Refractive Surgery 2017
Linking to the Expanded World of Refractive Surgery

Program Directors
Renato Ambrósio Jr MD and William B Trattler MD

The Annual Meeting of ISRS
Sponsored by the International Society of Refractive Surgery (ISRS)

Ernest N Morial Convention Center
New Orleans, Louisiana
Friday, Nov. 10, 2017

Presented by:
The American Academy of Ophthalmology

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Program Director
William B Trattler MD
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Daniel S Durrie MD
Bonnie A Henderson MD
A John Kanellopoulos MD
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On behalf of the American Academy of Ophthalmology and the International Society of Refractive Surgery, it is our pleasure to welcome you to New Orleans and Refractive Surgery 2017: Linking to the Expanded World of Refractive Surgery, the Annual Meeting of the International Society of Refractive Surgery.

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Program Director
Alcon Laboratories Inc.: C
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Abbott Medical Optics: C,L
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Guardian Health: C,O
Healthe: O | LensAR: C
Oculus, Inc.: L
Rapid Pathogen Screenings: O
Tear Science: C | Vmax Vision: C
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Strathspey Crown LLC: C,L,O

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Bausch+Lomb: C
Shire: C
Sun Pharmaceuticals: C

J Bradley Randleman MD
None

Marcony R Santhiago MD
Alcon Laboratories Inc.: L,C
Staar Surgical: L
Ziemer: C

A John Kanellopoulos MD
A.R.C. Laser GmbH: C
Alcon Laboratories Inc.: C
Avedro: C
Carl Zeiss Meditec: C
KeraMed Inc.: C
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Alcon Laboratories, Inc.: C
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Hoopes Durrie Rivera Research Center: C
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ThromboGenics, Inc.: S

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Aerie: C
Alcon Laboratories, Inc.: C,L,S
Allergan: C,L,S
Bausch Lomb: C,L
CoDa: C | ForeSight: C
NovaBay: C | Ocular Science: C,O
Ocular Therapeutix: C,S
PolyActiva: C | Shire: C
Slack Publishing: C
Sun Pharma: C
Syndexis: C | TearLab: C

R Michael Siatkowski MD
(Pediatric Ophthalmology)
National Eye Institute: S

Kuldev Singh MD
(Glaucoma)
Abbott Medical Optics Inc.: C
Aerie: C
Alcon Laboratories, Inc.: C
Allergan: C
Belkin Laser Ltd: C
Glaukos Corporation: C
InjectSense: C
Ivantis: C
Mynosys: C
National Eye Institute: S
Novartis Institute for Biomedical Research: C
Santen, Inc.: C
Shire: C
Thieme Medical Publishers: C
U.S. Food and Drug Administration: S,C

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Opticent Inc.: O

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CME Credit

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.

2017 Refractive Surgery Subspecialty Day Meeting Learning Objectives
Upon completion of this activity, participants should be able to:

■ Evaluate the latest techniques and technologies in refractive surgery, specifically the latest and emerging techniques and technologies in cornea biomechanics, cornea imaging, IOL calculations, and ectasia detection
■ Identify the current status and future of femtosecond laser, excimer laser, inlay, intracorneal ring segment, 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 that refractive surgery plays for any ophthalmology practice and the reasons to consider this subspecialty to improve patient care

2017 Refractive Surgery Subspecialty Day Meeting 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.

2017 Refractive Surgery Subspecialty Day CME Credit
The American Academy of Ophthalmology is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide CME for physicians.

The Academy designates this live activity for a maximum of 7 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

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

The Academy requires all presenters to disclose on their first slide whether they have any financial interests from the past 12 months. Presenters are required to verbally disclose any financial interests that specifically pertain to their presentation.

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 they are acknowledged, coauthors do not have control of the CME content, and their disclosures are not published or resolved.

Attendance Verification for CME Reporting
Before processing your requests for CME credit, the American Academy of Ophthalmology must verify your attendance at Subspecialty Day and/or AAO 2017. In order to be verified for CME or auditing purposes, you must either:

■ Register in advance, receive materials in the mail, and turn in the Subspecialty Day Syllabi exchange voucher(s) onsite;
■ Register in advance and pick up your badge onsite if materials did not arrive before you traveled to the meeting;
■ Register onsite; or
■ Scan the barcode on your badge as you enter an AAO 2017 course or session room.

CME Credit Reporting
Lobby B and Lobby G and Academy Resource Center, Hall G – Booth 3140
Attendees whose attendance has been verified (see above) at AAO 2017 can claim their CME credit online during the meeting. Registrants will receive an email during the meeting with the link and instructions on how to claim credit.

Onsite, you may report credits earned during Subspecialty Day and/or AAO 2017 at the CME Credit Reporting booth.
Academy Members: The CME credit reporting receipt is not a CME transcript. CME transcripts that include AAO 2017 credits entered onsite will be available to Academy members on the Academy’s website beginning Dec. 7, 2017.

After AAO 2017, credits can be claimed at www.aao.org.

The Academy transcript cannot list individual course attendance. It will list only the overall credits spent in educational activities at Subspecialty Day and/or AAO 2017.

Nonmembers: The Academy will provide nonmembers with verification of credits earned and reported for a single Academy-sponsored CME activity, but it does not provide CME credit transcripts. To obtain a printed record of your credits, you must report your CME credits onsite at the CME Credit Reporting booths.

Proof of Attendance

The following types of attendance verification will be available during AAO 2017 and Subspecialty Day for those who need it for reimbursement or hospital privileges, or for nonmembers who need it to report CME credit:

- CME credit reporting/proof-of-attendance letters
- Onsite registration receipt
- Instruction course and session verification

Visit www.aao.org/cme for detailed CME reporting information.
2017 Award Winners

José I Barraquer Lecture and Award
The José 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 José I Barraquer MD—one of the founding fathers of refractive surgery.

2017 Barraquer Award—Dr. Scott MacRae
Dr. Scott MacRae did his undergraduate, medical school, and residency programs at the University of Wisconsin, Madison. He did 3 corneal fellowships, including a cornea and external disease fellowship, a NEI-sponsored corneal physiology research training fellowship (both at the Eye Institute, Medical College of Wisconsin), and a brief contact lens and light toxicity of the eye fellowship at Emory University.

Dr. MacRae joined the faculty of Oregon Health Sciences University in 1983. He served as a panel member and consultant to the FDA Ophthalmic Devices Panel (1986-2000), chaired the Academy’s Public Health Committee (1991-1994), and ran the Academy’s Clinical Alert Program. He is winner of the Illinois Society to Prevent Blindness Young Investigator Award, the Amni Award, the Kambara Award, the AAO/ISRS Lans Award, and others.

He has authored over 120 published articles and book chapters on such varied topics as AIDS, public health, and corneal physiology. Dr. MacRae has increasingly turned his attention to the physiology of refractive surgery and, more recently, to the optics of refractive surgery.

On the editorial board for three ophthalmic journals for years, Dr. MacRae has served as senior editor for the Journal of Refractive Surgery, has chaired numerous international refractive symposiums, and is senior editor of the two best-selling books in ophthalmology, Customized Corneal Ablation: The Quest for SuperVision and Wavefront Guided Customized Treatment: The Quest for SuperVision II.

In 2000, Dr. MacRae accepted an appointment as professor of ophthalmology and visual science at the University of Rochester, Rochester, New York, where he joined a team of optical and visual scientists dedicated to maximizing the limits of human vision, with an emphasis on optics and optimizing visual processing. Together they have worked on refining customized laser vision correction, characterized the optics of multifocal IOLs, modified monovision, and binocular summation. In recent years, his team has developed a minimally invasive technique to change the refractive index of the cornea, IOLs, and contact lenses without changing their shape. He continuously promotes research and development of new refractive surgery techniques and technology.

2018 Barraquer Award—Dr. Ronald Krueger

Scott M MacRae MD
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—Dr. John Chang

Dr. John Chang was trained in ophthalmology at Jules Stein Eye Institute, University of California, Los Angeles; he then went to the University of California, San Francisco, and did a fellowship there. He is the president-elect of the International Society of Refractive Surgery and will serve as president from 2017 to 2018. Dr. Chang is a past president of the Hong Kong Association of Private Eye Surgeons. He is Honorary Associate Professor at both the University of Hong Kong and the Chinese University of Hong Kong. Dr. Chang is presently the director of the Guy Hugh Chan Refractive Surgery Centre of Hong Kong Sanatorium & Hospital and has been interested in cataract and refractive surgery for many years. He is clinical instructor for many refractive IOLs and surgeries including LASIK, intracorneal ring segments, conductive keratoplasty, and phakic IOLs.

Dr. Chang serves on the Executive Committee of the Asia Pacific Association of Cataract and Refractive Surgeons (APACRS). He is also on the editorial board of Cataract & Refractive Surgery Today, EyeWorld (Asia Edition), and Ocular Surgery News (APAO Edition) and is the chief editor of EuroTimes (China Edition). He has been awarded the Certified Educator Award by the APACRS, the Distinguished Service Award and Achievement Award by the Asia Pacific Academy of Ophthalmology, and the Achievement Award by the American Academy of Ophthalmology. Dr. Chang is active in research, publishing, and travelling abroad to give lectures as an invited speaker in order to share his knowledge and findings.

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—Dr. Daniel Durrie

Dr. Daniel Durrie, founder of Durrie Vision, has built a world-class vision correction surgery center located in Overland Park, Kansas. He has performed over 45,000 refractive procedures in his career and welcomes patients from all over the world. Dr. Durrie has been involved in over 150 FDA clinical studies as an investigator or medical monitor. He serves on the editorial board for Ocular Surgery News (section editor), the Journal of Corneal and Refractive Surgery, Review of Ophthalmology, AAO EyeNet, and Refractive Eye Care for Ophthalmologists.

Dr. Durrie serves on medical advisory boards for medical device and information technology companies and is recognized as an entrepreneur in his field. He has worked with numerous venture capital firms in the medical device and medical communication area.

As an internationally recognized refractive surgeon, Dr. Durrie has been named as one of the Top Ten Refractive Surgeons in America by Ophthalmology Times and named one of the Fifty Most Influential Ophthalmologists in the World by Cataract and Refractive Surgery Today. He has been awarded the Distinguished Lans Lectureship Award, as well as the highest honor awarded to an ophthalmologist by his peers, the Barraquer Lectureship, both by the International Society of Refractive Surgery. Dr. Durrie is the only refractive surgeon in the Great Plains region to receive the honor of being named one of America’s Top Doctors (Castle Connolly) every year since the listing’s inception, as well as being named one of the Best Doctors in America for 18 consecutive years. With more than 35 years’ experience in refractive and corneal surgery, he has dedicated his career to being a pioneer in refractive surgery technology and procedures.
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 Award—Dr. Boris Malyugin

Boris E Malyugin MD PhD is professor of ophthalmology and deputy director general (R&D, Edu) at the S Fyodorov Eye Microsurgery Institution in Moscow, Russia. He is also the president of the Russian Ophthalmology Society and a board member of the European Society of Cataract and Refractive Surgeons. He is a member of International Intraocular Implant Club and Academia Ophthalmologica Internationalis.

Dr. Malyugin has established himself as an internationally recognized expert in advanced anterior segment surgery and has pioneered several innovative technologies. He is well known for his development of the Malyugin ring, which is used in small pupil cataract surgery.

Dr. Malyugin is also world renowned for his educational activities, in Russia and abroad. He has participated in invited lectures and live surgery sessions in numerous national and supranational meetings. Thanks to his efforts, the Russian ophthalmological school founded by Prof. S Fyodorov has kept its worldwide reputation.

He has also received multiple international awards; for example, he is the only person awarded with the Cornelius Binkhorst Award by both the American Society of Cataract and Refractive Surgery and the European Society of Cataract and Refractive Surgeons.

