgery (EUREQUO) between 2008 and 2018.

Classification Performance

The performance of the classifiers was evaluated by a precision-recall (PR) curve. A PR curve can be used to visualize the trade-off of a probabilistic classifier between precision and recall. Precision is, in our application, the probability of PCR given that a classifier predicted PCR at a given threshold. Likewise, recall is the probability of a classifier predicting PCR at a given threshold, given that PCR occurred. The PR curves of the classifiers are depicted in Figure 1, and the area under the PR curve (AUPRC) is given in Table 1. Close examination of the AUPRC of each classifier reveals that the MLP network performs the best overall, followed by the BN and the LR model.

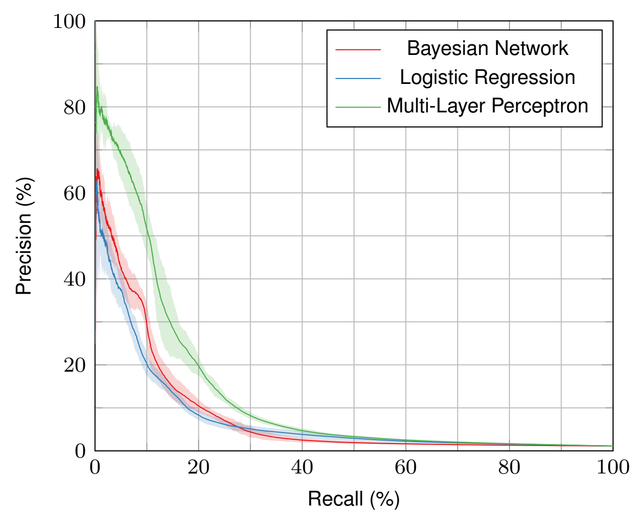

Figure 1. The precision-recall curves of the classifiers. The shaded areas highlight the 2 standard deviation error bands around the mean precision.

Table 1. The AUPRC of the Classifiers

Classifier	AUPRC
Bayesian network	8.05 ± 0.39
Logistic regression	7.31 ± 0.15
Multilayer perceptron	13.10 ± 0.41

Note: Data are mean ± SD.

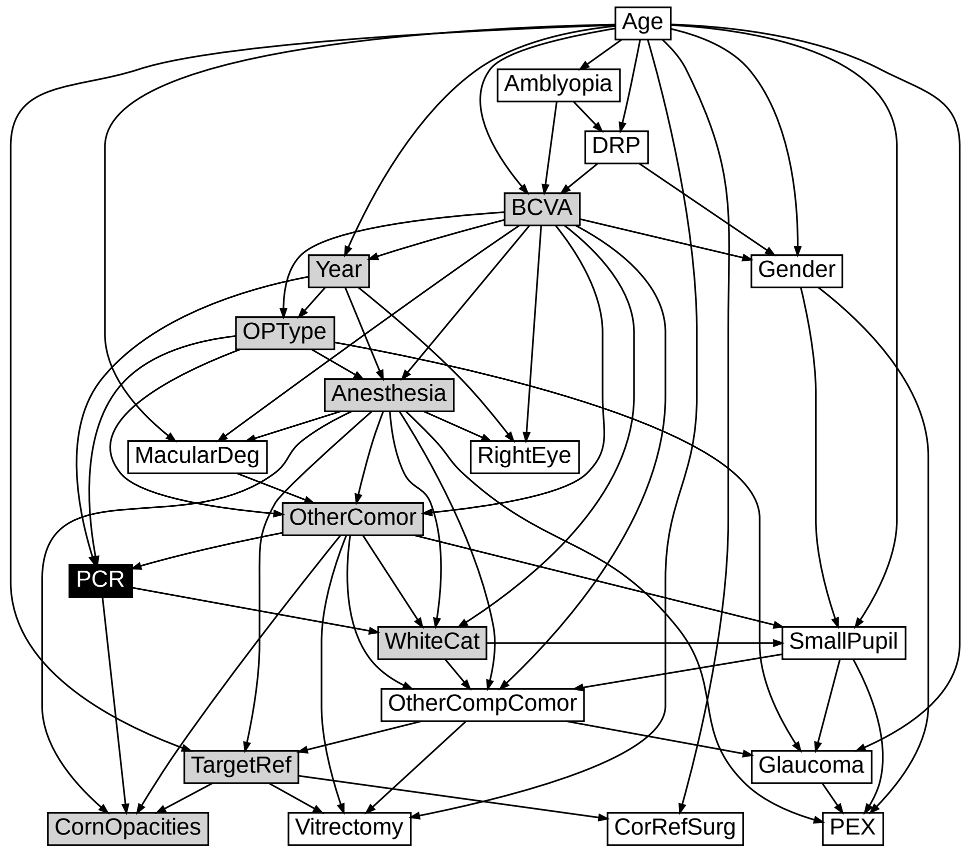

Figure 2. The independence graph of a Bayesian network learned from data of the EUREQUO. Nodes in the Markov blanket of PCR are highlighted in gray. These constitute direct risk factors of PCR. Indirect risk factors of PCR are highlighted in white. Abbreviations: DRP, diabetic retinopathy; BCVA, preoperative best corrected visual acuity; OPType, operation type; MacularDeg, macular degeneration; OtherComor, other ocular comorbidity; PCR, posterior capsule rupture; WhiteCat, white cataract; OtherCompComor, other complicating ocular comorbidity; TargetRef, target refraction; CornOpacities, corneal opacities; CorRefSurg, previous corneal refractive surgery; PEX, pseudoexfoliation.

When evaluating the performance of classifiers, it is important to consider the PCR rate. A classifier that randomly predicts PCR without knowledge about the patient or procedure has an expected AUPRC equal to the PCR rate, which is about 1.1% in our European cohort. Taking this into account, we conclude the classifiers perform relatively well. The MLP network achieved an AUPRC that is more than 12 times higher than the AUPRC of a random classifier.

It is challenging to compare the performance of the classifiers to that of existing scoring systems in the literature, as these systems have not been evaluated based on a PR curve. Nevertheless, the precision and recall of the scoring system proposed by Muhtaseb et al[1] can be calculated for different criteria.[4] Our results indicate that the MLP network has a considerably higher precision than the scoring model of Muhtaseb et al, especially at a lower recall.

Risk Factors

To identify direct and indirect risk factors for PCR, we analyzed the Markov blanket of PCR in the independence graph of the BN. The independence graph is depicted in Figure 2. Direct risk factors for PCR are highlighted in gray, and indirect risk factors for PCR are highlighted in white.

Previous studies have investigated risk factors for PCR, such as age, diabetic retinopathy, gender, small pupil, glaucoma, and pseudoexfoliation.[5-10] A limitation of these studies is that they are based on a traditional regression analysis, which can only measure the effect of individual risk factors on the probability of PCR, while interactions between risk factors are ignored. The BN and MLP network do not suffer from this limitation. In our study, we found that the aforementioned risk factors are indirect risk factors that do not provide any new information about the occurrence of PCR when data on all direct risk factors is available. This observation stresses the importance of modeling interactions between risk factors of PCR.

Conclusions

We have studied how different probabilistic classifiers can predict PCR before cataract surgery. Our results indicate that the MLP network predicts PCR the best. Although the precision is relatively low at high recall, the network appears to perform better than existing scoring models in the literature. Implementing the MLP network in clinical practice can potentially decrease the PCR rate even further than existing scoring models.

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Innovations in Digital Refractive Cataract Surgery

H Burkhard Dick MD

Digitalization and its offspring artificial intelligence (AI) are on the way to becoming firmly established in the operating room. While warnings about the potential perils of AI on the global scale seem to be increasing, ophthalmologists have mostly welcomed these new tools, in particular because, due to demographic change, the number of patients will continue to grow while the number of surgeons will see only a slight uptick.

We will see an encompassing integration of all steps involved in patient care into one digital platform, thereby greatly reducing the risk of errors during transcriptions and forwarding. This starts with the patient's data, including all the medical records with, as an example, a warning appearing in the microscope about his alpha receptor blocker medication and—imagine a red flag flashing!—the risk of intraoperative floppy iris syndrome. Seamless data transfer from EHR to diagnostic devices will speed up the entire process immensely.

Biometry will result in immediate presentation of the prospective IOL power(s) based on different formulas, taking into account the patient's individual visual demands and expectations. Error minimization and avoidance by automation will include checking the IOL before implantation and ensuring that an exact match with surgical plans is provided. (And of course, that eternal source of error, that ancient bane of any type of surgery that deals with organs that come in pairs, confusing OD and OS, will finally be eliminated.)

Comorbidities—utterly disliked by the cataract and refractive surgeon since they prevent optimal results and exorbitant patient satisfaction—will in a timely matter be automatically detected by patented algorithms on photos like diabetic retinopathy and tear film irregularities and can be treated preoperatively. AI will also help in detecting intraoperatively conditions like corneal astigmatism and asphericity, allowing the surgeon to immediately address these issues and perform some fine-tuning for the best possible refractive result. Also, potential complications might be discovered before they become clinically manifest and can thus be treated or their causes corrected immediately.

The quality of our cataract surgery will be analyzed by AI-supported training modules that can play an important role in the training of young ophthalmologists. Surgeons can also use virtual reality to simulate surgical procedures, practice complex techniques, and improve their skills before performing actual surgeries. Follow-up exam data will support quality improvement after surgery and customize personal A-constants to improve the refractive accuracy of future IOL implants. Postoperatively, teleconsultation will take over the role of traditional appointments, and some of the necessary follow-up examinations will done by the patient, with the data transferred to the physician's office, like IOP measurements by intraocular sensor (for cataract patients with glaucoma as a comorbidity) or imaging by a home-OCT handled by the patient (for cataract patients with AMD as a comorbidity).

Not all is bright sunshine in the brave new world of digital refractive cataract surgery. Bioethics and data protection will be challenges, as will convincing patients that these are duly honored. Cost is a more mundane concern—and a very important one. It remains to be seen whether this brave new world will offer its pearls to everyone and whether every patient will be able to benefit from it. And every surgeon.

Ultimately, we will still need to remind patients that it is, after all, surgery, and that the surgeon, not some machine, not some algorithm, carries the responsibility for their well-being. Because, as Aldous Huxley wrote in *Brave New World*, "most human beings have an almost infinite capacity for taking things for granted."

Creating "High-Performance" Surgeons

Samuel Masket MD

I. Ergonomics and Well-Being

A. Premium athletes spend upwards of $1M annually on training, etc.

B. We can be considered as underpaid premium athletes.

C. Our physical and emotional well-being are central to our clinical performance.

II. Every Picture Tells a Story

A. Indirect ophthalmoscopy

B. Slit-lamp exam

C. OR posture at microscope

III. Physician Well-Being and Fitness for Practice

IV. Survey of Musculoskeletal Disorders (MSDs) Among U.S. Ophthalmologists

Digit J Ophthalmol. 2020; 26(4):35-45.

A. 51% (127) response rate among Maryland eye physicians

B. 34-question survey regarding effects of MSDs on pain and practice pattern

C. Excluded if pain existed prior to becoming an ophthalmologist

D. 66% reported work-related pain (mean level 4).

E. Greater likelihood of pain with more time in surgery

F. 14% planned to retire early owing to symptoms.

V. The "Best" Single Article

If you can read only one: Ophthalmologists raise awareness of workstyle-related ergonomic problems. *Healio News*, May 6, 2019. www.healio.com/news/ophthalmology/20190502/ophthalmologists-raise-awareness-of-workstylerelated-ergonomic-problems.

VI. Ergonomics is everything!

I was totally ignorant of the impact of poor ergonomics and bad habits.

VII. The Crux of the Matter

VIII. "Burn Out" Among Physicians

IX. Paying the Price for Long-term Wear and Tear

A. I trained in an era when there was no regard for the health and well-being of the trainee.

B. I often spent more than 50 hours on direct duty as an intern.

C. During ophthalmology training there was never any discussion of how to best use diagnostic and surgical tools in order to reduce physical stress—concern was only in regard to surgical outcomes.

D. I was unaware of the impact of ergonomics until it was too late.

X. Solutions? Perhaps

A. Angled slit-lamp oculars

B. Modified slit-lamp stand

C. "Heads-up" surgery

XI. The Path Forward—Engagement

A. Achieve awareness of the issue across all Academy fellow/member age groups

B. Engage industry/ergonomic design

C. Engage Association of University Professors of Ophthalmology and training programs

Mind Over Matter

Kavita K Mishra MD MPH

NOTES

Eating for a Longer, More Robust Life!

Scott MacRae MD

I. Introduction

Longevity experts note that diet, social factors, and genetics are the strongest determinants of successful aging. Yet the typical Western diet (or American diet) is calorie rich and nutrient poor.