Dr. Malyugin has published in the literature extensively, coedited several books in various fields of ophthalmology, and contributed to the printed and video versions of Atlas of Ophthalmic Surgery and Video Journal of Cataract and Refractive Surgery.

Dr. Malyugin serves on the editorial board of the Journal of Cataract and Refractive Surgery, EyeNet, Cataract and Refractive Surgery Today, Eurotimes, Ocular Surgery News, Eye-World, and Ophthalmologist. He is a chief medical editor of the Ophthalmosurgery Journal (Russian) and Russian Eurotimes as well.

Lans Distinguished Lecturer Award

The Lans Distinguished Lecturer Award honors Dr. Leedert 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 Award—Prof. Leonardo Mastropasqua

Leonardo Mastropasqua is full professor of ophthalmology in the Faculty of Medicine and Surgery at the University “G d’Annunzio” of Chieti-Pescara. He is currently head of the National High Technology Center in Ophthalmology and the Center of Excellence in Ophthalmology, national president of the Ophthalmology Society of Italian Universities (SOU), scientific advisor of the Directive Council of the Italian section of IAPB (International Agency for the Prevention of Blindness), and Board member of EuCornea (European Society of Cornea & Ocular Surface Disease Specialists).

Prof. Mastropasqua has authored more than 240 original scientific articles published in peer reviewed journals included in the Journal Citation Report, as well as book chapters and monographs in ophthalmology. He is scientific reviewer for numerous international journals, including Investigative Ophthalmology and Visual Sciences, Journal of Refractive Surgery, Journal of Cataract and Refractive Surgery, and British Journal of Ophthalmology. Prof. Mastropasqua is also associate editor of BMC Ophthalmology and editorial board member of the Journal of EuCornea and Eye and Vision Journal.

His principle fields of interest include refractive surgery, corneal pathologies and surgery, cataract surgery, glaucoma, and advanced ophthalmic imaging. He is a pioneer in the field of femtosecond laser application in corneal, refractive, and cataract surgery, and he has performed more than 4,000 surgical procedures per year (anterior and posterior segment) and approximately 2,000 refractive procedures.

Prof. Mastropasqua received the Academy’s Binkhorst Award in 1994. More recently, in 2014 he was inducted into the American Society of Cataract and Refractive Surgery Hall of Fame, and in 2016 he received the Bahcesehir University Medal of Science.
**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—Dr. Emanuel Rosen**

I was the first ophthalmologist in the United Kingdom to practice and adopt the corneal laser surgery known as LASIK, which involves creating a flap in the cornea and reshaping the cornea to adjust the focus of an eye. It is a very successful procedure, and I created my own clinic based on that technology using the latest laser device for that purpose.

As a consequence of this development, I was invited by the Boots Laser Company, the foremost pharmaceutical company in the United Kingdom, to direct and lead their newly formed corneal laser company. Eventually we created nine country-wide clinics, of which I was director and key participant. This lasted from 2000 to 2004, when the Boots Laser Company decided to change direction and sold the business to the Optical Express Company, whom I did not work for.

I suggested to the company that they were limiting their options by performing only corneal laser surgery. I explained to them that many of the patients who approached them for treatment would fail on the parameters for application of corneal laser surgery, but that many of them would be amenable to refractive lens exchange surgery, which again I had pioneered in the United Kingdom. They adopted my suggestion, and to date they have carried out thousands of lens exchange procedures as well as corneal laser surgery, for which I am of course indirectly responsible.

I have since retired from refractive surgery, and it is a great pleasure for me to know that my efforts have been appreciated by international and national peer review groups, such as the United Kingdom and Ireland Society of Cataract and Refractive Surgeons (2015 Lifetime Achievement award).

**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—Dr. Warren Hill**

Warren E Hill MD completed his ophthalmology training in 1985 at the University of Rochester in New York and has been in private practice since that time in Mesa, Arizona. He is best known for his work helping physicians to obtain accurate IOL power calculations. His web sites, doctor-hill.com, the artificial intelligence IOL power calculator RBFCalculator.com, the SIA-calculator.com surgically induced astigmatism calculator, and the ASCRS post-refractive calculator, developed with Doug Koch MD and Li Wang MD PhD at Baylor University, are some of the most popular IOL power calculation resources in ophthalmology, with a combined total of over 350,000 visits per year.

Dr. Hill has published extensively, delivered 24 named lectureships, presented 740 clinical papers at national and international meetings in 42 countries, is an adjunct professor of ophthalmology at Case Western Reserve University, and is a member of the International Intraocular Implant Club. From 2007 to 2010 he served as the cataract and anterior segment subspecialty editor for the American Academy of Ophthalmology’s Ophthalmic News and Education (O.N.E.) Network.

Dr. Hill delivered the American Society of Cataract and Refractive Surgery’s 2014 Innovator’s Lecture, the Asia-Pacific Association of Cataract & Refractive Surgeons’ 2014 Arthur Lim Lecture, the Academy’s 2015 Charles Kelman Lecture, and the United Kingdom & Ireland Society of Cataract & Refractive Surgeons’ 2016 Rayner Medal Lecture.

Aside from the practice of ophthalmology, Dr. Hill’s other passion is flying military airplanes in air shows as a member of a close-formation demonstration team for which he is licensed as a multiengine commercial pilot. Each year this team regularly performs at a wide variety of air shows, including the EAA (Oshkosh) AirVenture, the largest such event in North America.
Presidential Recognition Award—Dr. Theo Seiler

Dr. Theo Seiler teaches general ophthalmology and is a specialist in corneal and refractive therapy, physiologic optics, lasers in ophthalmology, and anterior segment surgery. Born in Ravensburg, southern Germany, he studied medicine, mathematics, and physics at the University of Heidelberg and the University of Berlin. From 1976 to 1980, Dr. Seiler served as a professor of physics at the Peter-Silbermann College in Berlin. In 1981, he returned to medicine and began his residency at the Department of Ophthalmology at the Free University of Berlin. His doctorate followed in 1984 with a thesis on “Linearity of Tonometry,” and he then rose to senior assistant and lecturer in 1985. He was named a professor of ophthalmology in 1990. In 1993, Dr. Seiler was named professor and chairman of the Department of Ophthalmology at Technische Universität of Dresden, which is a unique interdisciplinary center focusing on research and teaching. In 2000, Dr. Seiler assumed the position as professor and chairman of the Department of Ophthalmology at the University of Zurich in Switzerland. In October 2002, he founded the Institute for Refractive and Ophthalmic Surgery (IROC) in Zurich and became the chairman in 2008.

Along with being a member of the American Academy of Ophthalmology and International Society of Refractive Surgery, Dr. Seiler also served on the Executive Board of the International Society of Refractive Surgery. He is also a member of the German Ophthalmological Society (DOG), the Swiss Ophthalmological Society, the American Society of Refractive and Cataract Surgery (ASCRS), and the European Cornea Society, and he has served as board member for the DOG and EuCornea.

Dr. Seiler’s earliest awards include the Axenfeld Award (DOG) in 1987 and the Academy’s 1994 Binkhorst Award.

26th 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—Dr. Riccardo Vinciguerra

Dr. Riccardo Vinciguerra is currently a cornea clinical fellow at the Royal Liverpool and Broadgreen University Hospital, Liverpool, United Kingdom, as well as a research collaborator at Biomechanical Engineering Group, University of Liverpool, UK. Despite his young age (31 years), he is a very well-known international researcher with various peer-reviewed publications, mainly in the fields of corneal biomechanics, refractive surgery, corneal collagen crosslinking, and corneal transplants.

Dr. Vinciguerra completed medical school at the Università degli Studi of Milano, Italy, where he graduated magna cum laude in 2011. His thesis, entitled “The treatment of keratoconus with corneal collagen cross-linking: refractive, topographic, tomographic, and aberrometric analysis,” was subsequently published in *Ophthalmology*. He then graduated from the Brescia-Insubria University as a specialist in ophthalmology and completed a glaucoma clinical fellowship at the Royal Liverpool University Hospital, Liverpool, United Kingdom. The article *Detection of keratoconus with a new biomechanical index*, published in the *Journal of Refractive Surgery*, earned him the prestigious Troutman Prize and was also previously awarded with the Trimarchi Prize by the University of Pavia (Italy).

Dr. Vinciguerra is the author of 37 original scientific articles in peer-reviewed journals and has received 4 prizes and awards. His work has been cited more than 650 times, with an h-index of 10.
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—Dr. Marcony Santhiago

Marcony R Santhiago MD PhD graduated in medicine and completed his residency in Rio de Janeiro, followed by a fellowship in refractive surgery at the University of São Paulo, where he also obtained his doctorate. Subsequently, he undertook a fellowship in refractive surgery at the Cleveland Clinic from 2009 to 2012. Currently Dr. Santhiago holds a faculty position as professor of ophthalmology at Federal University of Rio de Janeiro and at the University of São Paulo, where he also mentors PhD students.

Dr. Santhiago is associate editor of the Journal of Refractive Surgery, section editor of the Journal of Cataract and Refractive Surgery, chief editor of Revista Brasileira de Oftalmologia, and associate editor of the Brazilian Archives of Ophthalmology. He is also reviewer of the most prestigious journals in ophthalmology.

Dr. Santhiago has published more than 100 international studies and has particular research interest in risk factors for post-LASIK ectasia, corneal changes and remodeling after crosslinking, and corneal wound healing. He has won some prestigious awards, such as the Troutman Award and the Presidential Recognition Award by the International Society of Refractive Surgery, the Latin America Research Award in Cornea by the Pan-American Association of Ophthalmology, the Achievement Award and Best Scientific Video Award, both by the American Academy of Ophthalmology, the Best Paper of Section Award and Poster Winner Award by the American Society of Cataract and Refractive Surgery, the Gold Medal for contributions in refractive surgery by the Indian Intraocular Implant and Refractive Society, and the Scientific Video Award by the European Society of Cataract and Refractive Surgery.

He is also on the Board of Directors of the Brazilian Society of Cataract and Refractive Surgery (BRASCRS) and is a member of the International Council and of the Cataract and Refractive Surgery Committee of the International Society of Refractive Surgery (ISRS).

Dr. Santhiago has been nominated as program director of Refractive Surgery Subspecialty Day for AAO 2018 and 2019.
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Claudia E Perez-Straziota MD
Beverly Hills, CA

Yuri McKee MD
Mesa, AZ

Michael Mrochen PhD
Zurich, Switzerland

Roberto Pineda II MD
Waltham, MA
Arturo J Ramirez-Miranda MD  
Mexico City, DF, Mexico

Karolinnne M Rocha MD  
Mount Pleasant, SC

Tim Schultz MD  
Bochum, Germany

J Bradley Randleman MD  
Beverly Hills, CA

Alain Saad MD  
Paris, France

Theo Seiler MD PhD  
Zurich, Switzerland

Dan Z Feinstein MD  
London, England

Marcony R Santhiagio MD  
Rio de Janeiro, RJ, Brazil

Rupal S Shah MD  
Vadodara, India

Bibiana J Reiser MD  
Long Beach, CA

Giuliano Scarcelli PhD  
College Park, MD

Sunil Shah MD  
Birmingham, West Midlands, England
<table>
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<tr>
<td>Priyanka Sood MD</td>
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<td>Bogota, DC Colombia</td>
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<td>Emilio A Torres Netto MD</td>
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<td>Riccardo Vinciguerra MD</td>
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<td>R Doyle Stulting MD PhD</td>
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<td>William B Trattler MD</td>
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<td>John Allan Vukich MD</td>
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George O Waring IV MD
Mount Pleasant, SC

William F Wiley MD
Brecksville, OH

Steven E Wilson MD
Cleveland, OH

Elizabeth Yeu MD
Norfolk, VA

Sonia H Yoo MD
Miami, FL

Roger Zaldivar MD
Mendoza, Argentina
Ask a Question Live During the Meeting Using the Mobile Meeting Guide

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

- Access at www.aao.org/mobile
- Select “Program Handouts & Evaluations”
- Filter by Meeting—Refractive Surgery Meeting
- Select Current Session
- Select “Ask the presenter a question (live)” Link
- Click Submit Question
# Refractive Surgery 2017: Linking to the Expanded World of Refractive Surgery

The Annual Meeting of the International Society of Refractive Surgery

## FRIDAY, NOV. 10

### 7:00 AM
Continental Breakfast and Breakfast with the Experts

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<tr>
<td>Cataract and IOL Complications</td>
<td>Ashvin Agarwal MD, Roger Zaldivar MD*</td>
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<td>Elevation Corneal Tomography and Topography</td>
<td>Stephen D Klyce PhD*, Roberto Pineda II MD*</td>
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<tr>
<td>Femtosecond LASIK: Tips for Optimizing Visual Outcomes and Avoiding Complications</td>
<td>Ronald R Krueger MD*, Karl G Stonecipher MD*</td>
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<tr>
<td>Intracorneal Rings</td>
<td>Jorge L Allo MD PhD*, Aylin Kilic MD</td>
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<td>Laser Vision Correction Enhancements</td>
<td>Simon P Holland MD*, Steven E Wilson MD</td>
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<tr>
<td>Management of the Ocular Surface in Refractive Surgery Patients</td>
<td>Terry Kim MD*, Marguerite B McDonald MD*</td>
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<td>Pediatric Refractive Surgery</td>
<td>Bibiana J Reiser MD*, Erin D Stahl MD*</td>
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<tr>
<td>Phakic IOLs</td>
<td>Erik L Mertens MD, FRACOphth*, Gregory D Parkhurst MD*</td>
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<td>Small Aperture Procedures</td>
<td>Claudio L Trindade MD*, John Allan Vukich MD*</td>
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<td>Combined and Sequential Procedures for Surface Ablation and Crosslinking</td>
<td>A John Kanellopoulos MD*, R Doyle Stulting MD PhD*</td>
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<tr>
<td>Toric IOL Pearls</td>
<td>Damien Gatienel MD*, Elizabeth Yeu MD*</td>
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<tr>
<td>Visual Quality Assessment</td>
<td>Daniel S Durrie MD*, Karolinne M Rocha MD*</td>
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</table>

### Welcome and Introductions

8:00 AM Opening Remarks Renato Ambrosio Jr MD*, William B Trattler MD*

### Keynote Lecture

8:05 AM The Role of Personalized Medicine in Refractive Surgery John Marshall PhD* 1

### Section I: Corneal Refractive Surgery

Moderators: Renato Ambrosio Jr MD* and Steven E Wilson MD

Virtual Moderator: Marcony R Santhiago MD*

8:15 AM The Best for LASIK Eric D Donnenfeld MD* 2

8:22 AM The Best for SMILE Jodhbir S Mehta MBBS PhD* 3

* Indicates that the presenter has financial interest. No asterisk indicates that the presenter has no financial interest.
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<tr>
<td>8:29 AM</td>
<td>The Best for Surface Ablation</td>
<td>Marguerite B McDonald MD*</td>
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<tr>
<td>8:36 AM</td>
<td>The Case for Corneal Inlays and Onlays</td>
<td>Wayne Crewe-Brown MD*</td>
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<td>8:43 AM</td>
<td>Advances in Custom Ablations Including Topoguided</td>
<td>Karl G Stonecipher MD*</td>
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<td>8:50 AM</td>
<td>Why Every Refractive Surgeon Should Know About Crosslinking</td>
<td>Marcony R Santhiago MD*</td>
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<tr>
<td>8:57 AM</td>
<td>Advocating for Patients</td>
<td>Vineet N Batra MD*</td>
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<td>9:02 AM</td>
<td>Panel Discussion</td>
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<td>9:12 AM</td>
<td>REFRESHMENT BREAK</td>
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<td>9:57 AM</td>
<td>ISRS Awards</td>
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<td>10:07 AM</td>
<td>Refractive Lens Exchange: When to Remove the Lens?</td>
<td>William F Wiley MD*</td>
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<td>10:14 AM</td>
<td>Toric IOLs and Irregular Corneas</td>
<td>Thomas Kohnen MD PhD FEBO*</td>
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<td>10:21 AM</td>
<td>Small-Aperture IOLs</td>
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<td>10:28 AM</td>
<td>The Case for Phakic IOLs</td>
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<td>10:35 AM</td>
<td>Piggyback IOLs</td>
<td>Jorge L Alio MD PhD*</td>
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<td>10:42 AM</td>
<td>Refractive Surgery in the 50-Year-Old Patient: Cornea or Lens Based Surgery</td>
<td>Roger Zaldivar MD*</td>
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<tr>
<td>10:59 AM</td>
<td>Management and Prevention of Complications in Refractive Surgery</td>
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<tr>
<td>11:06 AM</td>
<td>Identifying Risk Factors for the Development of Ectasia following Refractive Surgery</td>
<td>Renato Ambrosio Jr MD*</td>
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<tr>
<td>11:13 AM</td>
<td>Management Options for Flap Complications with LASIK</td>
<td>Priyanka Sood MD*</td>
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<tr>
<td>11:20 AM</td>
<td>Management of SMILE Patients with Intraoperative Complications or Residual Refractive Error</td>
<td>Sri Ganesh MBBS MS*</td>
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<tr>
<td>11:27 AM</td>
<td>Management of Challenging Situations following Phakic IOLs</td>
<td>Erik L. Mertens MD FRACOphth*</td>
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<td>11:34 AM</td>
<td>Prevention and Management of Complications following Corneal Crosslinking</td>
<td>Farhad Hafezi MD PhD*</td>
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<td>11:41 AM</td>
<td>Management of Complications following Corneal Inlays</td>
<td>Enrique Barragan MD*</td>
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* Indicates that the presenter has financial interest. No asterisk indicates that the presenter has no financial interest.
### Section IV: Video-Based Master Complications

Moderators: Amar Agarwal MD* and William J Fishkind MD FACS*
Panelists: John So-Min Chang MD*, Terry Kim MD*, Jennifer M Loh MD*, Claudia E Perez-Straziota MD, and Alain Saad MD*

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<td>Curing Diplopia with IOLs: A Controversial but Successful Strategy!</td>
<td>Robert H Osher MD*</td>
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<td>Decentered IOL: Managing with Suture</td>
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<td>Decentered IOL: Managing with the Glued IOL Technique</td>
<td>Sadeer B Hannush MD</td>
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<td>Pre-Descemet Endothelial Keratoplasty with Single-Pass 4-Throw Technique Pupilloplasty</td>
<td>Amar Agarwal MD*</td>
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<td>1:48 PM</td>
<td>The Unhappy Multifocal IOL Patient</td>
<td>David F Chang MD*</td>
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<td>IOL Scaffold: Managing the Nucleus When the Posterior Capsule Has Ruptured</td>
<td>Yuri McKee MD*</td>
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<td>Phakic IOL Complications</td>
<td>Alaa M Eldanasoury MD*</td>
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<td>2:03 PM</td>
<td>SMILE to Frown</td>
<td>Ronald R Krueger MD*</td>
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<td>LASIK Nightmares</td>
<td>Sonia H Yoo MD</td>
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<td>Inlays: Pitfalls and Problems</td>
<td>George O Waring IV MD*</td>
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### Section V: ESCRs Symposium—Advances in the War on Presbyopia

Moderators: Simonetta Morselli MD* and Gerd U Auffarth MD*

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<td>Ciliary Muscle Electrostimulation to Restore Accommodation</td>
<td>Luca Gualdi MD</td>
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<td>Femto Lentotomy: Does It Work?</td>
<td>Sunil Shah MD*</td>
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<td>2:40 PM</td>
<td>Laser Blended Vision</td>
<td>Dan Z Reinstein MD*</td>
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<td>Picking Up Good Vibrations: The Miniwell Extended Depth of Focus IOL</td>
<td>Gerd U Auffarth MD*</td>
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<td>A Kamra in the Eye: The Small-Aperture Extended Depth of Focus IOL</td>
<td>Simonetta Morselli MD*</td>
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<td>The FluidVision IOL</td>
<td>Douglas D Koch MD*</td>
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### REFRESHMENT BREAK and BREAK WITH THE EXPERTS

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<td>Collagen Crosslinking</td>
<td>R Doyle Stulting MD PhD*</td>
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<td>William B Trattler MD* performing</td>
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<td>Corneal Inlays</td>
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<td>Wayne Crewe-Brown MD*</td>
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<td>George O Waring IV MD*</td>
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<td>Epithelial Mapping Prior to Corneal Refractive Surgery</td>
<td>A John Kanellopoulos MD*</td>
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<td>Dan Z Reinstein MD*</td>
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<td>How to Communicate with the Unhappy Patient</td>
<td>Daniel S Durrie MD*</td>
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<td>Vance Michael Thompson MD*</td>
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<td>Laser Refractive Lens Surgery</td>
<td>Kendall E Donaldson MD*</td>
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<td>Eric D Donnenfeld MD*</td>
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<td>Modulation of Corneal Wound Healing after Refractive Surgery</td>
<td>Marcony R Santithio MD*</td>
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<td>Steven E Wilson MD</td>
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<td>Ocular Surface Management</td>
<td>Deepinder K Dhaliwal MD*</td>
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<td>Jennifer M Loh MD*</td>
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## Program Schedule

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<td>Introduction of Troutman Prize</td>
<td>J Bradley Randleman MD</td>
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<td>Detection of Keratoconus with a New Biomechanical Index</td>
<td>Riccardo Vinciguerra MD*</td>
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<td>4:23 PM</td>
<td>Biomechanical Changes Associated with LASIK Flap Creation and Rapid Crosslinking Measured with Brillouin Microscopy</td>
<td>Giuliano Scarcelli PhD*</td>
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<td>4:28 PM</td>
<td>Preliminary Evidence of Successful Near Vision Enhancement with a New Technique: Presbyopic Allogenic Refractive Lenticule (Pearl) Corneal Inlay Using a SMILE Lenticule</td>
<td>Soosan Jacob FRCS</td>
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<td>Comparative Analysis of the Clinical Outcomes of SMILE and Wavefront-Guided LASIK in Low and Moderate Myopia</td>
<td>Mounir A Khalifa MD*</td>
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<td>Laser-Assisted Capsulotomy Centration: A Prospective Trial Comparing Pupil Centration with OCT-Based Scanned Capsule Centration</td>
<td>Tim Schultz MD</td>
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<td>In Vivo Brillouin Microscopy in Keratoconus Corneas</td>
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<td>Hyperopia Correction with SMILE Lenticules—A Comparison between Clinical Data and Biomechanical Simulations</td>
<td>Michael Mrochen PhD*</td>
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<td>The Light for Sight Study: Prevalence of Keratoconus among Children and Adolescents in Riyadh</td>
<td>Emilio A Torres Netto MD</td>
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<td>Collagen Crosslinking for Treatment of Refractory Infectious Keratitis</td>
<td>Ashraf H El Habbak MD</td>
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<td>Topography-Guided Astigmatism Correction during Laser-Assisted Cataract Surgery</td>
<td>Harvey S Uy MD*</td>
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<td>Effectiveness of 3% Trehalose on the Re–Epithelialization and Tolerability after Photorefractive Keratectomy (PRK)</td>
<td>Arturo J Ramirez-Miranda MD*</td>
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<td>JRS QwikFacts</td>
<td>J Bradley Randleman MD</td>
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<tr>
<td>5:28 PM</td>
<td>Closing Remarks</td>
<td>Renato Ambrosio Jr MD*</td>
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The Role of Personalized Medicine in Refractive Surgery

John Marshall PhD
The Best for LASIK

Eric Donnenfeld MD

I. LASIK is extremely safe and effective.
   A. We have nearly 2 decades of clinical experience with LASIK. In that time, more than 16 million patients have been treated here in the United States.
   B. There are thousands of clinical studies into LASIK safety and performance, resulting in a deep base of information, knowledge, and experience.