Successful aging includes living not just longer but more robustly, and living well without the debilitating morbidities characteristic of our Western culture, including heart disease, diabetes, and cancer. Numerous population-based studies have emerged demonstrating populations that live longer, more robust and wholesome lives. The regions where the healthiest, longest-living people live are called "Blue Zones," as documented by *National Geographic* writer Dan Buetner in his book *The Blue Zones*.

II. Characteristics of a Blue Zone Life—Long, Healthier, and Better

A. Move naturally: Incorporate physical activity into daily life.

B. Have a sense of purpose: What gets you out of bed?

C. Downshift: Take time to relax and unwind.

D. Plant based: Eat more whole, unprocessed foods, especially plants (fruits and vegetables).

E. Connection: Have good, strong, healthy social connections with friends and family.

III. Large Diet Cohort Studies for Longevity

Seventh Day Adventist 1 (34,192 subjects, *JAMA* 2001) and Adventist 2 Study (73,308 subjects, *JAMA* 2013)

A. Adventist 1 Study: Adventists who were vegetarians lived longer than the average Californians.

1. Males, 9.5 years longer
2. Females, 6.1 years longer

B. Adventist 2 Study, results on diet styles and longevity

1. Omnivores (ie, meat-eating nonvegetarians): highest death rates.
2. Semivegetarians (chicken, fish, dairy): 8% lower death rates
3. Lacto-ovo vegetarians (dairy, eggs): 9% lower death rates
4. Vegans (no dairy): 15% lower death rates
5. Pescovegetarians (fish eating): 19% lower death rates

IV. What About Protein?

A. The average Western diet provides more than enough. U.S. adults eat twice the recommended WHO daily recommendation (0.82 gm/kg.)

1. U.S. men eat an average 102 gm/day, but WHO recommends 30-56 gm/day.
2. U.S. women eat an average 70 gm/day, but WHO recommends 21-36 gm/day.

B. As we age, increased protein and vitamin D intake may minimize sarcopenia (muscle wasting), but excess protein (particularly red meat) stimulates the mTOR pathway, which is associated with accelerated aging. So a healthy balance is needed. Epidemiologic data strongly suggests that eating a diet rich in plant-based protein with occasional lean animal meat may be the best strategy, based on studies like the Adventist 1 and 2 Studies and the MIND and DASH diet studies.

V. Anti-Alzheimer's Strategies and Diet

A. Alzheimer's affects

1. 10% of the population over age 65
2. 50% of the population over age 85

B. The MIND diet

1. The MIND diet protects 7.5 years of cognitive health compared to lower-quality diet scores.
2. MIND is a combination of a lean Mediterranean and DASH (Dietary Approach to Stop Hypertension) diet. The MIND diet consists primarily of plant-based foods (preferably whole), including veggies, fruit, legumes, whole grains, nuts, seeds, spices, and some fish and chicken. The DASH diet has a similar approach and includes low-fat dairy with a low salt emphasis.

VI. Vision Studies

A. Glaucoma: More fruits and veggies may help prevent glaucoma, but they are not an effective treatment once it develops.

B. Cataract: Similarly, 2 servings of fruit and 3 servings of vegetables/day reduces the risk of cataract development, based on the UK Biobank Study.

C. AMD: AREDS and AREDS 2 studies support AREDS 2 vitamins and the Mediterranean diet.

1. A Mediterranean diet with high intake of dietary lutein/zeaxanthin causes a 16%-32% reduction in AMD.

2. A Mediterranean diet, with its components, fish, as well as "9 nutrients," causes a 31% reduction and 33% reduction in late AMD, respectively.

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Losartan Inhibition of Myofibroblast Generation and Late Haze (Scarring Fibrosis) After PRK in Rabbits

Lycia Pedral Sampaio MD

Corneal Wound Healing and Topical Losartan Studies

I. Biological Mechanisms of Topical Losartan

II. Previous Studies About Topical Losartan

III. Clinical Indications for Topical Losartan

   A. The effect of topical losartan compared to vehicle on the generation of myofibroblasts and development of late haze scarring fibrosis after PRK

   B. Topical losartan compared to vehicle significantly decreased corneal opacity and anterior stromal myofibroblast generation.

JRS—Hot, Hotter, Hottest Late Breaking News

Ectasia Risk Model: A Novel Method Without Cut-off Point Based on Artificial Intelligence Improves Detection of Higher-Risk Eyes

Marcony R Santhiago MD

Sequential Custom Therapeutic Keratectomy for the Treatment of Granular Corneal Dystrophy Type 1: A Long-term Study

Fabrizio I Camesasca MD

Sequential Custom Therapeutic Keratectomy for the Treatment of Granular Corneal Dystrophy Type 1: A Long-term Study

Avi Wallerstein MD

The Most Cited Articles and Authors in Refractive Surgery

J Bradley Randleman MD

Brillouin Imaging/Spectroscopy and Biomechanics

Julian D Stevens DO

NOTES

Drug-Eluting IOLs

For NSAID Delivery

Kenneth J Mandell MD PhD

Introduction

Drug-eluting IOLs offer promise as alternatives to eyedrops for postoperative management after cataract surgery. By automatically releasing drug inside the eye, drug-eluting IOLs have potential to avoid topical side effects, improve tolerability, guarantee compliance, and improve overall satisfaction with cataract surgery. Such benefits are particularly relevant to topical nonsteroidal anti-inflammatory drugs (NSAIDs) with tolerability and safety risks that limit their use in many patients.

Topical NSAIDs are effective for the treatment of postoperative inflammation but have known limitations with respect to their tolerability and safety.[1-3] Caution is recommended in patients with dry eye disease, diabetes, and systemic immunologic disorders due to an increased risk of corneal adverse events.[4] There is a need for alternative delivery mechanisms that overcome the limitations of topical NSAIDs. Here we report the first clinical results with a novel IOL-based NSAID delivery system in subjects undergoing cataract surgery.

Figure 1

Clinical Study

A Phase 1, open-label study was conducted to assess the safety and efficacy of the ketorolac ophthalmic implant (OcuRing-K) implanted on IOLs in subjects undergoing cataract surgery. Five subjects underwent cataract extraction with IOL insertion. Prior to implantation, OcuRing-K was applied to 1 haptic of the IOL, which was then inserted into the capsular bag using the standard surgical technique. Surgery was performed successfully in all subjects without complication. In all 5 subjects, IOLs were observed to be centered on the visual axis without tilt, and the ketorolac implants were visualized in their proper position. No additional anti-inflammatory medications were administered postoperatively. Subjects were evaluated postoperatively 1, 7, and 28 days after surgery. Inflammation was assessed by anterior chamber cell (ACC) score using the Standardization of Uveitis Nomenclature scale. The mean postoperative ACC scores were 0.6 and 0.4 at Days 1 and 7, respectively, and no ACC was observed in any subjects by Day 28. All subjects were pain free at Days 1, 7, and 28. No treatment-related adverse events were reported. No subjects required rescue therapy with topical anti-inflammatory medication.

Conclusions

These results provide the first evidence of efficacy and safety of an IOL-based NSAID delivery system in patients undergoing cataract surgery. By avoiding ocular surface side effects, OcuRing-K has potential to improve the tolerability and safety of NSAIDs while guaranteeing compliance and improving patient satisfaction.

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Artificial Intelligence for Refractive Surgery

Dimitri Azar MD

I. Introduction
   A. Introduction to artificial intelligence (AI)
      1. AI and machine learning in medicine: Background
      2. AI in refractive surgery
      3. Data processing for AI
      4. Medical applications of AI-based analysis
      5. AI learning algorithms
      6. Supervised learning neural networks
   B. Importance of AI in refractive surgery
      1. Applications rooted in diagnostic images
      2. AI publications in refractive surgery

II. Applications of AI in Refractive Surgery
   A. Preoperative planning
      1. Corneal topography analysis
      2. Wavefront analysis
      3. AI and keratoconus and corneal dystrophies
      4. IOL power calculations
      5. Predictive modeling/model training
   B. Intraoperative assistance: Image-guided surgical assistance and real-time biometric feedback
      1. Image-guided assistance in LASIK and SMILE
      2. Image-guided assistance in cataract surgery and clear lens
   C. Postoperative management: predictive outcomes, complication detection, and patient satisfaction analysis
      1. AI and post-LASIK ectasia
      2. AI and post-LASIK corneal nerves
      3. AI and post-LASIK infectious keratitis

III. Benefits of AI in Refractive Surgery
   A. Precision and accuracy
   B. Time efficiency
   C. Cost-effectiveness

IV. Limitations of AI in Refractive Surgery
   A. Ethical considerations, informed consent, privacy and data security
   B. Technical limitations, system complexity and reliability, and algorithm validation
   C. Humanistic elements
      1. Professionalism
      2. Surgeon training and adaptation
      3. Communication and trust

V. Conclusions and Future Directions
   A. Recap of AI applications
   B. Integration of AI with other technologies
      1. Wearable devices
      2. Telemedicine and remote surgery
   C. Summary of benefits and challenges
   D. Future direction of AI in refractive surgery

Telemedicine in Cataract and Refractive Surgery

Giselle Ricur MD, Sonia Yoo MD, Lana Srur MD, and Joshua Mark Reyes

I. Teleophthalmology: Fundamental Considerations

A. Information and communication technologies have long been applied to ophthalmology to enhance access to eyecare.[1] The different models of virtual care need to be tailored to the needs and expectations of each subspecialty.[2]

B. Cataract and refractive surgery delivery care models include asynchronous, synchronous, and hybrid.[3,4] They usually require a collaborative care approach, which differs depending on the country's regulatory context.[5,6]

C. New disruptive technologies are constantly challenging our models of care, and artificial intelligence (AI) and extended reality (XR) applications will undoubtedly play an important role in the near future.[7,8]

II. Overview of BPEI's Virtual Eye Care Programs

A. Preliminary results from Bascom Palmer Eye Institute's virtual care clinics for cataract and refractive patients will be highlighted.

B. Defining the right type of protocols and training for a "real-time" cataract evaluation clinic can be crucial for success.

C. New hybrid models for patients referred for cataract surgery can be successful if careful planning and monitoring are put in place.

III. Challenges and Lessons Learned

A. Resistance to change is one of the main human factors that affects the implementation of a clinical program that defies the usual paradigm of delivery models of care.

B. Understanding the stakeholder's degree of digital literacy is of the upmost importance, thus avoiding frustrations from unmatched expectations and the need for troubleshooting that may sometimes be very resource consuming.

C. Reimbursement issues have always been a concern, but the flexibilities that the public health emergency (PHE) bestowed during the past 2 years catalyzed wide-spread adoption. Uncertainty reigns in a post-PHE context, where waiver extensions and new provisions are expected.

IV. Conclusions

A. Teleophthalmology has proved to be an effective delivery care model.

B. Virtual eyecare protocols and workflows need to be tailored to cataract and refractive surgery clinics to optimize their productivity.

C. Innovative approaches should always be considered as an option, and tested appropriately (AI, XR); thus, emerging technologies will continue to help transform our services.

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Myopia Control: Light Therapy vs. Drops/Lenses

Mingguang He MD PhD

I. Background
   A. Myopia boom
   B. Myopia and axial elongation
   C. Outdoor time, light exposure, and myopia
   D. From increased outdoor time to local light therapy

II. Solution and Product
   A. Light emission system, control system, and backend
   B. What is low-level laser therapy?

III. Randomized Controlled Trial in Guangzhou
   A. Study design
   B. Primary and secondary outcomes
   C. Uncorrected visual acuity improved
   D. Choroidal thickening and increased blood flow
   E. Axial shortening and reverse of myopia progression
   F. Post-trial follow-up: sustained treatment effect and rebound
   G. A typical case, monozygotic twins, 1 in treatment and 1 in control

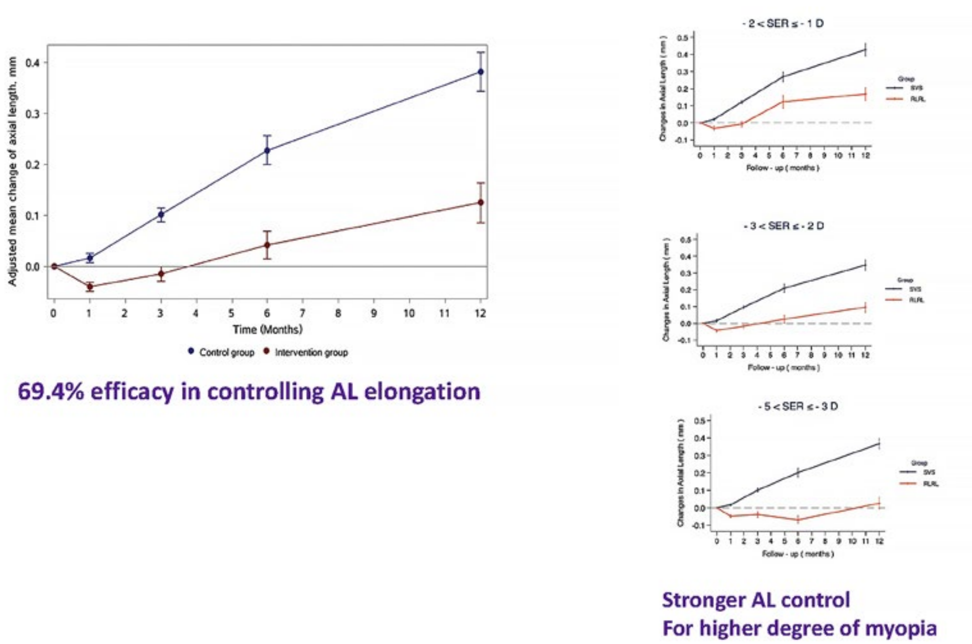

Figure 1. Primary outcomes: axial length (AL) elongation.