II. LASIK is tremendously valuable from a clinical perspective and is a procedure of choice for the majority of refractive surgeons for their qualified candidates.
   A. Its performance, safety, and patient satisfaction are excellent.
   B. The technology behind the procedure is state-of-the-art, representing the frontier of innovation in medicine today.
   C. The ongoing investment in improvement in technique, technology, and patient management supports LASIK as an essential asset to the refractive surgery category.

III. How effective is LASIK?
   A. We know that LASIK is effective as a result of more than 2 decades of clinical experience with millions of patients.
   B. The latest peer-reviewed meta-analysis of world-wide scientific literature into the latest LASIK technology and treatment profiles showed:
      1. Patient satisfaction rate of up to 98%
      2. Nearly 100% of patients achieving at least 20/40 vision, with more than 90% achieving 20/20 vision
      3. Overall, 90.9% of patients were within 0.5 D of target correction, and 98% were within 1 D.

IV. LASIK is the safest, most successful and most studied elective procedure in the world.
   A. LASIK has the highest patient satisfaction rate of any elective procedure.
   B. LASIK results have continually improved from when it was first approved, as technology and surgical techniques advance and preoperative diagnostic screening and patient selection become more refined.
The Best for SMILE

Jodhbir S Mehta MBBS PHD
The Best for Surface Ablation

Marguerite McDonald MD FACS

Epi-Bowman keratectomy (EBK) is a new method for removing corneal epithelium for surface ablation, phototherapeutic keratectomy, and epithelium-off (“epi-off”) crosslinking. It was first developed by Yariv Bar-on of Israel. The technique involves the use of a disposable hand-held instrument with a soft polymer tip and no moving parts. This instrument, the Epi-Clear device, lifts and removes the epithelium in strips and sheets, without removing or damaging the basement membrane; it disturbs fewer epithelial cells than standard techniques. This gentler removal process also provides faster re-epithelialization, less pain, faster return of vision, and better final clinical outcomes (higher percentage of 20/20 uncorrected and fewer enhancements) than the standard techniques. Clinical data and case examples from Israel, Europe, and the United States will be presented.

In addition, EBK (vs. standard epithelial removal techniques) has been extensively tested by Dr. Rohit Shetty of India for both surface ablation and epithelium-off crosslinking. Prospective randomized data document that the early postop pain is clinically and statistically significantly less: P-value for the pain difference in surface ablation = .009 immediately postop, and .01 at 3 days postop; P-value for the pain difference in crosslinking = .0001 immediately postop, and .001 at 3 days postop. The speed of return of vision is also significantly faster for both surface ablation and epithelium-off crosslinking.1

Reference

The Case for Corneal Inlays and Onlays

Wayne Crewe-Brown MD and Linda Crowe OD

Introduction

Globally the presbyopic population is the fastest growing demographic, expected to number 2.1 billion by 2020. Advances in refractive surgery over the past decade have brought tremendous strides in the treatment of myopia, hyperopia, and astigmatism. Our next great challenge is the surgical treatment of presbyopia. In this presentation, I would like to discuss corneal inlays and onlays, which may prove to be an answer to the problems of presbyopia for many individuals.

Background Observations

Corneal inlays and onlays are additive, they do not remove tissue, and they preserve future options for further presbyopic correction.

In My Experience

To date I have implanted 1000 AcuFocus Kamra inlays and 350 Presbia Microlens inlays. High levels of patient satisfaction can be achieved, so long as selection criteria are met; these will be discussed. Other corneal inlays and corneal onlays will be covered briefly.

Conclusion

I think most of us in ophthalmology realize that presbyopia is one of the final frontiers for refractive surgery. Based on my clinical experience to date, the minimally invasive nature of corneal inlays, combined with their removability, will allow this modality to play an ever-increasing role in our practices for the correction of presbyopia.
Advances in Custom Ablations Including Topo-Guided

Karl G Stonecipher MD

I. Who’s My Patient?
   A. Reduction or elimination of up to −9.00 D of spherical equivalent myopia or myopia with astigmatism
   B. With up to −8.00 D of spherical component and up to −3.00 D of astigmatic component at the spectacle plane
   C. In patients age 18+ with stable manifest refraction (0.5 D or less of preoperative spherical equivalent shift over 1 year prior to surgery)
   D. In eyes without previous refractive surgery, keratoconus, forme fruste keratoconus, or any other topographic abnormality

II. Who Can’t I Treat?

III. Wavefront Optimization Works Great!

IV. Standard Module (Wavefront Optimized)
   A. A pure refractive change
   B. Designed to treat spherocylinder errors without affecting higher-order aberrations (especially spherical aberration)
      1. Range:
         2. Myopia: 0 to −14 D
         3. Myopic astigmatism: 0 to −6 D
         4. Hyperopia: 0 to +6 D
         5. Hyperopic astigmatism: 0 to +6 D
         6. Optical zone: 4.5 to 8.0 mm

V. Pupil center = geometric center of the pupil

VI. A-CAT Module (Wavefront Guided)
   A. Line of sight
   B. Preop higher-order root mean square (RMSₜₜ) distribution

VII. The Emergence of Topography-Guided LASIK
   A. Developed to correct higher-order aberrations based on corneal topography
      1. Provides an alternative to the correction of higher-order refractive errors based on aberrometry
      2. Not dependent upon pupil size
      3. Can be measured reproducibly

   4. Unaffected by lenticular opacities and vitreous opacities
   5. Accurately measures peripheral corneal irregularities, which are responsible for many visual complaints

   B. T-CAT is aligned on the vertex.

VIII. Better Together

IX. Definition of Tilt

X. Tilt and Its Effect on the Ablation Profile

XI. Tilt On/Off

XII. Calculation of Height Data

XIII. Height Data Fitted to a Reference Shape

XIV. Raw Data

XV. Fitting Targets for Topography Guided
   A. The fitting objective for topography-guided treatments is based on the individual topography.
   B. The reference body and its asphericity are designed to balance ablation (cosine effect) within the optical zone.
   C. The fitting asphericity (Q) can be selected by the physician, within the limits set by the software (0 o -1.0), but alteration is not advised.

XVI. Ablation Design for Topography-Guided

XVII. Overview Map-Topography Landmarks

XVIII. Terms
   A. + is the geometric center of the pupil.
   B. o is the vertex of the cornea.
   C. The x and y values are the distance between the geometric center of the
XIX. Topography Landmarks
A. Corneal apex: Point on cornea of steepest curvature (the most anterior point of the cornea when it is in primary position)
B. Corneal vertex: Point on cornea through which line of fixation passes (central part of the cornea)
C. Pupil center: Often differs from corneal vertex by angle kappa (angle lambda) / geometric center of the pupil
D. Angle kappa: The difference between the center of the pupil (pupillary axis) and the visual axis (line of sight). Also called angle lambda.
E. Angle alpha: The difference between the center of the limbus and the visual axis

XX. Impact on Patients
At 12 months, without correction, Contoura Vision patients experienced the following results:
A. 34.4% could see 20/12.5 or better.
B. 64.8% could see 20/16 or better.
C. 92.6% could see 20/20 or better.

XXI. Impact on Patients: BCVA

XXII. Impact on Patients: Visual Symptoms
Postop symptoms at 12 months vs. baseline:
A. Light sensitivity: 5.2% decrease
B. Difficulty driving at night: 8.0% decrease
C. Reading difficulty: 8.7% decrease
D. Complaints of glare: 4.8% decrease

XXIII. Treatment Planning
XXIV. New Data – Bad Data
XXV. Diagnostics
First you have to have an image you can treat.

XXVI. How Do You Improve Your Outcomes?
XXVII. Comparison of Results
Why Every Refractive Surgeon Should Know About Crosslinking

*Marcony R Santhiago MD*
2017 Advocating for Patients

Vineet “Nick” Batra MD

Ophthalmology’s goal to protect sight and empower lives requires active participation in and commitment to advocacy from every ophthalmologist. Contributions to the following three critical funds are a part of that commitment:

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

Please join the dedicated community of ophthalmologists who are contributing to protect quality patient eye care for everybody. The OPHTHPAC Committee is identifying Congressional Advocates in each state to maintain close relationships with federal legislators in order to advance ophthalmology and patient causes. At Mid-Year Forum 2017, we honored nine of those legislators with the Academy’s Visionary Award. This served to recognize them for addressing issues important to us and to our patients. The Secretariat for State Affairs is collaborating closely with state ophthalmology society leaders to protect surgery by Surgeons at the state level. This year has seen an unprecedented effort by optometry to advance its scope of practice via legislation rather than education. Our mission of protecting sight and empowering lives requires robust funding of both the Surgical Scope Fund and the OPHTHPAC Fund. Each of us has a responsibility to ensure that these funds are strong.

OPHTHPAC® Fund

OPHTHPAC is a crucial part of the Academy’s strategy to protect and advance ophthalmology’s interests in key areas, including physician payments from Medicare and protecting ophthalmology from federal scope of practice threats. Established in 1985, OPHTHPAC is one of the oldest, largest, and most successful political action committees in the physician community. We are very successful in representing your profession to the U.S. Congress.

As one election cycle ends, a new one starts, and the pressure to remain vocal on our issues remains. Advocating for our congressional issues is a continuous battle, and OPHTHPAC is always under financial pressure to support our incumbent friends as well as to make new friends with candidates. These relationships allow us to have a seat at the table with legislators willing to work on issues important to us and our patients.

The relationships OPHTHPAC builds with members of Congress is contingent on the financial support we receive from Academy members. Academy member support of OPHTHPAC allows us to advance ophthalmology’s federal issues. We need to increase the number of our colleagues who contribute to OPHTHPAC and the other funds. Right now, major transformations are taking place in health care. To ensure that our federal efforts and our PAC remain strong, we need the support of every ophthalmologist to better our profession and ensure quality eye care for our patients.

The significant impacts that OPHTHPAC has made include the following:

- Derailed the onerous global surgery data collection proposal
- Preserved global surgical payments
- Halted the Part B Drug Demonstration
- Continued efforts in collaboration with subspecialty societies to preserve access to compounded and repackaged drugs such as Avastin

Contributions to OPHTHPAC can be made here at AAO 2017 or online at www.aao.org/ophthpac by clicking “Join.” Leaders of the American Society of Cataract & Refractive Surgery (ASCRS) are part of the Academy’s Ophthalmic Advocacy Leadership Group (OALG), which meets every January in the Washington, D.C., area to provide critical input and to discuss and collaborate on the Academy’s advocacy agenda. The topics on the 2017 OALG agenda included panel discussions on the Merit Based Incentive Payment System (MIPS) and APM implementation, as well as Academy analysis initiatives related to the IRIS® registry. In addition, meeting participants discussed the changing paradigm for optometric scope battles, held a roundtable to discuss challenges for surgical subspecialties, and considered opportunities to ensure physician and patient choice regarding access to pharmaceuticals.

At Mid-Year Forum 2017, the Academy and ASCRS ensured a strong presence of refractive specialists to support ophthalmology’s priorities, and a record number of ophthalmologists visited members of Congress and their key health staff to discuss ophthalmology priorities as part of Congressional Advocacy Day. The ASCRS remains a crucial partner with the Academy in its ongoing federal and state advocacy initiatives.

Surgical Scope Fund

The Surgical Scope Fund (SSF) provides grants to state ophthalmology societies to support their efforts to derail optometric surgery proposals that pose a threat to patient safety. Since its inception, the Surgery by Surgeons campaign and the SSF, in partnership with state ophthalmology societies, have helped 32 state/territorial ophthalmology societies reject optometric scope of practice expansion into surgery.

In 2017, your colleagues serving on the Academy’s Secretariat for State Affairs, along with State Governmental Affairs staff and the leaders of state ophthalmology societies, have been put to the task while dealing with an unprecedented number of simultaneous legislative battles. Eleven states have been affected so far this year:

- Alaska
- California
- Florida
- Georgia
- Illinois
- Iowa
- Maryland
- Massachusetts
- Nebraska
- North Carolina
- Pennsylvania
Patient safety setbacks as well as victories will be reviewed during the presentation, but do know that in each of these legislative battles, the benefits from SSF distributions are abundantly clear. The best lobbyists and public relations consultants are contracted as necessary, and media campaigns (including TV, radio, and social media) to educate the voting public are launched when needed to secure success and stop optometry from expanding its scope of practice to include surgery. Each of these endeavors is very expensive, and no one state has the resources to wage one of these battles on its own. Ophthalmologists must join together and donate to the SSF to fight for patient safety when a state faces a scope battle over optometric surgery.

The Academy relies not only on the financial contributions to the SSF from individual ophthalmologists and their practices, but also on the contributions made by ophthalmic state, subspecialty, and specialized interest societies. The ASCRS contributed to the SSF in 2016, and we thank them and look forward to their contribution in 2017. Contributions to the SSF can be made here at AAO 2017 or online at www.aao.org/ssf.

State Eye PAC

It is also extremely important for all ophthalmologists to support their respective State Eye PACs because campaign contributions to legislators at the state level must come from individual ophthalmologists and cannot come from the Academy, OPHTHPAC, or the SSF. The presence of a strong State Eye PAC providing financial support for campaign contributions and legislative education to elect ophthalmology-friendly candidates to the state legislature is critical, as scope of practice battles and many regulatory issues are all fought on the state level.

Action Requested: ADVOCATE FOR YOUR PATIENTS

Academy SSF contributions are used to support the infrastructure necessary in state legislative/regulatory battles and for public education. PAC contributions are necessary at the state and federal level to help elect officials who will support the interests of our patients. Contributions to each of these three funds are necessary and help us protect sight and empower lives. SSF contributions are completely confidential and may be made with corporate checks or credit cards, unlike PAC contributions, which must be made by individuals and are subject to reporting requirements.

Please respond to your Academy colleagues and be part of the community that contributes to OPHTHPAC, the SSF, and your State Eye PAC. Please be part of the community advocating for your patients now.

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Refractive Lens Exchange: When to Remove the Lens

William F Wiley MD

Refractive lens exchange is a great refractive surgery option for your refractive patient.

Indications
- Who are the best patients for refractive lens exchange?
- Setting goals and expectations

Alternatives
- Implantable contact lens
- Small-incision lenticule extraction (SMILE)
- LASIK
- PRK

Ideal Prescription to Treat
- Refractive lens surgery carries inherent risks different than those of other refractive surgeries.
- Risks, benefits, and alternatives to lens exchange should be considered, weighing the benefits vs. risks based on age, refractive error, and other eye conditions.
- Nearsighted vs. farsighted vs. presbyopic patients, and where refractive lenses are preferred

Ideal Age to Treat
- Presbyopic patients and patients with lens dysfunction should be considered over younger patients with functional lenses.
- When refractive error weighs heavier than age concerns

Risks
- Intraocular risks vs. external eye risks of alternative eye procedures
- Quality of optics vs. risk profile

Lens Technology
- Presbyopic lens options
- Monofocal and astigmatism-correcting lens options

Future Technology and Other Considerations
- Bilateral eye surgery
- Intraocular medications
- Light adjustable and exchangeable IOLs

Conclusion
Toric IOLs and Irregular Corneas

Thomas Kohnen MD PhD FEBO
Small Aperture IOLs

John Allan Vukich MD

I. Single-Piece Hydrophobic Acrylic IOL with Embedded Opaque Mask

II. IOL Design and Method of Action
   A. Extends depth of focus using the pinhole or small-aperture effect
   B. Post-market study
      1. Prospective, multicenter, nonrandomized evaluation
      2. 114 patients followed for 6 months
      3. Contralateral implantation of a small-aperture IOL in 1 eye and an aspheric colorless monofocal IOL in the fellow eye

4. 6-month results
   a. Achieved uncorrected visual acuity (UVA): 0.06 ± 0.15 for far, 0.08 ± 0.12 for intermediate, and 0.18 ± 0.14 for near
   b. Binocular UVA: −0.06 ± 0.10 for far, 0.04 ± 0.12 for intermediate, and 0.16 ± 0.13 for near
   c. Small-aperture IOL mitigates effect of 1.50 D of corneal cylinder and provides consistent VA across all focal distances, with up to 1.00 D deviation from intended refractive endpoint.
   d. Monocular and binocular contrast sensitivity remains within normal limits.
   e. Posterior segment evaluation and surgery remain possible with the IOL in place.
The Case for Phakic IOLs

Gregory D Parkhurst MD

- Myopia is a big problem.
- Glasses / contacts / LASIK are not ideal for everyone.
- Phakic IOLs are not a new idea.
- Low-hanging fruit: non-LVC candidates
- ICL only for non-LVC candidates?
- What are the risks of phakic IOLs according to evidence-based medicine?
Piggyback IOLs

Jorge L Alió MD PhD FEBOphth and Veronica Vargas MD

Introduction: What Is an Add-On Lens, and What Is It Used For?

The piggyback technique, first described in 1993 by Gayton and Sanders, involves the implantation of 2 IOLs in the posterior chamber. One important drawback of this technique was the development of interlenticular opacification, which appeared when both IOLs were placed on the capsular bag. Add-on lenses are specifically designed for implantation on the sulcus, in front of a posterior chamber IOL. Their main indication is for the correction of postoperative ametropia, astigmatism, and presbyopia, or in extreme power IOLs; they can also be used in high refractive defects after keratoplasty, cataract surgery in children, eyes with silicone oil, and for image magnification in eyes with AMD.

Types of Add-On Lenses

(See Table 1.)

How to Calculate an Add-On Lens

- Myopic refractive error: Spherical equivalent x 1.2
- Hyperopic refractive error: Spherical equivalent x 1.5
- The Refractive Vergence Formula or the Holladay R formula can also be used.

Outcomes of Add-On Lenses

The Add-On IOL (HumanOptics AG) has reported good outcomes for correcting residual refractive errors, and because of its optic size, visual disturbances like glare are reduced. The Sulcoflex IOL has also shown good visual outcomes, achieving spectacle independence for distance. The macular add-on IOL has proved to improve near vision in patients with AMD without altering distance vision. There are not yet clinical results about the use of multifocal add-on IOLs.

Table 1. Types and Characteristics of Add-On Lenses

<table>
<thead>
<tr>
<th>Material</th>
<th>Sulcoflex (Rayner IOLs)</th>
<th>Add-On (HumanOptics AG)</th>
<th>AddOn 1stQ (Medicontur Ltd.)</th>
<th>Macular Add-On (Scharioth Macula Lens A45SML, Medicontur Ltd.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall length</td>
<td>14 mm</td>
<td>14 mm</td>
<td>13.5 mm</td>
<td>13 mm</td>
</tr>
<tr>
<td>Optic size</td>
<td>6.5 mm</td>
<td>6 mm</td>
<td>6 mm</td>
<td>Central portion of 1.5 mm with +10.0 D</td>
</tr>
<tr>
<td>Haptics</td>
<td>Posterior angulation to avoid contact with the iris</td>
<td>10° angulation</td>
<td>Romboideal</td>
<td>4 symmetric haptics</td>
</tr>
<tr>
<td>Incision</td>
<td>2.8 mm</td>
<td>3.2 mm</td>
<td>2.2-2.5 mm</td>
<td>2.2 mm</td>
</tr>
</tbody>
</table>

Implanting a piggyback IOL is preferable to exchanging an IOL after cataract surgery residual refractive errors, because it is difficult to remove an IOL, especially if there is fibrosis on the capsular bag. The manipulation of the IOL can produce a posterior capsule rupture, and also with IOL exchange the main incision has to be enlarged, inducing astigmatism.

The piggyback technique has the advantage of being reversible, and surgically it is not difficult to perform. Also the power selection is easier than an IOL exchange because there is no need to know the power of the primary IOL. Although LASIK has shown a more accurate result for correcting refractive errors after cataract surgery, piggyback is a good option for those patients who have any contraindication for LASIK.

References


Refraction Surgery in the 50-Year-Old Patient: Cornea- or Lens-Based Surgery

Roger Zaldivar MD

Patients in their 50s are perhaps the most challenging cases in our practices nowadays. Their main concern is they no longer want to use glasses for distance and reading. Most of the time, these baby boomers present to me for a LASIK evaluation or a LASIK enhancement. The question is, should we perform LASIK in these patients, or should we consider a refractive lens exchange (RLE)? Given the fact that these patients typically have dysfunctional lens syndrome (DLS), they are often best treated with RLE. From an optics and functional vision standpoint, RLE may be the most effective treatment for these patients since they might be experiencing some scatter due to early opacification, or they just need an advanced optics IOL to restore their near and intermediate functional vision. In my opinion, the existence of an aging crystalline lens is a great opportunity to upgrade a patient’s optics through a life-lasting procedure, rather than performing LASIK now and cataract surgery 5 to 7 years from now with known limitations in IOL selection in future procedures. Furthermore, all components of the dysfunctional lens are addressed in a single procedure.

**Diagnosis**

These patients suffer from symptoms, such as difficulty reading or driving at night, that are caused by age-related lens changes. These symptoms will continue to worsen each year, whether or not they undergo corneal refractive surgery.

DLS encompasses 3 primary characteristics of the aging crystalline lens. The clinical findings typically include (1) lens opacities, whether cortical lens changes or nuclear lens changes or both, (2) the inability to accommodate due to presbyopia, and (3) an aberration profile that has changed, specifically with increased spherical aberration and/or coma. All 3 of these issues can be best treated with RLE.

Presbyopia is a progressive inability to accommodate, and everyone develops lens opacities with aging. Therefore, everyone will experience DLS at some point in their life, just as everyone eventually will develop a cataract. We can help patients in their 50s optimize their vision and reduce their dependence on spectacles, while avoiding cataract surgery in the future.

Currently, I am working with 2 diagnostic methods to help patients understand their stage in the lens aging process. One of them is the Pentacam (Oculus). With its Scheimplug camera, the Pentacam delivers a clear image of the internal anterior chamber status (iris configuration and lens densitometry). The other tool I find extremely useful is the HD Analyzer (Visiometrics), which is a double-pass wavefront that captures and quantifies the forward light scatter in terms of an optical scatter index and simulates a point-spread function on the retina. It also provides a very valuable approach to quantifying and qualifying the optical pattern of the tear film for each individual, since it has the ability to measure the retinal image in a dynamic way. The interest in this approach stems from the fact that double-pass images are affected by both ocular aberrations and scattering. We propose the use of dynamic analysis of double-pass retinal images as an indirect indicator of the relative quality of the tear film by recognizing 5 different tear film patterns.

**Tailor-Made IOL**

There is no such thing as a good or bad IOL; instead there are good or bad IOL choices. I individually tailor the lens to each patient’s needs and take into account the stability of the tear film to assess which optic will work better under that specific condition. This multifactorial decision includes but is not limited to the patient’s age, lifestyle, expectations, post–refractive surgical status, comorbidities, topography, tomography, aberrometry, ocular surface health, pupil size, and macular health.

For patients who are relatively young and active, my preferred IOL is an enhanced depth of field IOL. My experience with the Symfony IOL (J&J Vision) has been favorable, with functional vision at all distances. Additionally, patients’ satisfaction with this IOL is high, and it seems to be less dependent on variable pupil diameters.