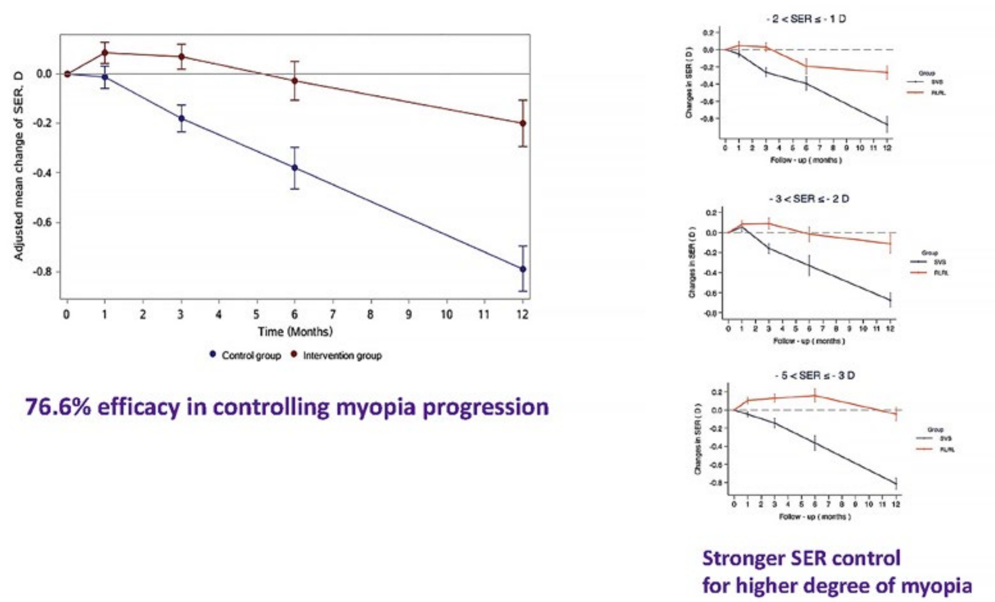

Figure 2. Secondary outcome: spherical equivalent refraction (SER) progression.

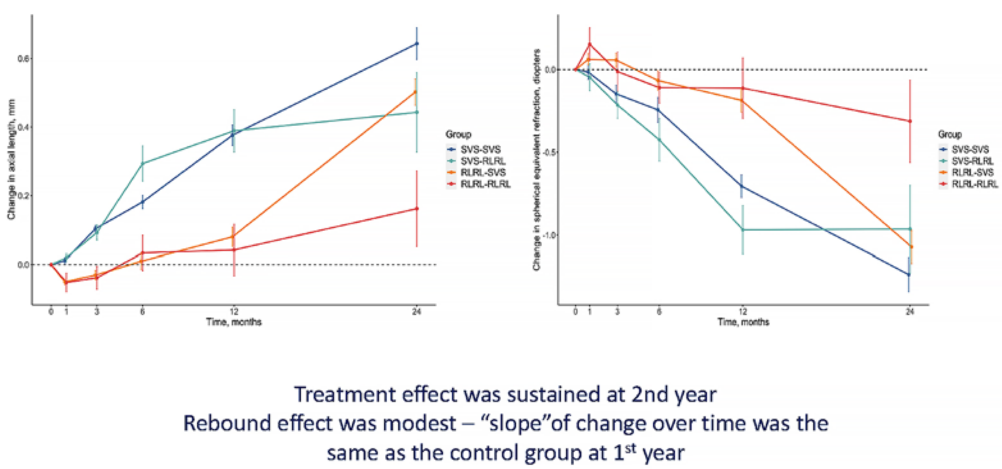

Figure 3. Long-term efficacy and safety profile: 24-month follow-up.

IV. Other Independent Clinical Trials

A. A published systemic review and meta-analysis

B. A randomized trial comparing RLRL with low-dose atropine

C. A prophylactic trial on adopting RLRL to prevent myopia onset

V. Safety

A. ANSI light hazard protection

B. ANSI testing on retinal photochemical hazard, retinal visible and infrared radiation thermal hazard, unweighted anterior segment visible and infrared radiation irradiance

C. ISO 13485:2016 accreditation for manufacturing

D. CE marking approval

E. Other approval in United Kingdom and New Zealand and final approval in Australia, Singapore, and many other countries

F. FDA pivotal trial

VI. International Clinical Trial

A. RLRL on axial length shortening among highly myopic children

B. RLRL on reversing choroidal thinning and myopic macular degeneration

VII. The first case with rare complication (light injury) was published—meaningful clinical data

VIII. Conclusions

Note on conflict of interest: Inventors on the patents and patent applications related (CN201910490186.6). Director and shareholder in Eyerising Xuanjia Optoelectronics Technology Ltd Suzhou and Eyerising International Pty Ltd.

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EO	Owner of Company Ownership or controlling interest in a company, other than stock.
SO	Stock Options Stock options in a private or public company.
PS	Equity/Stock Holder – Private Corp (not listed on the stock exchange) Equity ownership or stock in privately owned firms, excluding mutual funds.
US	Equity/Stock Holder – Public Corp (listed on the stock exchange) Equity ownership or stock in publicly traded firms, excluding mutual funds.
I	Independent Contractor Contracted work, including contracted research.

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Physiol: C,L
PRN Physician Recommended Nutriceuticals: C,SO
Tarsus Pharmaceuticals: C
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Johnson & Johnson Vision: C
Kowa American Corp.: S
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SUN: C
Tarsus Pharmaceuticals: C
Tissue Tech: C
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Allergan, Inc.: C
Azura Ophthalmics: C,SO
Bausch + Lomb: C
Dompé: C
Expert Opinion: C,SO
HanAll BioPharma: C
Johnson and Johnson Vision: C
Kala Pharmaceuticals, Inc.: C
Lensar: C
New World Medical Inc: C
Novartis Pharma AG: C
Ocular Science: C,SO
Ocular Therapeutix: C
Orasis Pharmaceuticals Inc: C,SO
Oyster Point Pharma: C,SO
Sight Sciences, Inc.: C
Spyglass: C,SO
Sun Pharmaceutical Industries Inc: C;
Surface: C,SO
Tarsus Pharmaceuticals: C,SO
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TearClear: C,SO
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Carl Zeiss Meditec: C
cxlo: C
Glaukos Corp.: C,US
Johnson & Johnson Vision: C
Kala Pharmaceuticals, Inc.: C
MYZE: C,PS
Tilleron: EO

Mingguang He MD PhD
Eyerising International Pty Ltd: PS,P
Eyerising, Suzhou Xuanjia Optoelectronics Technology: PS,P

Simon P Holland MD
Canadian Agency for Drugs and Technologies in Health: C
Claris-Bio: C
Novartis, Alcon Pharmaceuticals: C

Soosan Jacob MBBS FRCS
Madhu Instruments Pvt., Ltd.: P
Ziemer Ophthalmics AG: C

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None

Sumitra S Khandelwal MD
Alcon Laboratories, Inc.: C
Bausch + Lomb: C
Carl Zeiss Meditec: C
Dompé: C
Kala Pharmaceuticals, Inc.: C
Ocular Therapeutix: C

Douglas D Koch MD
AcuFocus, Inc.: C
Alcon Laboratories, Inc.: C
Bausch + Lomb: C
Carl Zeiss Meditec: C
Johnson & Johnson: C
Perfect Lens, LLC: C
Trefoil: C

Thomas Kohnen MD PhD FEBO
Allergan, Inc.: C
Bausch + Lomb: C
Carl Zeiss Meditec: C,S
Geuder AG: C
Johnson & Johnson Vision: C,S
LensGen, Inc.: C
MedUpdate: C
Novartis, Alcon Pharmaceuticals: C,S
Oculentis: C,S
Oculus Optikgerate GmbH: C,S
Presbia: C,S
Santen, Inc.: C
Schwind eye-tech-solutions: C,S Staar Surgical: C
Ziemer Ophthalmics AG: C

Ronald R Krueger MD
Alcon Laboratories, Inc.: C
Bausch + Lomb: S
Glaukos Corp.: C
Ocutrx Vision Technologies, LLC: PS
RxSight Inc.: US
Strathspey Crown LLC: PS

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Alcon Laboratories, Inc.: EE

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None

Scott M MacRae MD Bausch + Lomb: P
Clerio: SO

Edward E Manche MD Alcon Laboratories, Inc.: S Allergan, Inc.: S
Avedro, Inc.: C,S
Best Doctors, Inc.: C
Carl Zeiss, Inc.: C,S
Glaukos Corp.: S
Johnson & Johnson Vision: C,S
KKR: C
Novartis Pharma AG: S Placid0: PS,SO
Presbia: S
RxSight, Inc.: US
VacuSite: P,PS

Kenneth J Mandell MD PhD
Aramis Biosciences: C,PS
Intergalactic Therapeutics: C
Janssen Pharmaceuticals, Inc.: C
LayerBio, Inc.: EE,PS

Samuel Masket MD
Alcon Laboratories, Inc.: C
CAPSULaser: C
Haag Streit USA: C,P
Morcher GmbH: P
Ocular Therapeutix: C

Cathleen McCabe MD AbbVie: C
Alcon Laboratories, Inc.: C,L,S
Allergan, Inc.: C,S,L
Bausch + Lomb: C,L
Carl Zeiss Meditec: C,L Dompé: C
Easee: C
Elios: C
Engage Technologies: C,PS
EyePoint Pharmaceuticals: C,L,S
Glaukos Corp.: L,S ImprimisRx: C
iSTAR Medical: C
Ivantis, Inc.: C,L,S
Johnson & Johnson Vision: S
LENSAR: C,L
Novartis Pharma AG: C,L Ocular Therapeutix: C,L,S Ocuphire: C
Omeros Corporation: C,L
Quidel Eye Health: C
RX Sight : L
ScienceBased Health: C
Sight Sciences, Inc.: C,L
Spyglass: C
Sun Ophthalmics: C
Surface Pharma: S
Tarsus Pharmaceuticals: C,L
ViaLase Inc: C
Visus Therapeutics Inc: C

Jodhbir S Mehta MBBS PhD
ACEVision: SO
BMRC (Singapore): S
Carl Zeiss, Inc.: L
CordLife: P
Lecia Microsystems, Inc.: L
Moria: L
NMRC (Singapore): S
Santen, Inc.: L
Trefoil Therapeutics: SO
Ziemer Ophthalmics AG: L

Rupert Michael Menapace MD
Hoya Corp.: C,S
Ziemer Ophthalmics AG: C,S

J Morgan Micheletti MD
Alcon Laboratories, Inc.: C,L,S
Allergan, Inc.: C,S
Avellino Labs: C
Bausch + Lomb: C
Beaver-Visitec International, Inc.: C
Carl Zeiss Meditec: C
Centricity Vision, Inc.: C
Diamatrix, Ltd.: L,P
Glaukos Corp.: C,L
Johnson & Johnson: C,L,S
New World Medical, Inc.: C
Ophthalmic Neo-Innovations of Texas: P,EO
RxSight Inc: C,
STAAR Surgical: C,L
Tarsus Pharmaceuticals: C
Visus Therapeutics Inc: C

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None

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Carl Zeiss Meditec: EE

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Tarsus Pharmaceuticals: C

Rudy Nuijts MD
Alcon Laboratories, Inc.: C,L,S
Carl Zeiss Meditec: S
Johnson & Johnson: S
Ophtec: L

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None

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Staar Surgical: C,L

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Johnson & Johnson Vision: EE,SO,US