For older patients, my choice of lens is an apodized diffractive trifocal IOL such as the IOL +3.5 Physiol (Finevision), which provides a comfortable reading distance. For patients with dry eye disease and unstable tear film or a mild epiretinal membrane, I will typically use an IOL such as the Comfort (Oculentis).

For post–refractive surgery patients, I may use blended vision to suit their needs, with a negative asphericity IOL in postmyopic ablations and neutral post-hyperopic ablations. I correct astigmatism with limbal relaxing incisions in lower degrees or implant Alcon’s toric IOL for moderate to high degrees of astigmatism.

**Conclusion**

DLS is an omnipresent condition that has been widely underestimated. With the evolution of advanced diagnostic tools, improved IOL designs and surgical techniques, I believe we will see this syndrome more readily recognized and managed.
Therapeutic and Refractive Options for Patients with Suspicious Corneas

David R Hardten MD

I. Options for patients with unusual corneas continue to expand.
   A. Topography-guided treatments with the excimer laser are increasingly available.
      1. Treat based on direct data where the problem is in uneven corneal corrections
      2. Are not misguided by intraocular aberrations
      3. Don’t measure direct total refractive errors
   B. Wavefront-guided excimer treatments are increasingly robust.
      1. Higher-resolution systems now approach resolution of topography systems.
      2. May be misguided by intraocular aberrations
      3. Can measure total ocular refractive errors

II. Stability of disease is key.
   A. Keratoconus is one typical cause of irregular corneas or suspicious corneas.
      1. In keratoconus, disease may be progressive, and removal of tissue may exacerbate progression.
      2. Crosslinking may be able to halt progression.
      3. Crosslinking is important for early disease where there is concern about progression.
      4. Crosslinking may cause some shape change to the cornea.
   B. Scars are typically stable and therefore may not require any other treatment prior to excimer correction.
   C. Some dystrophies are stable, some are progressive.
   D. Need to understand the disease process to decide best management strategy

III. Management Options
   A. Keratoconus
      1. Spectacle correction
      2. Contact lenses
      3. Surgical corrections
         a. Crosslinking in keratoconus or ectasia is thought to have potential for progression.
            i. Then possibly glasses or contact lens management
            ii. Possible Intacs if corneal shape still not amenable to glasses or contacts
         b. Deep anterior lamellar or penetrating keratoplasty in disease too ectatic for good result with glasses, contacts, Intacs, or excimer laser correction
   B. Corneal scars or dystrophies
      1. Often spectacle management is acceptable.
      2. Contact lens corrections
      3. Surgical corrections
         a. Typically disease is not progressive.
         b. Oftentimes broad-beam dusting of cornea with laser after superficial keratectomy is adequate.
         c. May benefit from epithelial and dystrophy mechanical removal followed by wavefront- or topography-based excimer treatment if pattern of underlying cornea is somewhat predictable
         d. May require deep anterior lamellar or penetrating keratoplasty in very deep scars or very unpredictable corneal shapes

IV. Patient Counseling
   A. Each case is very unique, unlike refractive error for myopia or astigmatism.
   B. Patient counseling about monitoring for disease progression is important.
      1. Avoid eye rubbing for keratoconus patients
      2. Avoid face sleeping, sleep apnea for keratoconus / ectasia patients
   C. Long recovery and unpredictability for excimer treatments and keratoplasty
   D. Crosslinking can stabilize disease, but minimal impact on vision, unpredictable effect on curvature

Selected Readings


Identifying Risk Factors for the Development of Ectasia following Refractive Surgery

Renato Ambrósio Jr MD PhD

I. Key Points

*There are known knowns. These are things we know that we know. There are known unknowns. That is to say, there are things that we know we don’t know. But there are also unknown unknowns. There are things we don’t know we don’t know.* —Donald Rumsfeld

A. Progressive keratectasia is an uncommon but also a very severe complication of laser vision correction (LVC) procedures.

B. Ectasia occurs due to a combination of 3 basic factors:

1. Preoperative ectatic corneal disease, which is the most important risk factor
2. The surgical impact on corneal structure
3. Significant trauma postoperatively (including eye rubbing)

Other weakening corneal conditions such as pregnancy may also be related to late ectasia (keratectasia) progression.

C. A combination of these 3 factors likely determines stability or ectatic progression in every case.

D. Screening for subclinical ectasia (and ectasia susceptibility) relies on proper interpretation of advanced diagnostic technologies, including front surface corneal topography, 3-D tomography, and biomechanical assessments.

1. In fact, characterizing ectasia susceptibility goes beyond but not over detecting mild keratoconus.
2. Studies involving eyes with normal and stable corneas, compared to eyes with frank ectatic diseases and to eyes with normal topography from patients with very asymmetric ectasia (VAE), allow for developing advanced methods and testing its sensitivity.
3. However, the ideal studies for testing the sensitivity and specificity of ectasia risk assessments are, respectively, the preoperative study of cases that developed ectasia and of cases with stable outcomes after LVC.

E. Young age and low thickness are surrogates of corneal biomechanics, which may be replaced as risk factors by direct measurements, when these are available.

F. The impact from the LVC procedure on the cornea is related to the residual stromal bed (RSB) and to the percentage tissue altered (PTA).

1. PTA higher than 40% is a more sensitive parameter than a fixed value for minimal RSB of 250 µm.
2. The biomechanical impact from surgery is related to the region and number of lamellae that are severed, so that flap thickness and geometry should play a more relevant role, which is in agreement with finite element simulations.

G. Artificial intelligence methods allow for combining parameters, which significantly enhance the accuracy for detecting ectasia risk.

1. Data integration: key to improve decision-making in screening of refractive surgery: www.youtube.com/watch?v=z1tUJkrUMDY &t=6s
2. See “Enhanced Screening for Ectasia”: www.youtube.com/watch?v=d4jOG7jAPwU

H. An enhanced screening approach for preventing keratectasia should consider both preoperative patient-related data and procedure-related parameters to individually characterize ectasia susceptibility or predisposition.

I. Advising the patient to avoid eye rubbing may also play a key role in preventing progressive ectasia after LVC. In fact, every patient should understand the potential risk and the importance of proper follow-up.

J. Refractive surgery stimulated tremendous progress in understanding, detecting (diagnosis and prognosis), and treating ectatic corneal diseases (ECD).

1. Keratoconus and ECD is considered a novel subspeciality in ophthalmology.
2. Such increase in awareness and interest leads to the emergence of international societies focused on ectasia and the International Journal of Keratoconus and Ectatic Corneal Diseases (IJK-ECD; www.ijkecd.com).

II. Introduction to Understanding Keratectasia

A. Progressive “iatrogenic” keratectasia after LASIK is defined as progressive corneal steepening with secondary loss of visual acuity.
Section III: Management and Prevention of Complications

A. Identifying cases at high risk or susceptibility for biomechanical failure after LVC represents a major challenge for refractive surgeons. Screening is the application of a diagnostic test to detect cases with mild to moderate disease or with high susceptibility to or predisposition for developing disease. It is typically applied to prevent suffering and morbidity when treatment decisions can best alter the natural course for the patient.

B. Placido disc–based corneal topography has sensitivity to detect abnormal front curvature patterns of ectatic disease in patients with relatively normal distance corrected visual acuity and unremarkable biomicroscopy. Corneal topography and central corneal thickness (CCT) have a recognized but limited role for screening refractive candidates.

C. For improving screening efficiency, the Ectasia Risk Scoring System (ERSS) was developed by Randleman and coworkers, finding abnormal topography as the most important risk factor for ectasia development, but considering also the impact from surgery and the patient’s other preoperative data such as age and level of correction.

1. The combined approach represented an improvement, but there were still 8% false negatives and 6% false positives found at the original ERSS study.
2. Also a much higher incidence of both false positives and false negatives have been reported.
3. There is significant interobserver variability in subjective classifications of corneal topography maps. Also, changing from an absolute to a normative scale increased the scores on the classifications by the same examiner, with significant intraobserver variability.
4. Objective quantitative indices, such as the classic Rabinowitz inferior-superior dioptric asymmetry value (I-S) and the keratoconus percentage index (KISA), and qualitative pattern of asymmetric bowtie with skewed radial axes (AB/SRAX), were an attempt to add objective measurement to the previous subjective evaluation.

D. Nevertheless, normal topography does not exclude mild or early ectatic corneal disease. For example, there are subclinical cases with normal topography, such as those from patients with clinical ectasia in the fellow eye (VAE; see Figures 1-5).

1. These cases have been considered to demonstrate enhanced accuracy of corneal tomography. However, they do not represent the ideal study population for assessing high susceptibility or predisposition for ectasia progression. This is because some of these patients may have unilateral, mechanically induced ectatic disease due to unilateral stimuli such as chronic eye rubbing.
2. There is a consensus that true unilateral keratoconus does not exist and that ectasia may occur due to mechanical causes. While only longitudinal follow-up studies are able to elucidate such cases, these cases have been referred as forme fruste keratoconus (FFKC) in the non-affected eye with normal topography.
Figure 1. Scheimpflug (A and B) and Placido-disc based (Oculus Keratograph 5; C and D) curvature maps from a female patient, 50 years old, presenting with very asymmetric keratoconus. O.D. has mild keratoconus while O.S. has a normal curvature map. Note the similarity of the generated maps from these different technologies. Uncorrected distance visual acuity was 20/200 in both eyes; manifest refraction (MRx) was $-0.75 = -2.25 \times 81^\circ$, giving 20/25 in O.D. and $-2.00 = 0.50 \times 115^\circ$, giving 20/20 in O.S.
Figure 2. Belin/Ambrósio Enhanced Ectasia Display (BAD) from the left eye (same case as Figure 1).

Figure 3. Segmental tomography with OCT-FD (RTVue, Optovue; Freemont, CA) from both eyes (same case as Figure 1).

Figure 4. Ocular Response Analyzer of the right (A) and left (B) eyes (same case as Figure 1).
E. Forme fruste keratoconus (FFKC) may not be an accurate term, as it was originally described by Prof. Marc Amsler (1891-1961) based on reflection Placido-disc photography, prior to the development of computerized corneal imaging technologies. FFKC was used to describe an abortive form of the disease that may progress or not.\textsuperscript{10,20,27}

F. The need for enhancing the sensitivity for detecting mild or subclinical ectatic disease is also supported by the reported cases of ectasia after LASIK without identifiable risk factors (Clinical Example 2, see Figures 6 and 7).\textsuperscript{28,29} These cases, when a thick flap or excessive tissue ablation are excluded, represent the closest to the ideal population for the studies involving screening for ectasia risk. In fact, the analysis of the preoperative data from these cases has provided the most important advances in the field.\textsuperscript{11,12,29,30}

G. Considering ectasia susceptibility, any cornea can undergo ectasia progression if there is enough disturbance from surgery and/or other environmental factors, such as ocular trauma and eye rubbing.\textsuperscript{9,12}

1. This is in agreement with the current consensus\textsuperscript{26} and with the two-hit hypothesis.\textsuperscript{31}

2. The goal of screening for ectasia risk is not solely to detect or screen for mild or subclinical keratoconus but to assess an individual’s susceptibility to ectasia progression.\textsuperscript{22}

3. Risk for keratectasia also depends on the biomechanical impact from the LVC procedure.\textsuperscript{12,18}

IV. Advanced Corneal Analysis beyond Curvature

A. “Corneal tomography” provides a 3-D reconstruction of the corneal shape, enabling the calculations of elevation maps of the front and back surfaces of the cornea, along with pachymetric mapping.\textsuperscript{18,20}

1. In addition, the ability to create epithelial thickness mapping by “segmental” or “layered” tomography using OCT\textsuperscript{32} and very-high-frequency ultrasound\textsuperscript{33} may provide additional information for ectasia risk detection.

2. Reinstein and coworkers demonstrated improved specificity by verifying stability after LASIK in corneas with preoperative topographic abnormalities but confirmed as non-ectasia susceptible by epithelial thickness profile in a retrospective case-control comparative study.\textsuperscript{33}

3. Sinha-Roy’s group developed the Bowman roughness index (BRI),\textsuperscript{34} which characterizes the irregularity of the Bowman layer (BL). The BRI, in conjunction with epithelial thickness data and BAD-D, did improve the sensitivity for detecting mild forms of ectasia in studies involving the fellow eye with normal topography from VAE cases.

B. Corneal morphologic changes due to ectasia (including curvature, elevation, and thickness) are secondary signs of a primary structural\textsuperscript{7} or biomechanical\textsuperscript{15} abnormality.

1. Roberts and Dupps have proposed that there is a focal biomechanical failure in ectasia,

Figure 5. Corvis ST of the left eye (same case as Figure 1). Corneal biomechanical index (CBI) was 0.61.
rather than a generalized weakening.\textsuperscript{35} The Ocular Response Analyzer (ORA, Reichert; Buffalo, NY; see Figure 4),\textsuperscript{8,22,28} the Corvis ST (Oculus; Wetzlar, Germany; see Figure 5),\textsuperscript{20,22} and Brillouin optical microscopy (Harvard Medical School, Boston, MA)\textsuperscript{36} are promising technologies for the clinical assessment of the biomechanical properties of corneal tissue. Interestingly, the CBI is a novel biomechanical index developed by Vinciguerra and coworkers to integrate corneal deformation response (DCR) metrics from the Corvis ST, having high accuracy to detect clinical ectasia.\textsuperscript{37}

2. Ultimately, the integration of biomechanical data and corneal shape data has been proposed for further improving accuracy to detect mild ectasia or even its susceptibility.\textsuperscript{29,38}
V. Basics and Pitfalls of Clinical Data Interpretation

A. Corneal elevation data in maps depend on the reference surface chosen.39

1. The method of depicting the elevation is the subtraction of the measured surface (either front or back) and a reference shape, which is calculated to have the highest coincident points to a determined area of the cornea that was analyzed. The best-fit sphere (BFS) to the 8-mm zone has been recommended, as it provides adequate data points without the need to use extrapolated data for the majority of cases.19,20

2. The map pattern, the elevation values at the thinnest point and at maximum elevation within central 4-5 mm zone are the most important characteristics for clinical interpretation.19,20 Different reference shapes, such as the best-fit toric and aspheric ellipsoid (BFTA or BFTE), may be used.25

a. Using the Pentacam, the cut-off criteria for the posterior elevation value at the thinnest point using the BFS was 12 μm; and using the BFTE, 8 μm—with respective sensitivity of 96.28% and 95.04% and specificity of 98.79% and 99.09% for detecting keratoconus.20

b. Using the Galilei Analyzer (Ziemer Ophthalmic Systems AG; Port, Switzerland), the cut-off values for maximum posterior elevation within the central 5-mm diameter obtained by BFTA were 16 μm and 13 μm for keratoconus and mild (forme fruste) keratoconus, respectively, with sensitivities of 99% and 82%.25

B. The concept of an enhanced elevation has been introduced by Belin and implemented on the Pentacam.19,20 After calculating the standard BFS for the 8-mm corneal zone, a second “enhanced” best-fit sphere for the same zone excluding the 3.5-mm-diameter zone centered at the thinnest point is calculated. The difference map from the standard and enhanced BFS will exaggerate any differences (protrusions) within the excluded zone. More than 5 μm of difference for the front elevation and 12 μm difference for the back elevation are considered suspicious.19,20,22 Changes in posterior corneal elevation have been studied to document long-term stability after LASIK, so that using the same BFS for the preoperative corneal information, less than 7 μm on the maximal difference in the central 4.0-mm zone, was found on stable LASIK cases.40

C. Corneal thickness maps enable the characterization of the thinnest point (TP) value and its location, along with thickness distribution.19,20,22 The TP is a more accurate parameter than central thickness for screening ectatic corneal diseases,19,20,22,27 as well as for calculating the PTA and RSB.12,22

D. In the Pentacam, thickness distribution is described as the average of thickness values in concentric annular circles with increasing diameters centered on the TP. These values are presented in the corneal thickness spatial profile (CTSP) and the percentage of thickness increase (PTI) graphs, which also contain reference data (mean and 95% confidence intervals) from a normal population.19,20,22 The pachymetric progression index (PPI) is calculated for every 1 degree of meridians of the cornea, starting from the TP outward.

1. This calculation considers the increase in thickness comparing to the TP at each point of the cornea, referencing to a normal population.

2. The Ambrósio relational thickness (ART) values are calculated as the ratios of the TP and the average of the PPI at all meridians (ART-Ave) and the meridian with maximal PPI (ART-Max).20,22 See “Thin or Thinned, Thick or Thickened: Should We Care?” www.youtube.com/watch?v=LhmBHYSLtjs

3. The cut-off criteria for ART-Ave for clinical and mild (FFKC) keratoconus were respectively 474 μm and 521 μm, with sensitivity and specificity of 99.59% and 98.19% for keratoconus and 91.49% and 93.05% for FFKC. For ART-Max, 386 μm and 416 μm were the cut-offs, which had, respectively, sensitivity and specificity of 99.17% and 97.28% for keratoconus and 85.11% and 93.05% for subclinical disease.20

VI. The Pentacam Belin / Ambrósio Enhanced Ectasia Display (BAD)

A. The BAD is a comprehensive display that combines the standard and enhanced BFS elevation maps of the front and back surfaces and the thickness distribution data. Different tomographic parameters are presented as the standard deviation from normality toward disease (d values): anterior and posterior elevation at the TP (8 mm BFS), change in anterior and posterior elevation of the standard and enhanced BFS, thinnest value and location, PPI, ART and maximal curvature (Kmax). The BAD-D final parameter is calculated based on a regression analysis to maximize accuracy for detecting ectatic disease.19,20,22,41

B. BAD-D higher than 2.11 was a criteria with sensitivity and specificity of 99.59% and 100% for diagnosing keratoconus, while for detecting mild or subclinical disease the criteria of higher than 1.22 provided 93.62% sensitivity and 94.56% specificity.20

1. BAD-D (v3) values turn yellow in the display when higher than 1.6.

2. Novel series studies demonstrate lower sensitivity for detecting abnormality among the normal topography eyes from VAE cases. This determines the need to further improve the artificial intelligence method for identifying ectasia susceptibility and even the need to further integrate novel data such as that from segmental tomography (ie, epithelial thickness data) and corneal biomechanics.
C. In a retrospective nonrandomized study involving preoperative LASIK data from an international pool comprised of 23 post-LASIK ectasia cases and 266 stable LASIK cases with over 1 year of follow-up, the criteria of BAD-D higher than 1.29 provided 87% sensitivity and 92.1% specificity. Even though the BAD-D was the most accurate parameter in predicting ectasia risk, the data suggest room for further improvement.

VII. The Impact from Corneal Procedures

A. While ectasia is much more common after LASIK, it has also been reported after surface ablation procedures. The excimer ablation itself has a biomechanical impact on the cornea, but the LASIK flap has a more pronounced effect. Interestingly, there are reported cases of unilateral keratectasia after LASIK, while the fellow eye remained stable after photorefractive keratectomy (PRK).

B. The relative contributions on corneal biomechanical properties of the lamellar delamination and side cuts at different depths were studied in vitro in organ-cultured human corneas using radial shearing speckle pattern interferometry (RSSPI). The loss of structural integrity, measured by a reducing corneal strain, was much more pronounced due to the vertical cut through corneal lamellae and was proportionally dependent on the cut depth. The horizontal lamellar dissection had a mild non-depth dependent impact.

VIII. Finite Element Simulation

A. The biomechanical effect of different LVC procedures can be simulated using finite element analysis. This approach may assist in the understanding of the surgical effect on the corneal structure. For that purpose, the impact from 2 extreme LASIK parameters with the same PTA were simulated on the same model eye with central curvature of 43.34 D and central thickness of 546 µm using Optimeyes software (Integrated Scientific Services; Biel, Switzerland). Both LASIK procedures were designed with PTA of 39.4%, femtosecond planar flap with 8-mm diameter, and planned optical zone of 6.15 mm. A thin flap of 90 µm and ablation of 125 µm to treat −8 D (A125), and a thick flap with 150 µm with 65 µm (A65) ablation to treat −4 D were compared to evaluate the percentage of induced stresses in the central stromal bed. The thick-flap LASIK procedure leads to higher induced stresses than the thin-flap LASIK case on this simulation. An overall stress increase of 6% was found in the A65 case, while stress increase of 3% was observed in the A125 for a central 5-mm disc in the posterior half of the cornea (see Figure 8). Furthermore, ablation thickness profile had a direct impact on induced stresses in the stromal bed just below the ablation (A125: +31%, A65: +22%), whereas flap thickness rather influenced stress increase in stromal tissue below the flap periphery (A125: +2%, A65: +20%). Interestingly, different zonal stress increase was observed due to the differences on overall volume of tissue removal.

B. Thereby, the complexity of the impact from LVC procedures on corneal structure requires individualized calculations considering different parameters from surgery and also from the patient preoperatively. Contemplation of the impact from the flap cut parameters may significantly improve clinical application of simplified models such as the PTA and the mathematical model to estimate the relative change in stromal tensile strength following photorefractive keratectomy (PRK), LASIK, and small-incision lenticule extraction (SMILE).

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Figure 8. Showing the distribution of equivalent (or van Mises) stresses in the numerical surgery simulation models (thick-flap A65 on the left and thin-flap A125 on the right). Stress values are given in megapascals (mPa) and are color coded (blue [bottom of legend] = 0.00 mPa, red [top of legend] = 0.076 mPa). The 2 images show that the cut flaps do not carry any load and that the thicker flap (left) induced higher average stresses than the thinner flap (right), with respect to the preoperative stress distribution.
IX. Enhanced Screening for Ectasia Susceptibility

*Everything should be as simple as possible, but not simpler.* —Albert Einstein

A. An enhanced screening approach for the prevention of keratoconus should consider preoperative corneal data to estimate ectasia susceptibility and procedure-related parameters. While this may be a challenging and complex task for the clinician to combine the data from different sources, artificial intelligence techniques such as neural network (NN), decision tree (DT), support vector machine (SVM), and regression analysis have been used to facilitate clinical decisions.12,18,24,27,30

B. In a retrospective case-control study, 177 normal eyes were compared to 148 eyes with clinical keratoconus and to 47 eyes with normal topography from 47 patients with clinical keratoconus in the fellow eye using the Galilei. Fifty-five parameters were analyzed so that a machine learning algorithm was created using a DT approach. Two machine learning algorithms were created using automated DT classifier. The one for the discrimination between normals and keratoconus had 100% sensitivity and 99.5% specificity. The one developed for discriminating between normals and mild (subclinical) keratoconus had 93.6% sensitivity and 97.2% specificity.24 However, it is fundamental to validate such approaches in a new set of cases. In another study, a combination of corneal topography (I-S value) and minimum pachymetry from OCT was statistically the most significant in separating the ectatic from normal eyes.27

C. Recently, studies were accomplished to integrate shape and biomechanical analysis and develop the tomographic biomechanical index (TBI). The TBI combines data from the Corvis ST and from the Pentacam HR (Oculus; Wetzlar, Germany), through a random forest method with leave-one-out cross validation (RF-LOOCV). This novel index has shown very high accuracy for detecting ectasia, including a very high sensitivity for subclinical ectasia among eyes with normal topography in very asymmetric patients, performing better than any other parameter tested.46 For example, there are cases with normal topography and also normal tomography, including a BAD-D value lower than 1 but present with abnormal TBI. Figures 9 and 10 illustrate the clinical presentation of a patient with VAE in which the eye with normal topography has a very low BAD-D score and a TBI of 1. Such analysis may provide a better understanding of ectasia susceptibility and also confirm if the fellow eye with normal front surface curvature is a mild or “fruste” keratoconus of if this is a factual unilateral ectasia patient.