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None

Michelle K Rhee MD
Abbott: US
Gilead Sciences: US
LifeMine: C
NovaBay Pharmaceuticals: C
Ocular Therapeutix: S
The Eye Bank for Sight Restoration: C
Vyluma: C

Giselle C Ricur MD
None

Cynthia Roberts PhD
Oculus Optikgeräte GmbH: C
Ziemer Ophthalmics AG: C

Karolinne M Rocha MD
Allergan, Inc.: C
Bausch + Lomb: C
Carl Zeiss Meditec: C
Dompé: C
Johnson & Johnson Vision: C
LaserAce: C

Alain Saad MD
Bausch + Lomb: C
Geuder AG: C
Heidelberg Engineering: C
Moria: C,P
Nidek, Inc.: C

Saama Sabeti MD
Claris Biotherapeutics: S
Kowa Pharmaceuticals: S
Sun Pharmaceutical Industries Ltd.: C

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None

Marcony R Santhiago MD
Alcon Laboratories, Inc.: C,L
Ziemer Ophthalmics AG: C

Julie M Schallhorn MD
Carl Zeiss Meditec: C
Forsight V6: C
Journey 1: C,PS
Long Bridge: C,PS
Neurotrigger: C,PS
Novus Vision: C,PS

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Glaukos Corp.: C
Schwind Eye-tech-Solutions GmbH: C
Ziemer Ophthalmics AG: C

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Alcon Laboratories, Inc.: C
Allergan, Inc.: L

Neda Shamie MD
Alcon Laboratories, Inc.: C,L
Allergan, Inc.: C
Bausch + Lomb: C
Glaukos Corp.: C,L
Johnson & Johnson Vision: C
RxSight Inc.: C,L
Staar Surgical: C,L

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None

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None

Michael E Snyder MD
Alcon Laboratories, Inc.: I
Beyeonics Surgical, Ltd.: C
BVI Ophthalmics: C
EyeD Pharma: C
Haag Streit USA: C
HumanOptics: C,P
Johnson & Johnson Vision: I
Trefoil Therapeutics: I
W L Gore: C

Julian D Stevens DO
Intelon, Inc.: C,SO
Staar Surgical: C
Wavefront Dynamics: PS

Audrey R Talley Rostov MD
Alcon Laboratories, Inc.: C
Allergan, Inc.: C,L
Aurion (husband is employee): C
Bausch + Lomb: C
Carl Zeiss Meditec: C
Eyevance Pharmaceuticals LLC: C
Glaukos Corp.: C
Johnson & Johnson: C
Lensar: C
MicroSurgical Technology: C
SightLife: C,S
SUN: C
Tarsus Pharmaceuticals: C
Trefoil Therapeutics: C
Visus Therapeutics, Inc.: C

Vance Michael Thompson MD
2EyesVision: C,SO
AcuFocus, Inc.: C,L,SO
AdOM: C,SO
AI Optics: SO
Alcon Laboratories, Inc.: C,L
Allergan, Inc.: C
Allotex: C,SO
Avellino Labs: C,L,SO
Avisi Technologies: C,SO
Bausch + Lomb: C,L
Beaver-Visitec International, Inc.: C
BRIM Biotechnology, Inc.: C
C.S.O. Srl: C
Carl Zeiss, Inc.: C,L
Centricity Vision, Inc.: C,L,SO
Conjtac: C,EO
Crystilex: C,SO
D&D Biopharmaceuticals: C,SO
Equinox: C,SO
Euclid: C,L,SO
Expert Opinion: C,SO
eyeBrain Medical, Inc.: C,L,SO
Eyedetec Medical, Inc.: C,SO
Eyesafe: C,SO
Fontana Biosciences: SO
Forsight Robotics: C,SO
Glaukos Corp.: C,L
Iveena Delivery Systems: C,SO
Johnson & Johnson Vision: C,L
LayerBio: C,SO
Medevise: C,SO
Melt Pharmaceuticals: C,SO
NanoDrops: C,SO
Ocular Innovations: C,SO
Ocular Therapeutix: C
Oyster Point Pharmaceuticals: C,L,SO
Rayner Intraocular Lenses Ltd: L
Reopia: C,SO
RxSight, Inc.: C,L,SO
Sight Sciences, Inc.: C,SO
Singular Strategies: EO
Staar Surgical: C
Stepwise Medical: C
Stuart Therapeutics: C,SO
Tarsus Pharmaceuticals: C,SO
TearClear: C,SO
TearOptix: C,SO
Thea: C
TherOptix: C,SO
Treehouse Health: C,SO
True North: EO
Vance Thompson Vision Clinic: C,EO
Visant: C,SO
Visionary Ventures: C
Visus Therapeutics, Inc.: C,SO

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None

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Alcon Laboratories, Inc.: C
Allergan, Inc.: C,L,S
ArcScan, Inc.: PS
Avellino Labs: C
Azura Ophthalmics: C
Bausch + Lomb: C,L
Beaver-Visitec International, Inc.: C
Bio-Tissue, Inc.: C,L
Carl Zeiss, Inc.: C
CXLO: C,PS
Dompé: C
Glaukos Corp.: C
Guardion Health Sciences: US
Horizon Therapeutics Plc: C
Johnson & Johnson Vision: C,L
LayerBio: SO
LensAR: C
Ocular Science: C
Oculus, Inc.: L
Orasis: PS
RxSight, Inc.: C
Sun: C,L
Tarsus Pharmaceuticals: C
Thea: C
Trefoil Therapeutics: SO
Trefoil: C,SO
Visus : C

Tanya Trinh MBBS
AbbVie: L
Alcon Laboratories, Inc.: L
Teleon: C

Riccardo Vinciguerra MD
Intelon: C
Oculus, Inc.: C

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None

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2eyes Vision S.L.: C,SO
AbbVie: C
ACE Vision: C,SO
AcuFocus, Inc.: C
Alcon Laboratories, Inc.: C,L
Allergan, Inc.: C,L
Atia Vision: C
Avedro, Inc.: C,L
Bausch + Lomb: C,L
Carl Zeiss Meditec: C
Glaukos Corp.: C,L
Johnson & Johnson Vision: C,L
Novartis: C
Oculus, Inc.: C,L
Omega Ophthalmics LLC: C,SO
Omeros Corp.: C
Perfect Lens, LLC: C,SO
Refocus Group: C
Shire: L
SRD Vision: C
Visiometrics, S.L.: C,SO
Visus: C
Zepto: C

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AcuFocus, Inc.: C,S
Alcon Laboratories, Inc.: C,L
Allergan, Inc.: C
Bausch + Lomb: C,S
Beaver-Visitec International, Inc.: C,S
Carl Zeiss Meditec: C
CorneaGen: C
Dompé: C
Glaukos Corp.: C
ImprimisRx: C,P
Johnson & Johnson Vision: C
Lensar: C
New World Medical, Inc.: C
RxSight Inc.: L,S
Sight Sciences, Inc.: C
Staar Surgical: C,L,S

Elizabeth Yeu MD
AbbVie: C
AcuFocus, Inc.: C
Adaptilens: C
Advanced Vision Group: C
Alcon Laboratories, Inc.: C,L
Aldeyra Therapeutics Inc.: C
Allergan, Inc.: C,L
Aurion: C
Avellino Labs: C
Bausch + Lomb: C
Bio-Tissue, Inc.: C,L
BlephEX, LLC: C
Bruder Healthcare Company: C
BVI: C
Carl Zeiss Meditec: C,L
Centricity: C
CorneaGen: C
Dompé: C
Elios: C
Expert Opinion: C
Eyenovia: C
Foresight: C
Glaukos Corp.: C,L
Guidepoint: C
Iveric Bio: C
Johnson & Johnson Vision: C,L
Kala Pharmaceuticals, Inc.: C
LayerBio: C
Lensar: C
Melt: C
Merck & Co., Inc.: C
New World Medical, Inc.: C
Novartis Pharma AG: C
Ocular Science: C
OCuSOFT, Inc.: C
Samsara: C
Science Based Health: C
Sight Sciences, Inc.: C
Staar Surgical: C
Surface: C
Tarsus Pharmaceuticals: C,S
Thea: C
Visus Therapeutics, Inc.: C

Sonia H Yoo MD
Carl Zeiss Meditec: C
Dermavant: C
Oyster Point Pharma: C

Dagny C Zhu MD
Alchemy Vision: C
Alcon Laboratories, Inc.: C,S
Allergan, Inc.: C,L
Bausch + Lomb: C,L
Beyeonics Surgical, Ltd.: C
Bruder Healthcare Company: C
Entelexo: C
Epion Therapeutics: C
Eyenovia: C
Eyesafe: C
Johnson & Johnson Vision: C
Kala Pharmaceuticals, Inc.: C
Lensar: C
Neurotech: C
Ocuphire: C
RadiusXR: C,SO
Santen, Inc.: L
Sight Sciences, Inc.: C
Staar Surgical: C
Tarsus Pharmaceuticals: C,L
Trukera Medical: C
Visus : C

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Controversies in Refractive Surgery

Corneal Biomechanical and Biometric Changes After Femtosecond SMILE Refractive Procedure at Different Treatment Depths
RP30075751

Senior Author: Arturo J Ramirez-Miranda MD
Coauthors: Simran Mangwani Mordani MD, Jose Y Arteaga Rivera MD, Jorge E Valdez-Garcia MD, Alondra Mendizabal-Velazquez, Alejandro Navas MD, and Enrique O Graue Hernandez MD

Purpose: To compare the changes of biomechanical properties of femtosecond SMILE at depths of 100 µm, 120 µm, 140 µm, and 160 µm. **Methods:** Retrospective, comparative case series designed to assess outcomes following SMILE. Four cap depth settings were compared. Preoperative corneal biomechanical properties, by Dynamic Scheimpflug analyzer (Corvis ST) were measured on Days 1, 7, 30, and 90 postop. **Results:** 280 eyes were included: 70 eyes in each group. Deformation amplitude (DA) and the first applanation time (A1T) were not significantly different between groups. Second applanation time (A2T) was similar between the groups on Days 1, 7, and 30 except for Day 90 after surgery (22.52 ± 0.18 ms at 160 µm vs. 22.02 ± 0.23 ms at 140 µm vs. 21.84 ± 0.24 ms at 120 µm vs. 21.34 ± 0.34 ms at 100 µm; $P = .004$). DA curve depth (µm) was steeper in the 100-µm depth cap, and the curve will be reduced as the SMILE has a deeper cap. AT2 will be significantly shorter in the 100-µm depth cap SMILE than in the 160-µm depth cap. **Conclusion:** A deeper cap while performing SMILE (120-160 µm) has less biomechanical effect in the cornea than with a cap created at 100 µm.

Corneal Higher-Order Aberrations and Asphericity Changes After Femtosecond SMILE Performed at Different Cap Depths
RP30075753

Senior Author: Jose Y Arteaga Rivera MD
Coauthors: Simran Mangwani Mordani MD, Jorge E Valdez-Garcia MD, Alondra Mendizabal-Velazquez, Alejandro Navas MD, Enrique O Graue Hernandez MD, and Arturo J Ramirez-Miranda MD

Purpose: To determine total corneal higher-order aberrations (HOAs) and asphericity (Q) values after SMILE at stromal cap depths of 100 µm, 120 µm, 140 µm, and 160 µm in high and mild-to-moderate myopic patients. **Methods:** This retrospective, comparative case series included 240 eyes of 123 healthy patients. Total corneal HOAs and Q were measured by Scheimpflug tomography with Pentacam AXL (Oculus; Wetzlar, Germany) preoperatively and on Days 1, 7, 30, and 90 postoperatively after SMILE surgery. **Results:** In high and mild-to-moderate myopic patients, HOAs showed no statistically significant differences ($P > .05$) at any cap depths, between them and through time. Regarding corneal Q, there were no statistically significant differences ($P > .05$) at any cap depths, between them and through time, except the 100 µm cap depth/mild-to-moderate myopia group. **Conclusion:** HOAs and corneal Q in high and mild-to-moderate myopic patients stabilizes at Day 1 after SMILE at all cap depths except the 100-µm group. In addition, no differences were found in HOAs and corneal Q between the different cap depth groups.

Comparison of Microkeratome LASIK and Implantable Collamer Lenses in High Myopia Beyond 10 D
RP30075761

Senior Author: Niveditha Narayanan MD
Coauthor: Madhuvanthi Mohan MD

Purpose: To compare microkeratome LASIK (MK-LASIK) and implantable collamer lenses (ICLs) in terms of refractive outcome and safety in correcting high myopia of more than 10 D. **Methods:** In this retrospective, comparative study of 154 myopic eyes between –10.00 and 13.00 D of spherical equivalence, 112 underwent MK-LASIK and 42 had ICL. We analyzed preoperative, 1-month, and 1-year postoperative outcomes between the groups to assess the refractive outcome, stability, and safety. **Results:** The average preop spherical equivalent was –11.72 ± 1.56 D and –12.88 ± 1.05 D, and the mean spherical refractive error at 1 month postop was –0.46 ± 1.34 D and –0.02 ± 0.13 D in the MK-LASIK and the ICL groups ($P = .066$), respectively. The cylindrical error reduction was significant ($P = .0001$) in both groups: 0.82 ± 0.04 in LASIK and –0.21 ± 0.06 in ICL. The average postop safety indices were 0.86 ± 1.20 D and 0.72 ± 0.42 D in the MK-LASIK and the ICL groups, respectively. **Conclusion:** For the refractive correction of myopia between 10 and 13 D of spherical equivalence, ICL provides better accuracy, stability, and safety up to 1 year of follow-up.

Combinative Approach of Transzonular Triamcinolone-Moxifloxacin and Perioperative Drops to Minimize Postoperative Complications of Cataract Surgery
RP30075775

Senior Author: Behnam Rabiee MD
Coauthors: Iftikhar M Chaudhry MD and Imtiaz M Chaudhry MD

Purpose: To investigate the effectiveness of combination therapy using transzonular triamcinolone-moxifloxacin (Tri-Moxi) and conventional perioperative drops in reducing postoperative complications of cataract surgery. **Methods:** Medical records of 1057 eyes (single surgeon) were analyzed. **Results:** The combination therapy group (564 eyes) showed a 26.9% lower relative risk of postoperative inflammation. The incidence of endophthalmitis was 0% in the combination therapy group vs. 0.5% in the drops-only group. Severe IOP spikes were similar between groups. The relative risk of postoperative cystoid macular edema was 51.4% lower in the combination therapy group during the 3-month follow-up. Visual outcomes (BCVA) at 1 month postoperatively were significantly better in the combination therapy group (logMAR 0.10) compared to the drops-only group (logMAR 0.14). Baseline VA did not significantly differ. **Conclusion:** Transzonular Tri-Moxi combined with perioperative eyedrops minimizes postoperative inflammation, improves visual outcomes, and may potentially reduce the risk of endophthalmitis and cystoid macular edema.

Effect of SMILE, Wavefront-Guided PRK, and Wavefront-Optimized PRK on Early Low-Contrast Acuity
RP30075786

Senior Author: Rose Kristine C Sia MD
Coauthors: Hind Baydoun PhD MPH, Denise Ryan COA MS, Jennifer Eaddy, Samantha B Rodgers MD, Bruce A Rivers MD, and Zachary P Skurski DO

Purpose: To compare low-contrast visual acuity (LCVA) after SMILE, wavefront-guided PRK (WFG PRK), and wavefront-optimized PRK (WFO PRK). **Methods:** A harmonized dataset was generated from 2 completed prospective cohort studies comprised of active duty service members undergoing either SMILE, WFG PRK, or WFO PRK. Secondary analysis was performed on identical outcome measures such as night vision and photopic and mesopic LCVA up to 3 months postoperatively and compared between treatment groups. LCVAs were recorded as logMAR, so lower values corresponded to better outcomes. **Results:** Compared to SMILE, WFG PRK was associated with significantly worse mesopic LCVA at 1 month postop ($\beta = 0.040$, $P = .042$). No other significant differences were observed in night vision or photopic LCVA when SMILE was compared to either WFG PRK or WFO PRK at 1 and 3 months postoperatively. **Conclusion:** SMILE and PRK on either a WFG or WFO laser platform demonstrated excellent visual outcomes, but SMILE had a slight advantage over WFG PRK, with an earlier improvement in mesopic vision.

Factors Affecting Patient-Reported Outcomes After Cataract Surgery
RP30075793

Senior Author: Jacob Lifton MD
Coauthors: Steven C Schallhorn MD, Stephen Hannan OD, and Julie M Schallhorn MD

Purpose: To identify predictors of satisfaction after cataract surgery or refractive lens exchange (RLE). **Methods:** Patients who underwent bilateral cataract surgery or RLE at a high-volume practice filled out a preop personality questionnaire and the Patient Health Questionnaire-2 depression screening tool. At postop Month 1, patients rated their satisfaction. Demographics, clinical parameters, and patient responses were used in a multivariate regression model examining predictors of satisfaction. **Results:** Of 689 patients, 617 (89.5%) were satisfied and 72 (10.5%) were dissatisfied. Better preop uncorrected distance visual acuity (UDVA) ($P = .041$), worse postop UDVA ($P = .01$), photic ($P < .001$) and dry eye symptoms ($P < .001$) predicted dissatisfaction. Multifocal lenses were associated with dissatisfaction via increased photic symptoms. Self-reported perfectionist tendencies ($P = .56$) and depressive symptoms ($P = .62$) did not predict dissatisfaction. **Conclusion:** Self-reported perfectionism and depression scores do not predict satisfaction after cataract surgery or RLE.

Keratoconus Stability After Treatment With CXL According to the Amsler-Krumeich Classification
RP30075805

Senior Author: Itamar Vigderovich MD
Coauthors: David Jimenez-Collado, Arturo J Ramirez-Miranda MD, Alejandro Navas MD, Carlos Adolfo Muller MD, and Enrique O Graue Hernandez MD

Purpose: To document keratoconus stability after management with CXL and compare data between disease stages according to the Amsler-Krumeich (AK) classification in order to identify a correlation between natural history of disease and response to treatment. **Methods:** Retrospective longitudinal study in which data of 127 eyes treated with CXL for keratoconus was obtained. CXL was performed between February and November 2019. Data obtained included flattest, steepest, and mean keratometries; thinnest point pachymetry; noncorrected VA; and contact lens–corrected VA. Said parameters were registered previous to CXL and posteriorly, at 1, 3, 6, and 12 months and yearly after the procedure. **Results:** Mean patient age was 27.6 years, and mean follow-up time was 27.7 months. AK stages 1 and 2 showed keratometric stability, while stages 3 and 4 showed pachymetric instability. **Conclusion:** Our results suggest that the stage of the disease in which a patient is treated correlates with keratoconus stability after treatment with CXL; namely, earlier stages show better response to the procedure.

Accuracy of Formulas to Calculate IOL Power After Hyperopic Excimer Laser Refractive Surgery
RP30075811

Senior Author: Michele Lanza MD
Coauthors: Luigi Serra MD, Rosa Boccia MD, Giuseppe Luciano DD, and Francesca Simonelli MD

Purpose: To compare precision of formulas to calculate IOL power in eyes undergoing cataract surgery and previously submitted to hyperopic excimer laser refractive surgery (HRS). **Methods:** In this retrospective, comparative study, 112 eyes of 112 patients underwent cataract surgery after previous HRS. IOL powers to implant were calculated with Haigis L (HL). Postoperative refractive data were used to compare precision of the following tested formulas: Barrett True-K No History (BTKNH), HL, ASCRS-average, and Shammas (SF). The mean absolute prediction error (MAE) predicted refraction was calculated for each of the formulas and compared with the actual refractive outcome to give the prediction error. **Results:** Means of MAE provided by BTKNH, HL, ASCRS, and SF were, respectively, –0.59 D, –0.43 D, –0.41 D, and –0.65 D. **Conclusion:** Even if tested formulas have an absolute lack of precision in targeting emmetropia, they are all providing very good refractive results in eyes facing cataract surgery after HRS.

Comparison of Epithelium-Off Hypo-CXL and Oxygen-Assisted Epithelium-On Iso-CXL in Keratoconus in Corneas Thinner Than 400 Microns Excluding the Epithelial Thickness: A Randomized Comparative Trial
RP30075816

Senior Author: Rajesh Sinha MD FRCS
Coauthors: Siri D MD, Namrata Sharma MD MBBS, Tushar Agarwal MD, and Jeewan S Titiyal MD

Purpose: To perform a comparative study evaluating the efficacy of epi-off hypo-corneal crosslinking (CXL) and epi-on iso-CXL with supplemental oxygen in thin keratoconic corneas. **Methods:** Forty eyes of progressive keratoconus with corneal thickness less than 400 microns excluding epithelium-on anterior segment OCT but more than 400 microns including epithelial thickness were divided into 2 arms of 20 each. Group 1 was subjected to accelerated epi-off hypo-CXL, and Group 2 underwent accelerated trans-epi iso-CXL under high oxygen concentration. **Results:** There was a greater reduction in Kmax, K1, and K2 in Group 1. Depth of demarcation line was comparable. No difference was noted in biomechanical parameters like DA ratio and INV R over time between the 2 groups. Pain score was significantly higher at first follow-up in Group 1. **Conclusion:** Epithelium-off hypo-CXL under normal oxygen concentration is more efficacious in optimizing corneal topography than trans-epi iso-CXL under increased oxygen concentration in this cohort. **Results:** Mean patient age was 27.6 years, and mean follow-up time was 27.7 months. AK stages 1 and 2 showed keratometric stability, while stages 3 and 4 showed pachymetric instability. **Conclusion:** Our results suggest that the stage of the disease in which a patient is treated correlates with keratoconus stability after treatment with CXL; namely, earlier stages show better response to the procedure.

Topography-Guided PRK for Correction of Irregular Astigmatism Following Penetrating Keratoplasty
RP30075823

Senior Author: Derek B Chan BSc
Coauthors: Parham Elmi BSc, David T C Lin MD, and Simon P Holland MD

Purpose: Post-penetrating keratoplasty (PK) eyes may have high and irregular astigmatism refractory to rigid contact lens correction. We evaluated the effectiveness of topography-guided photorefractive keratectomy (TG-PRK) for the correction of irregular astigmatism following PK. **Methods:** Patients with 12 months of follow-up data were included, with a total of 179 eyes. Preoperative and postoperative uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), manifest refraction (MR), and topographic cylinder were analyzed. **Results:** Postoperatively, 57 eyes out of 179 (32%) had UDVA ≥20/40 at 12 months compared to preoperatively. Only 1 eye (0.9%) preoperatively had a recorded UDVA ≥20/40. Fifty-nine eyes (52%) had improved CDVA. Twenty-nine eyes (26%) gained ≥2 lines, and 8 eyes (7.1%) lost ≥2 lines in CDVA. Mean astigmatism was –5.15 ± 2.3 D preoperatively and –2.26 ± 1.69 D postoperatively. Mean spherical equivalent improved from –3.53 ± 3.41 D to –1.42 ± 2.11 D. **Conclusion:** TG-PRK showed efficacy and safety for treatment of irregular astigmatism in contact lens–intolerant post-PK patients.

Visual and Refractive Outcomes of High Myopic Patients
RP30075826

Senior Author: Sara Sella MD
Coauthors: Itay Lavy MD, Jamel Corredores MD, Benjamin Stern, and David Smadja MD

Purpose: To evaluate the efficacy, predictability, stability, and safety of the LASIK procedure using the FS200 femtosecond laser and EX500 excimer laser platform and PRK procedure using an EX500 excimer laser. **Methods:** Consecutive myopic and myopic-astigmatism eyes with a spherical equivalent (SEQ) ranging between –6.5 and –12.25 D underwent a LASIK or PRK procedure using the Alcon Wavelight EX500, FS-200 excimer laser. Treatment accuracy, efficacy, safety, stability, and regression analysis to predict treatment outcomes. **Results:** Seventy-five eyes scored a preoperative SEQ of –8.14 ± 1.8 D, within a median follow-up of 12 months. A total of 65.3%, 96%, and 99% of eyes exhibited ±0.13 D, ±0.5 D, ±1 D SEQ target refraction (R^2 = 0.998). The efficacy index was 0.91 ± 0.12, with 88% and 96% of the eyes achieving 20/20 and 20/25. Alpins astigmatism vector analysis revealed a correction index (CI) of 1.04 ± 0.24, with a safety index of 1.05 ± 0.12. Spherical and coma root mean square postoperative aberrations were 1.07 ± 0.34, 0.67 ± 0.25, and 0.70 ± 0.40 µm. **Conclusion:** High myopia was treated with Alcon safely and effectively.

Evaluation on 1-Year Outcome of Topography-Guided PRK and CXL for Post-LASIK Ectasia
RP30075828

Senior Author: Parham Elmi BSc
Coauthors: Derek B Chan BSc, David T C Lin MD, and Simon P Holland MD

Purpose: Topography-guided PRK (TG-PRK) for post-LASIK ectasia (EC) with crosslinking (CXL) using a Schwind Amaris 1050 excimer laser (SA) was evaluated. **Methods:** Post-LASIK ectatic eyes that underwent treatment with the SA and Athens protocol CXL were evaluated. Preoperative and 12-month postoperative uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), manifest refraction (MR), and topographic cylinder were analyzed. **Results:** Seventy-seven eyes with complete data at 12 months were included. Fifty-two eyes (68%) showed UDVA ≥20/40 postoperatively. Thirty-one eyes (41%) had improved CDVA. Fifteen eyes (19.7%) gained 2 or more lines, while 6 eyes (8%) lost 2 lines or more. No cases showed ectatic progression. Mean astigmatism changed from –3.33 ± 1.65 D to –1.17 ± 1.115 D. Mean spherical equivalent improved from –1.24 ± 2.75 D to –0.53 ± 1.51 D. **Conclusion:** Early results of TG-PRK CXL as a treatment for post-LASIK ectasia show safety and efficacy as a potential alternative treatment for post-LASIK ectasia.

Topography-Guided PRK for Irregular Astigmatism After Radial Keratotomy Using a High-Speed Laser
RP30075829

Senior Author: Parham Elmi BSc
Coauthors: Derek B Chan BSc and Simon P Holland MD

Purpose: To evaluate topography-guided PRK (TG-PRK) for irregular astigmatism after radial keratotomy (RK) with Schwind Amaris 1050 (SA). **Methods:** Eighty-one RK eyes treated with SA excimer laser with corneal crosslinking (CXL) with Athens protocol. Preoperative and postoperative uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), manifest refraction (MR), and topographic cylinder were analyzed after 12 months of follow-up. **Results:** Forty-six eyes (57%) showed UCVA ≥20/40 postoperatively. Thirty-six eyes (45%) had improved CDVA, and 12 (15%) gained ≥2 lines, while 3 (4%) lost 2 or more lines. Mean astigmatism was reduced from –2.63 ± 1.82 D to –1.41 ± 1.39 D. Mean spherical equivalent improved from 2.19 ± 2.79 D to –0.29 ± 1.81 D. **Conclusion:** Early results of TG-PRK CXL with SA show efficacy and safety in treating post-RK irregular astigmatism. More than a half (57%) had UDVA ≥20/40 at 1 year, and 45% had improved CDVA. The technique may be an alternative treatment for post-RK with contact lens intolerance.

Two-Year Outcomes of Topography-Guided PRK With CXL for Keratoconus
RP30075830

Senior Author: David T C Lin MD

Purpose: Evaluation of 2-year results of topography-guided PRK (TG-PRK) with simultaneous collagen crosslinking (CXL) for keratoconus (KC). **Methods:** We assessed the outcomes of KC management using TG-PRK with the Schwind Amaris 1050 excimer laser and simultaneous CXL. Preoperative and postoperative uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), manifest refraction (MR), and topographic data were analyzed. **Results:** At 2 years, 88 eyes had sufficient data for analysis. Fifty eyes showed UDVA ≥20/40 postoperatively. Thirty-six eyes had improved CDVA, and 20 gained 2 or more lines, while 22 eyes lost CDVA, with 8 eyes losing 2 lines or more. Mean astigmatism changed from 2.83 ± 1.81 D to 1.82 ± 1.64 D. Mean spherical equivalent improved from –3.46 ± 3.65 D to –0.52 ± 2.14 D. Four eyes showed KC progression, and 5 had haze sufficient to reduce CDVA. **Conclusion:** Two-year results of TG-PRK with CXL for KC show that it may provide an alternative for contact lens–intolerant keratoconus patients.

Malpractice Litigation in LASIK Surgery in the Northeast United States: A Review of the WestLaw Database
RP30075832

Senior Author: Andrieh Darwich
Coauthors: Ora Batash BA, Matthew Anfuso BS, and Andrew W Trippiedi MD

Purpose: To provide a comprehensive overview and analysis of malpractice litigation in LASIK procedures in order to understand the legal implications and contributing factors. **Methods:** Thirty-five LASIK cases from the WestLaw database between the years 2000 and 2020 were included from 12 states in the northeast United States. Alleged factors were categorized into workup error, surgical error, and postoperative error. **Results:** Thirty-four cases (97.1%) were resolved through a jury trial, 37.1% of which were associated with plaintiff verdicts, with an average award of $1,624,143. One case resulted in settlements of $190,000. 65.7% of cases involved improper diagnosis, inappropriate workup, or informed consent gaps, 17.1% involved surgical errors, and 14.3% involved postoperative treatment and follow-up. The average length of litigation was 1.74 years. **Conclusion:** LASIK malpractice litigation was most common after diagnosis from improper workup. These cases highlight the importance of detailed preoperative evaluation and informed consent. As well, plaintiff verdicts ended with higher awards compared to the settlement.

Intrastromal Corneal Ring Segment Implantation Followed by Epi-On CXL in Patients With Corneal Ectasia After Refractive Surgery
RP30075835

Senior Author: Diego Ivan Cervera-Ruiz MD
Coauthor: Maria De Lourdes Julieta Vera MD

Purpose: To evaluate the clinical outcome of intracorneal ring segment (ICRS) implantation followed by epi-on CXL in patients with corneal ectasia after refractive surgery. **Methods:** Retrospective study in which clinical records of patients with corneal ectasia after refractive surgery and ICRS implantation followed by epi-on CXL (4 months after ICRS implantation) were analyzed. **Results:** Ten eyes from 5 patients with corneal ectasia were analyzed (8 eyes after LASIK and 2 eyes after radial keratotomy). Spherical equivalent improved from –7-.78 ± 6.95 to –5.67 ± 6.52 D (*P* = .013); uncorrected distance VA, from 0.81 ± 0.3 to 0.540 ± 0.35 logMAR (*P* = .003); corrected distance VA, from 0.320 ± 0.36 to 0.130 ± 0.17 logMAR (*P* = .061); SimK1, from 43.6 ± 5.6 to 41.62 ± 5.02 D (*P* = .003); SimK2, from 48.15 ± 7.38 D to 44.33 ± 6.3 D (*P* = .001); corneal astigmatism, from –4.49 ± 1.88 D to –2.71 ± 1.92 D (*P* = .001). **Conclusion:** After these procedures, the spherical equivalent, the uncorrected distance VA, and the best corrected distance VA were significantly improved. There is a significant decrease in SimK1 and SimK2 and corneal astigmatism. No significant change in thinnest pachymetry.

Cutting-edge Research

Induction of Crosslinks in Corneal Tissue by Sunlight Exposure and Oral Riboflavin Administration in Rabbits: The Biomechanical Impact Using Extensometry and High-Resolution OCT Elastography
RP30075756

Senior Author: Emilio A Torres Netto MD PhD
Coauthors: Sabine Kling PhD, M Enes Aydemir, Nanji Lu MD, Nikki Leilah Hafezi, Mark Hillen, and Farhad Hafezi FARVO MD PhD

Purpose: To assess whether oral riboflavin combined with exposure to natural sunlight may lead to a stiffening effect in the corneas of free-moving rabbits. Biomechanical changes were analyzed using OCT elastography and stress-strain extensometry. **Methods:** Sixteen male New Zealand white rabbits were used. The riboflavin group received vitamin B2 and sunlight exposure, while the control group was exposed to sunlight only. A total light dosage of 2700 klux*h was targeted. OCT elastography and stress-strain extensometry were conducted. **Results:** Control and riboflavin conditions had a stress of 152 ± 11.5 kPa and 146 ± 7.0 kPa (*P* = .57). The mean elastic modulus between 0.1 and 0.2 strain was 4.1 and 4.0 MPa (*P* = .870). In elastography, the posterior half of the riboflavin cornea presented a higher strain amplitude compared to the control cornea (8.1‰ vs. 3.8‰; *P* = .03). **Conclusion:** Oral riboflavin and reduced sunlight exposure in vivo did not significantly improve the corneal stiffness of rabbit corneas. Interestingly, animals that received riboflavin and were exposed to sunlight showed a trend toward softening in the posterior corneal stroma.

Comparison of a Novel Chaotic Model With Conventional Convolutional Neural Networks Models for Diagnosis of Keratoconus
RP30075783

Senior Author: Soheil Adib-Moghaddam MD
Coauthors: Moein Bahman MD and Hooman Ahmadzadeh MD

Purpose: To develop a novel artificial intelligence (AI) model for diagnosing keratoconus and compare it to a conventional convolutional neural networks (CNN) model. **Methods:** Many phenomena exhibit chaotic behavior; they are based on well-known physics principles but are very challenging to predict. The keratoconus process can be considered one such phenomenon. We established a novel AI model based on chaos system principles for diagnosing keratoconus using tomographic data. We also compared overfitting in our model to a conventional CNN model by running simulations using 64 factors with 0, 8, and 16 common sources (redundant data). **Results:** Our designed model showed very encouraging results in our preliminary tests (sensitivity: 92%; specificity: 96%; *n* = 64 normal, 44 keratoconus). Analyzing for overfitting showed that adding 8 and 16 common sources to a conventional CNN model caused severe overfitting, while adding up to 16 common sources did not cause any overfitting in our model. **Conclusion:** We showed a high overfitting tendency in CNN, while our model did not experience any adding up to 16 common sources. This model may be valuable in a broad range of ophthalmologic or other conditions.

Synthetic Corneal Endothelial Substitute: Results of an Exploratory Clinical Trial
RP30075800

Senior Author: Lional Raj Daniel Raj Ponniah MD

Purpose: Evaluation of safety and efficacy of novel synthetic endothelial substitute (SES) in cases of chronic endothelial dysfunction. **Methods:** Prospective open-label safety and efficacy evaluation. Cases of endothelial dysfunction not associated with herpes or prior corneal surgeries were subjected to central 6-mm SES after 7-mm descemetorrhexis, attached with gas. Pre- and postop pachymetry (mic), vision (ETDRS), and pain (1-100) were analyzed, in addition to rebubbling and toxicities. **Results:** Twelve subjects. Minimum follow-up: 8 months. Baseline VA was 9.75 ± 1.7, which improved to 41.75 ± 8.7 by Month 1 and was retained after Month 8 at 55.59 ± 7.1. Central pachymetry reduced from 715 mic to 504 by Month 1 and 492.5 mic by Month 8. Baseline pain was 90.5 ± 2.3 at Month 1 and was further reduced to 68.25 ± 4.03 by Month 4 (*P* = .0001). No immunologic or adverse reactions were noticed, no explantations. Three cases rebubbled (D7, D7, D12, 21). Postmortem HPE in a subject after Month 6, had fibrosis of SES edges to cornea, favoring retention. **Conclusion:** Endothelial keratoprosthesis improved vision, reduced edema, was not associated with adverse events or toxicities until Month 8, which are being monitored. SES is a safe alternative to EK, with no rejection risks.

Low-Contrast Acuity Outcomes After SMILE, Wavefront-Guided LASIK, and Wavefront-Optimized LASIK
RP30075815

Senior Author: Zachary P Skurski DO
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Purpose: To compare low-contrast VA (LCVA) after SMILE, wavefront-guided LASIK (WFG LASIK) and wavefront-optimized LASIK (WFO LASIK). **Methods:** A secondary analysis was performed using a harmonized dataset derived from 2 completed prospective cohort studies on active duty military service members undergoing either SMILE (n = 37), WFG LASIK (n = 51), or WFO LASIK (n = 56). Night vision and photopic and mesopic LCVA up to 3 months postoperatively were compared between groups. LCVAs were recorded as logMAR; thus lower values corresponded to better outcomes. **Results:** Compared to SMILE-treated eyes, WFG LASIK–treated eyes had significantly better night vision and photopic LCVA at 1 month postoperatively ($\beta = -0.039$, $P = .016$; $\beta = -0.043$, $P = .007$, respectively). WFO LASIK–treated eyes had significantly better photopic LCVA at 1 month postoperatively ($\beta = -0.039$, $P = .012$) but had worse mesopic LCVA at 3 months postoperatively ($\beta = 0.033$, $P = .015$) vs. SMILE-treated eyes. **Conclusion:** SMILE and LASIK, on either WFG or WFO laser platform, yielded excellent outcomes; however, LCVA seemed to recover more quickly following LASIK compared to SMILE.

Patterns of Corneal Epithelial Remodeling After Refractive Surgery Can Affect Asphericity
RP30075825

Senior Author: Sara Sella MD
Coauthor: David Smadja MD

Purpose: This study aims to investigate the correlation between epithelial remodeling after laser vision correction surgeries and corneal asphericity measured by 2 devices. **Methods:** A retrospective cross-sectional and analytical study was conducted using spectral domain OCT. We calculated the corneal epithelial thickness in 37 subjects. Twenty-three had PRK and 14 had LASIK. OCT was performed preoperatively and 1 and 3 months after surgery. Uncorrected (UDVA) and corrected (CDVA) distance visual acuity and residual refractive error were measured. Asphericity (Q) was measured with OPD-Scan iii and Galilei-6 pre- and postoperatively. Predictive factors for epithelial changes according to asphericity changes were investigated. **Results:** This study included 37 eyes of 37 patients. Twenty-three had PRK and 14 had LASIK; no significant preop parameters. Mean age was 28 ± 7 years, pre- and postoperative manifest refraction: –4.9 ± 2, 0.006 ± 0.2. Aphericity increased to 0.43 ± 0.39 in both devices. The epithelial thickening positively correlated with changes in asphericity ΔQ ($P < .01$). **Conclusion:** The epithelial changes correlated to asphericity.

Innovation

High-Resolution OCT Elastography: Clinical Evaluation of Normal and Keratoconus Corneas
RP30075755

Senior Author: Emilio A Torres Netto MD PhD
Coauthors: Matteo Frigelli, M Enes Aydemir, Mark Hillen, Nanji Lu MD, Farhad Hafezi FARVO MD PhD, and Sabine Kling PhD

Purpose: Optical coherence elastography (OCE) is a new technology that aims at detecting localized biomechanical changes using local tissue deformation via OCT imaging. Here, we assessed the ability of OCE to differentiate keratoconus (KC) from normal corneas. **Methods:** Nine healthy individuals and 15 patients with KC underwent OCE measurements. A total of 128 consecutive B-scans were recorded. Corneal deformation was quantified using a phase-based displacement. **Results:** Overall corneal strain was positive in KC and negative in healthy corneas. KC and healthy corneas had accumulated a posterior strain of 1.80 ± 0.77‰ and –2.22 ± 0.62‰ ($P = .001$), respectively. Anterior strain showed no significant difference ($P = .62$). Regarding the central cornea, anterior KC corneas tended to move forward further on average than healthy corneas (84 ± 37 nm vs. –55 ± 58 nm; $P = .054$). **Conclusion:** OCE is capable of clinically differentiating between normal and keratoconic corneas by analyzing in-depth corneal strain. Localizing biomechanical changes in the cornea may open new horizons for KC diagnosis and monitoring ectasia progression.

A Novel Keratoconus Staging System Based on OCT
RP30075757

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Purpose: To establish a numerical spectral domain OCT (SD OCT)-based keratoconus (KC) staging system and compare it with existing KC staging systems. **Methods:** Scheimpflug tomography, air-puff tonometry, and SD OCT were performed. All SD OCT-derived parameters of the epithelium and stroma were evaluated based on their receiver operating characteristic (ROC) curves, area under the curve (AUC), sensitivity, and specificity to discriminate between normal and KC eyes. The best performing parameters were subsequently used to create an OCT-based staging system, which was compared with existing tomographic and biomechanical staging systems. **Results:** 236 normal eyes and 331 KC eyes of different stages were included. The highest ranked AUC ROC SD OCT parameters, derived from stroma and epithelium, were stroma overall minimum thickness and epithelium overall standard deviation. A numerical SD OCT staging system including these 2 parameters was proposed. **Conclusion:** This new staging system is the first to take the epithelium with its sublayer stroma information into account, showing a strong compatibility with the existing systems.

Corvis ST Analysis of Corneal Biomechanical Properties After Refractive Surgery
RP30075767

Senior Author: Isabel De La Fuente
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Purpose: To evaluate the changes in corneal biomechanics after 2 modalities of excimer laser ablative refractive surgery (PRK and LASIK) using the Corvis ST. **Methods:** Retrospective chart analysis of patients who attended an ophthalmology reference center in Mexico and underwent PRK or LASIK. Biomechanical properties were evaluated with Corvis ST in the preoperative and postoperative period at 1 and 9 months. **Results:** Twenty-seven eyes of 25 patients were included. Seven (25.9%) and 20 (73.1%) eyes underwent PRK or LASIK, respectively. A1, DA, ARTH, SPA1, and Corvis Biomechanical Index changed significantly from baseline when evaluated at 1 and 9 months postoperatively in both groups. These changes compared between both groups did not represent a significant difference. **Conclusion:** Laser refractive surgery modifies corneal biomechanics, although PRK and LASIK changes in corneal elasticity result in no statistically significant differences.

Minimonovision Performance of a Nondiffractive Extended-Depth-of-Focus IOL
RP30075772

Senior Author: Ramin Khoramnia MD
Coauthors: Gerd U Auffarth MD and Caridad Perez Vives

Purpose: To descriptively compare visual outcomes and patient-reported outcome measures in subjects with minimonovision and emmetropia after bilateral implantation of AcrySof IQ Vivity IOL. **Methods:** Multicenter, ambispective registry study conducted in Europe, Australia, and New Zealand. **Results:** 202 subjects fell in the minimonovisision group and 649 in the emmetropia one. Binocular mean logMAR (SD) uncorrected distance (UCDVA), uncorrected intermediate (UCIVA), and uncorrected near (UCNVA) VAs were 0.027 (0.100), 0.071 (0.114), and 0.203 (0.141) for the mini-monovision group and 0.005 (0.101), 0.089 (0.123), and 0.258 (0.154) for the emmetropia group, respectively, at 3-6 months postop. Patients reported never/rarely using spectacles at near, intermediate, and distance by 75.2%, 92.6%, and 90.0% for the minimonovision and 56.5%, 88.4%, and 94.1% for the emmetropia group, respectively. More than 90% of subjects in both groups reported no halos, glare, or starbursts. **Conclusion:** These results suggest an improvement at near and intermediate vision with a minimonovision approach compared to emmetropia in patients implanted with AcrySof IQ Vivity IOL, while maintaining performance at distance and a low level of visual disturbances.

Nondiffractive Extended-Depth-of-Focus Toric IOL: Visual Performance and Patient-Reported Outcomes in a Large Cohort Real-World Study
RP30075776

Senior Author: Mike P Holzer MD
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Purpose: To evaluate visual acuity, patient satisfaction, spectacle independence, visual disturbance, and refractive outcomes in patients implanted with an extended-depth-of-focus (EDOF) toric IOL, AcrySof IQ Vivity Toric. **Methods:** Multicenter registry study of 321 subjects implanted with the toric AcrySof IQ Vivity IOL in at least in 1 eye. After 3 months of follow-up, binocular uncorrected distance VA (UCDVA)/best corrected distance VA (BCDVA), uncorrected intermediate VA (UCIVA)/distance-corrected intermediate VA (DCIVA) @66 cm, and uncorrected near VA (UCNVA)/distance-corrected near VA (DCNVA) @40 cm were measured. Spectacle independence, patient satisfaction, and visual disturbances were evaluated. **Results:** Binocular mean (SD) (logMAR) UDVA, 0.016 (0.105); UIVA, 0.088 (0.113); UNVA, 0.256 (0.153); BCDVA, –0.024 (0.082); DCIVA, 0.107 (0.127); and DCNVA, 0.307 (0.152). Over 82% of eyes had ≤0.50 D of manifest refractive cylinder postop. 87.1% reported never wearing glasses at distance; at arm's length, 76.3%. 91.3% were satisfied with their sight. No halos, glare, or starbursts were reported by 92.5%, 90.3%, and 95.6%, respectively. **Conclusion:** Subjects achieved low cylinder refractive errors, very good distance, intermediate, and functional near vision, and high levels of spectacle independence, with low levels of visual disturbances.

Corneal Biomechanical Metrics by Corvis ST in a Healthy Mexican Population
RP30075780

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Purpose: To determine parameters derived from the Corvis ST in healthy eyes from a Mexican population. **Methods:** Retrospective analysis of 511 healthy patients who fulfilled the safety criteria. We obtained biomechanical property recordings using Corvis ST and central corneal thickness (CCT) taken with Pentacam. Relationship between CCT and IOP with biomechanical measurements was assessed. Differences between Corvis ST and Pentacam CCT measurements were obtained. **Results:** Patient mean age was 28.07 ± 5.41 years. Pentacam CCT and IOP were statistically significantly correlated to most of the parameters from the Corvis ST. The strongest association was found to be between IOP and deformation amplitude. Mean CCT showed statistically significant differences between Corvis ST and Pentacam measurements. Mean values in our study sample were statistically significantly different to those reported in other ethnic populations. **Conclusion:** Ethnicity has an important role in corneal biomechanical properties—hence the importance of using customized charts to improve accuracy of detecting abnormal cases in each particular population.

Accuracy of IOL Power Calculation Formulas in Eyes Undergoing Descemet-Stripping Endothelial Keratoplasty Combined With Cataract Surgery
RP30075812

Senior Author: Michele Lanza MD
Coauthors: Luigi Serra MD, Rosa Boccia, Giuseppe Luciano DD, Mario Bifani Sconocchia MD, Paolo Melillo PhD, and Francesca Simonelli MD

Purpose: To evaluate the precision in IOL power calculation in eyes undergoing Descemet-stripping automated endothelial keratoplasty (C-DSAEK) surgery, using the following formulas: SRK/T, Holladay 2 (H2), Haigis, Hoffer Q (HQ), Barrett Universal II (BUII), EVO, and Kane. **Methods:** In this retrospective, comparative study, 48 eyes of 48 patients underwent C-DSAEK. The IOL powers to implant were calculated with H2 formula targeting –1 D refraction. Preoperative and postoperative data were used to obtain the median of absolute prediction errors (MAE) targeting emmetropia with every tested formula and then compared among them. **Results:** Means of MAE calculated were +1.31 D with SRK/T, +1.46 D with H2, +1.58 D with Haigis, +1.47 D with HQ, +1.51 D with BUII, +1.44 D with EVO, and +1.45 D with Kane. MAE provided by SRK/T showed significant ($P < .01$) difference compared to the ones provided by the other formulas. **Conclusion:** Even if tested formulas are not able to accurately target emmetropia, SRK/T seems to be able to provide closer results in eyes undergoing C-DSAEK.

Validation of a Virtual Eye Model System for Refractive Surgery Treatment
RP30075813

Senior Author: Jorge L Alio MD PhD
Coauthors: Marina José-Martínez BSc, Alejandra E Rodriguez PhD, Jesper Hjortdal MD, Joaquim N Murta MD PhD, and Francesco Versaci MS

Purpose: To provide a solution that offers data-driven clinical support for refractive surgery by building a virtual eye using real eye data. **Methods:** Biometric data were taken from the VEMoS-AXL device to create a personalized virtual eye. The software developed registers and stores data obtained from clinical trials and is an interactive tool for the professional to visualize postoperative scenarios. Comparative and repeatability analyses evaluate biometric parameters from the VEMoS-AXL and IOLMaster 700. Simulations are validated comparing Zernike coefficients and metrics obtained with Zemax systems. **Results:** Initial outcomes show statistical repeatability by comparing ocular measurements of axial lengths (AL). No statistical differences were found for mean values of AL, and high correlations for biometric parameters were obtained comparing both devices. Zemax and VEMoS software highly correlate and illustrate the visual quality simulations. **Conclusion:** Identification of appropriate techniques, standardization of data, and reduction of adverse effects result in reliable postoperative simulations, preventing subjective decision making.

The Lumina Accommodative IOL: Visual Outcomes, Optical Quality, and Accommodative Response
RP30075814

Senior Author: Jorge L Alio MD PhD
Coauthors: Elinor Megiddo MD, Antonio Martinez-Abad PhD, and Pilar Yebana MSc

Purpose: To evaluate accommodative, refractive, and ocular performance of the Lumina (Akkolens) accommodative IOL. **Methods:** Prospective study. Fifty eyes all underwent cataract surgery and Lumina implantation and completed 6 months follow-up, including full ophthalmic check, defocus curve, contrast sensitivity (CS), optical quality analyzer system (OQAS), and open field aberrometer (OFA) for accommodation measurement. **Results:** Six-month uncorrected distance, uncorrected near, and distance-corrected near VAs were 0.1 ± 0.14, 0.31 ± 0.17, and 0.34 ± 0.1 logMAR, respectively. Subjective accommodation was 1.37 ± 0.74, 2.05 ± 0.75, and 3.63 ± 0.68 D at VA of 0.1, 0.2, and 0.4 logMAR, respectively. Mean CS at 6 months was 1.66 ± 0.15, 1.99 ± 0.18, 1.79 ± 0.19, and 1.34 ± 0.24 log units for 3, 6, 12, and 18 cpd, respectively. The root mean square, higher-order aberration, and point spread function (PSF) Strehl ratios (SR) were 0.72 ± 0.9, 0.54 ± 0.63, 0.45 ± 0.66 µm, and 0.23 ± 0.13, respectively. The PSF SR did not differ significantly between OQAS and OFA. **Conclusion:** The Lumina effectively restores visual performance for far, with functional performance for intermediate and near and good CS. Accommodative range is variable (1-3 D), with accommodation and pseudoaccommodation justifying part of the near vision.

Global Trends of Publications on Machine Learning and Refractive Surgery
RP30075822

Senior Author: Philipp Lassaren MD BS

Purpose: To relate global productivity of research on machine learning (ML) within refractive surgery (RS) to population size and gross domestic product (GDP). **Methods:** A search containing ML- and RS-related terms was run in PubMed on 6/6/2023 and analyzed in R using "pubmedR" and "bibliometrix." Country affiliations of all authors were extracted. **Results:** 255 articles were retrieved in 1994-2023. Annual growth was 9.25%, with 76% published since 2018. Most authors are from China (385), the United States (351), Germany (130), India (127), and the United Kingdom (124). Most authors (per million people) are from Singapore (16.5), Austria (4.7), the Netherlands (4.0), Switzerland (3.6), and Hungary (2.7). Most authors (per GDP; trillion USD) are from Singapore (253), Hungary (162), Austria (94), Portugal (80), and the Netherlands (76). Egypt is the only African country represented. No authors are from low-income countries. **Conclusion:** Research output on ML within RS is unevenly distributed, possibly reflecting cost of RS treatment and of research. Notably, Singaporean authors are highly productive in relation to both population size and GDP.

Cataract Surgery Outcomes in Patients With Disabilities
RP30075834

Senior Author: Madhura Shah BS
Coauthor: Susannah G Rowe MD

Purpose: Data on the safety and benefits of cataract surgery for people with intellectual/developmental disabilities is largely anecdotal. To inform decisions for this group of patients, we report outcomes for a case series of people with intellectual disability, dementia, and/or autism who underwent cataract surgery under general anesthesia. **Methods:** Chart review of 51 consecutive surgeries of patients with people with intellectual/developmental disabilities with cataract surgery under general anesthesia. **Results:** Of 51 surgeries, zero adverse events were noted (including vitrectomy, wound dehiscence, infection, low or high IOP, or systemic complications). At postop Day 1, 70% of caregivers reported patients had minimal or no discomfort. Eighty-four percent of caregivers noted vision-related quality-of-life improvements after surgery. **Conclusion:** With appropriate modifications, cataract surgery can be safe for people with intellectual/developmental disabilities and improve quality of life in meaningful ways.

JRS—Hot, Hotter, Hottest Late Breaking News

Functional Outcomes After Binocular Femtosecond Laser–Assisted Refractive Lens Exchange and Implantation of a Diffractive Trifocal IOL
RP30075771

Senior Author: Ramin Khoramnia MD
Coauthors: Isabella Diana Baur, Grzegorz Labuz, Louise Bloeck, Nikola Henningsen, Emanuel Reitemayer, Oliver Hassel, and Gerd U Auffarth MD

Purpose: Clinical evaluation of a new glistening-free trifocal IOL in refractive lens exchange patients. **Methods:** In an ongoing study, bilateral implantation of the new Clareon IQ PanOptix IOL (Alcon; Fort Worth, TX, USA) is performed in 56 eyes of 28 refractive lens exchange patients. Postoperative follow-up at 3 months includes uncorrected (UDVA) and corrected distance visual acuity (CDVA), uncorrected (UIVA) and distance-corrected (DCIVA) intermediate visual acuity (60 cm), uncorrected (UNVA) and distance-corrected (DCNVA) near visual acuity (40 and 33 cm), defocus curve testing, and contrast sensitivity testing under photopic and mesopic conditions. **Results:** UDVA and CDVA were 0.00 ± 0.04 and −0.10 ± 0.06 logMAR. UIVA and DCIVA were −0.08 ± 0.05 and −0.09 ± 0.07 logMAR. UNVA and DCNVA were 0.01 ± 0.03 and −0.02 ± 0.04 logMAR at 40 cm and 0.11 ± 0.07 and 0.09 ± 0.06 at 33 cm. The defocus curve revealed a VA of 0.10 logMAR or better from +0.5 to -3.0 D. **Conclusion:** The Clareon IQ PanOptix IOL provided very good distance, intermediate, and near visual outcomes. Spectacle independence was achieved in more demanding refractive lens exchange patients.

Celebrity Influence and Public Interest in Ophthalmology Procedures: Google Trends Analysis
RP30075781

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Purpose: This study explores the effects of Joe Jonas' endorsement of EVO ICL in August 2022 and how media attention after his surgery impacted public interest in ophthalmology procedures broadly. **Methods:** Google Trends (GT) databases of search volumes were collected for terms related to EVO ICL, vision correction, and refractive surgery categories from January 2004 to June 2023 using the "related queries" feature. Mean search volumes prior to celebrity announcements were compared to the period starting 6 months after. The percent change from the months preceding announcements were compared to the month of the announcement for each search term. **Results:** All terms demonstrated peak interest in October 2022. Following Jonas' endorsement, "EVO ICL" rose 1360%, "Evo Lens" rose 800%, and "Evo Visian" rose 650%. For all search terms, interest was higher after October 2022 than before. **Conclusion:** While GT data trends correlate with shifts in public interest influenced by celebrities, more research is needed to assess whether GT data trends are a useful tool for real-time prediction of ophthalmic procedures and corresponding surgical procedure volumes.

Corneal Biomechanical Analysis Detects Changes in Patients With a TGFBI Mutation Before Clinically Significant Corneal Deposits
RP30075808

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Purpose: To evaluate corneal biomechanical changes in patients with mutation in the TGFBI gene. **Methods:** A family with history of confirmed granular corneal dystrophy type 2 (GCD2) was divided into 2 groups—patients with mutation and clinical GCD2 (Group 1, $n = 8$) and patients with mutation yet no clinical corneal dystrophy changes (Group 2, $n = 3$)—plus a control group (Group 3, $n = 20$). Biomechanical corneal stiffness was determined using the Corvis Biomechanical Index (CBI). Statistical analysis was performed with Tukeys range test. **Results:** Eight out of 15 were mutation positive. Group 1 had a mean CBI of 0.63, Group 2 had a mean CBI of 0.58, and Group 3 had a mean CBI of 0.12. The difference in CBI between Groups 1 and 2 was not statistically significant ($P = .729$). The difference in CBI between Groups 1 and 2 with Group 3 was statistically significant ($P < .0001$). **Conclusion:** Patients with mutations in the TGFBI gene have increased corneal elasticity. The fact that Group 2 also had a higher CBI suggests that the mutation itself alters corneal biomechanical structure, independently of corneal deposits. These patients should not be considered for corneal refractive surgery long-term.

What's New for Me in 2023

New Phakic Lens Supported in the Ciliary Body With an Elongated Depth of Focus to Correct Myopia and Presbyopia
RP30075779

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Purpose: To assess the results in distance, intermediate, and near vision of a new phakic lens with elongated depth of focus (EDOF). **Methods:** The ICL EVO Viva phakic lens (Implantable Collamer Lens, Staar Surgical) presents a monofocal optic with EDOF obtained by negative spherical aberration. The study included 40 patients (80 eyes). The main inclusion criteria were patient age between 45 and 55 years, with myopia between 2 and 15 D and glasses use. Changes in VA, refraction, defocus curve, aberrometry, endothelial cell count, and vault were analyzed. **Results:** In the last examination performed, the mean distance-corrected binocular VA was 0.97. The mean distance-uncorrected binocular VA at 66, 50, and 40 was higher than 0.9, 0.6, and 0.5, respectively. These data meet the requirements for the defocus curve to EDOF criteria. The total mean SA decreased −0.34 µm, and the mean total comatic aberration increased 0.24 µm. Twenty percent of patients lost a distance-corrected binocular VA line. The mean vault at the last visit was 337 ± 141 µm. **Conclusion:** The results obtained allow us to advise its implant in the selected patient profile.

Outcome of Implantable Collamer Lens by a Single Surgeon in a Tertiary Care Center
RP30075798

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Purpose: To analyze the long-term safety and refractive stability of the implantable collamer lens (ICL). **Methods:** A retrospective descriptive study from August 2015 to February 2023. **Results:** We analyzed 124 eyes with an average spherical equivalent of −13.83 ± 4.15 D, which was reduced to −0.52 D postop for a mean follow-up of 12.4 months. Seven had a residual error of more than −2.00 D, and 6 of them had a preop of more than −18.00 D. The average preop BCVA improved from 0.14 to 0.13 logMAR at the last visit. The changes in endothelial cell count, hexagonality, and coefficient of variation were insignificant, with *P*-values of .07, .49, and .35, respectively. The mean vault was stable at postop Day 1, 1 month, and the last visit, with values of 555.92 ± 205.82, 562.22 ± 218.60, and 536.2 ± 188.33 microns, respectively (*P*-values: 0.80). Two each had IOP spikes or needed ICL exchange, and 3 each developed guttate or cataracts.

Refractive and Visual Outcomes of LASIK for Hyperopic Eyes Using Custom-Q Mode: Twelve-Month Follow-up
RP30075819

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Purpose: To evaluate the refractive and visual outcomes of moderate to high hyperopic patients treated with LASIK using Custom-Q mode. **Methods:** Monocentric retrospective case series. Alcon suite (Wavelight EX-500, FS-200, Alcon Laboratories) with negative aspheric ablation profile. Twelve-month data was collected. Primary outcome measures were safety and efficacy. Secondary outcomes kinetic of stabilization within 12 months according to age, preoperative refraction, and regression analysis. **Results:** Twelve-month data of 30 eyes was collected. Mean age was 33.2 ± 19; mean preoperative spherical equivalent, +4.2 ± 1.3 D. Efficacy of 0.9 and safety of 1.0. Uncorrected distance VA of 20/20 within 75%, spherical equivalent of ±0.5 within 70%, and 90% within 1 D. 13.4% (4/30) required flap lift for overcorrection. A slight trend of regression was noticed after 12 months. TIA was 1.59 and SIA was 0.2; 83% of 0.5 D residual cylinder and angle of error of 80% within ±15 degrees. **Conclusion:** Using negative aspheric profile with Custom-Q mode with Alcon laser suite is safe and effective among moderate to high hyperopic patients.

Outcome of PRK With Advanced Beam Profile for Myopia
RP30075824

Senior Author: Derek B Chan BSc
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Purpose: Outcomes of transepithelial PRK (TE-PRK) using the Schwind Amaris 1050 (SA) laser with SmartSurfACE beam profile for myopia were evaluated. **Methods:** Patients with moderate myopia (0.00 D to −6.00 D), high myopia (−6.25 D to −10.00 D), and extreme myopia (> −10.00 D) were included. Pre- and 12-month postoperative uncorrected VA (UCVA), corrected distance VA (CDVA), and manifest refraction were noted. **Results:** A total of 915 eyes—546 eyes with moderate, 298 eyes with high, and 71 eyes with extreme myopia—were evaluated. Mean spherical equivalents improved for all eyes from −5.20 ± 1.68 D to −0.03 ± 1.29 D; for moderate myopia, −3.41 ± 1.39 D to −0.03 ± 1.63 D; for high myopia, −7.25 ± 1.21 D to 0.00 ± 0.41 D; and for extreme myopia, −10.86 ± 1.11 D to −0.26 ± 0.64 D. UCVA ≥20/25 was achieved by 525 (96%), 281 (94%), and 54 (76%) eyes, respectively. CDVA showed a gain of 2 lines or more in 50 (9.16%), 17 (5.7%), and 1 (1.45%) eyes, respectively. 529 (97%), 289 (97%), and 58 (84%) eyes, respectively, had improved or unchanged CDVA. **Conclusion:** TE-PRK with SA showed efficacy and safety in a range of myopic eyes, including eyes with extreme myopia.

Topography-Guided PRK for Retreatment on Post-LASIK Refractive Error

RP30075831

Senior Author: Simon P Holland MD

Purpose: To evaluate early results of topography-guided PRK (TG-PRK) for retreatment on post-LASIK residual refractive error with SmartSurfACE (SS) and Schwind Amaris 1050 (SA) excimer laser. **Methods:** Eyes with post-LASIK residual refractive error that underwent treatment with SA and SS technology were evaluated. Preoperative and 6-month postoperative uncorrected distance VA (UDVA), corrected distance VA (CDVA), manifest refraction (MR), spherical equivalent (SE), and topographies were analyzed. **Results:** Seventy-five eyes were included. Thirty-three eyes (44%) showed UDVA ≥20/40 preoperatively. This improved to 61 eyes (81%) postoperatively. Sixty-two eyes (83%) had unchanged or improved CDVA, while 3 eyes (4%) lost 2 or more lines. Mean SE improved from −0.93 ± 1.84 D to −0.22 ± 1.04 D. Mean astigmatism changed from 0.97 ± 1.11 D to 0.50 ± 0.73 D. **Conclusion:** Early results of TG-PRK with SS and SA show efficacy and safety as treatment for post-LASIK residual refractive error.