D. The ectasia susceptibility score (ESS-I) was created based on the preoperative clinical and corneal tomography data from 23 cases that developed ectasia after LASIK and from 266 stable-LASIK cases with over 1 year of follow up.30 The regression formula combining BAD-D, age, and RSB was calculated. The cut-off of 0.068 (6.8% of relative risk) provided 100% sensitivity and 94% specificity, with better area under the receiver operating characteristic (ROC) curve (AUC = 0.989; 95% CI, 0.969 to 0.998) than all parameters, including the BAD-D (AUC = 0.931; CI, 0.895 to 0.957; De Long, P > .001).30 Thereby, the ESS-I enables the calculation of the relative risk of developing ectasia accordingly to the BAD-D, age, and RSB. The logarithmic function leads to a binary outcome from 0 to 1, which represents the relative risk for ectasia. For example, a patient who is 21 years old with a BAD-D of 0.9 would be at high risk of ectasia (24%) with 350 μm of RSB. But a patient who is 21 years old with a BAD-D of 0.2 and RSB of 350 μm would be at low risk (3%). Also, a patient who is 42 years old and has a BAD-D of 0.9 would have low ectasia risk (1%) with RSB of 350 μm.30

Validation studies and further improvement for the conception of the enhanced ectasia susceptibility score (EES see) are currently being performed, including a larger set of 60 cases of ectasia with preoperative corneal tomography data (Ramos et al. ECRS 2014 Poster). This is a work in progress by the Brazilian Study Group of Artificial Intelligence and Corneal Analysis (BrAIN), in which the refractive clinical data will be integrated to access the individualized risk of ectasia progression, accordingly to the procedure (see “Data Integration: Key to Improve Decision Process in Refractive Surgery Screening.” Film produced by JM Lyra and R Ambrósio, 2016. www.youtube.com/watch?v=ztUjKrUMDY).

X. Conclusion and Remarks about the Future

A. Considering there is high variability on subjective classifications of color-coded maps,17 objective and validated criteria are essential for diagnostic interpretation and for the clinician to take full advantage of the diagnostic technologies.12,18,20,27

B. The analysis uses advanced corneal characterization of the preoperative state of cases that developed ectasia and of the ones that are stable after LVC, representing the closest to ideal populations for the development and testing sensitivity and specificity of ectasia risk assessment approaches.

C. Young age and low preoperative thickness are surrogates of corneal biomechanical properties, presenting as important risk factors for keratectasia. However, the advent of corneal biomechanical parameters may exclude these factors in artificial intelligence techniques, such as regression analysis, support vector machine, and random forest. Nevertheless, application of cross-validation techniques and external validations in separate populations are fundamental steps for the development of such methods, in order to ensure clinical applicability and reliability for the test.
Considering that keratectasia occurs due to a combination of preoperative predispositions or susceptibility of the patient’s cornea and the impact from surgery on corneal structure, the approaches for assessing ectasia risk should consider a combination of patient-related data and procedure-related parameters. We anticipate fast developments and the integration of simulation analysis and artificial intelligence strategies, which will play a significant role in this field.

References


Management Options for Flap Complications with LASIK

Priyanka Sood MD

Introduction
LASIK is one of the most successful elective procedures performed for correction of refractive error. While it is generally a very safe and effective procedure, complications can happen. There are some intraoperative flap complications that are similar between microkeratome-created and femtosecond laser-created flaps and some that are unique to each technology. Appropriate management of these complications can result in excellent outcomes.

Intraoperative Flap Complications and Treatment
- Microkeratome flap complications: Overall flap complications have been reported to occur in 0.4% to 10%.
- Femtosecond flap complications: Overall flap complications have been reported to occur in 0.16% to 15%.
- Epithelial defects (microkeratome and femto): Treatment
  - Try to replace loose epithelium.
  - If significant amount, consider bandage contact lens to be removed at 1 week.
- Decentered flaps (microkeratome and femto): Treatment
  - If large enough flap and small optical zone that can still be centered on the pupil, proceed.
  - If not, lay flap down and allow to heal for 1-3 months, awaiting refractive stability and corneal stability.
  - Retreat with surface ablation technique.
- Incomplete flap (microkeratome and femto): Treatment
  - If residual area is in the periphery of the flap, or in side cut, you can use Vannas or crescent blade to gently cut the flap.
  - Otherwise, abandon flap and consider repeat with smaller side cut or surface ablation after refractive stability.
- Limbal bleeding (microkeratome and femto): Treatment
  - Make sure to clear heme from the stromal bed during excimer ablation.
  - After flap has been replaced, irrigate copiously to minimize amount under the flap.
  - Can use phenylephrine after flap has been replaced to minimize bleeding.
  - Consider increased topical steroid postoperatively as risk of diffuse lamellar keratitis has been reported to be slightly higher.
- Interface debris (microkeratome and femto)
  - Try to minimize risk by decreasing meibomian gland fluid, lint, and fibers on the ocular surface using BSS to irrigate before the flap lift and after the excimer ablation.
  - If debris is noted under the flap after it has been replaced, you can use and irrigating cannula to flush the debris from the interface.
- Button holes (microkeratome): Treatment
  - Do not lift the flap, or if it is lifted, gently replace it.
  - Place bandage contact lens.
  - Allow to heal for 1-3 months awaiting refractive stability and corneal stability.
  - Retreat with surface ablation technique, taking great care when removing surface epithelium.
- Free cap (microkeratome): Treatment
  - Perform excimer ablation as planned, replace cap and allow to dry in place for 3-5 minutes.
  - Place bandage contact lens.
  - Consider suture or adhesive.
- Opaque bubble layer (femto): Treatment
  - Proceed with excimer ablation.
  - Can occasionally interfere with pupil tracking; can use Weck-Cel to sweep and lighten opaque bubble layer.
- Anterior chamber gas bubbles (femto): Treatment
  - Attempt pupil tracking and proceed with excimer laser if able to obtain.
  - Otherwise wait for dissipation and then proceed when pupil tracking is obtained.
- Vertical gas breakthrough (femto): Treatment
  - Gently try to loosen the area by coming from all angles with your flap lifting instrument.
  - If in periphery and able to gently use blade to lift it, you can try this.
  - If unable to lift completely, replace and await refractive stability and then perform advanced surface ablation. Can consider doing as soon as 2 weeks.

Conclusion
Outcomes of LASIK are excellent. Complications during flap formation do occur, but if appropriate steps are taken excellent outcomes can still be achieved.

Selected Readings
Management of SMILE Patients with Intraoperative Complications or Residual Refractive Error

Sri Ganesh MBBS MS
Management of Challenging Situations following Phakic IOLs

Erik L Mertens MD FEBOphth

I. Introduction

Phakic IOL (P-IOL) models can be divided into 3 categories, depending on their location within the anterior segment: iris-fixated anterior chamber (AC) P-IOLS, posterior chamber (PC) located P-IOLs, and angle-supported anterior chamber P-IOLS. In this summary the focus is going to be placed on the first 2 categories. The complication rate for P-IOLS is low; however, the most challenging complications are listed below.

II. Iris-Fixated Anterior Chamber P-IOLs

Within this category we find the Iris-Fixated Artisan / Artiflex (Ophtec; Groningen, Netherlands) and the Verisyse / Veriflex (AMO; Santa Ana, CA). The most challenging situations for these designs are as follows:

A. Moderate to severe endothelial cell loss and corneal decompensation
   1. Management: Removal of the P-IOL and/or Descemet-stripping automated endothelial keratoplasty (DSAEK) / Descemet membrane endothelial keratoplasty (DMEK)
   2. How to prevent: Preoperative endothelial microscopy is essential to avoid this complication.

B. Iris-fixated IOL subluxation
   1. Management: This can lead to a significant decrease in visual acuity that may need re-entla- vation or, when that is not possible, explanta- tion of the lens.
   2. How to prevent: Factors that may contribute to this event are trauma-induced lens dislocation and insufficient iris tissue grasp.

C. Chronic postoperative inflammation / uveitis

D. Pigment dispersion / lens deposits

E. Iris complications (pupil ovalization)

F. IOP elevation

III. Posterior Chamber Phakic IOLs

Visian ICL (Staar Surgical; Monrovia, CA, USA) and MPL (Medennium; CA, USA) are located in the poste- rior chamber.

A. Lens implanted upside down

Kumar DA et al report a rate of 3.8% of eyes that had accidental Visian ICL intraoperative inversion. Although some upside-down Visian ICL lenses would not induce any immediate complications, most cases will present some of these scenarios: It can be unnoticeable with good outcomes, or it can present a refractive surprise, with blurred vision and poor UCVA. Vault could be high, optimal, or low. Vault can be low with possible lens opacity or high IOP (with or without angle closure). Other symptoms may occur: retinal detachment, ciliary body damage, pigment dispersion, etc.

1. Management: Explantation with repositioning in the correct position
2. How to prevent: To ensure correct orientation of the ICL, distal and proximal footplate marks of correct orientation have to be checked before placing the lens in the ciliary sulcus.
D. Cataracts
1. Reported incidence of anterior subcapsular opacities after ICL requiring surgery ranges from 0% to 1.8%.6
2. How to prevent: The latest generation of EVO Visian ICL with Aquaport doesn’t seem to induce cataract.4

E. Pigment dispersion glaucoma
F. Improper sizing (decentration, rotation)
The reported rates of complications related to vault (after the Visian ICL design with KS Aquaport, V4c) are generally low, except in those cases series where additional risk factors such as higher levels of myopia and older age have impacted the incidence of cataract.6

IV. General Complications of Intraocular Surgery: Endophthalmitis
A. The reported incidence after ICL is 0.0167%.5 Although this rate is very low, it is very important to pay attention to early signs in order to treat promptly to avoid any vision loss.
B. How to prevent
1. Use povidone iodine 15 min and 3 min before surgery, eyelid 15% and ocular surface 5%.
2. Short surgical intervention time
3. Small incisions

References
**Prevention and Management of Complications following Corneal Crosslinking**

Farhad Hafezi MD PhD

**Introduction**

Corneal crosslinking (CXL) is a safe and effective tool to stop progression of corneal ectatic disease, with a low complication rate when conducted by an experienced surgeon. However, potential complications can arise; these complications may be classified into categories, including excessive haze and scar formation with and without massive remodelling, endothelial cell damage, (potential) stem cell damage, and infectious keratitis. These complications can be avoided if certain considerations and details are respected.

**Massive Haze**

Haze after CXL is usually seen starting at 2-3 weeks postoperatively. In contrast to haze after PRK, CXL-associated haze is deeper, but it usually also dissipates after 2-5 months. While excessive, visually disabling haze is rare after epithelium-off CXL, it seems to be more common when CXL is combined with wavefront-guided surface ablation. In these cases, epithelial healing is also delayed and may take up to several weeks instead of the typical 3-4 days.1,2

**Massive Remodelling**

Massive remodelling was first observed in 2010 when clinical researchers in Zurich analyzed their first 1000 CXL procedures and noted that massive remodelling occurred in 1:200 eyes. Massive remodelling may start as early as 10 days after CXL and can lead to a flattening effect of up to 11 D. In all cases, flattening is accompanied by a distinct, permanent deep stromal haze. In these highly irregular corneas, the flattening effect of the haze leads to an increase in correctable distance visual acuity. This advantage outweighs the negative effect of increased glare caused by the haze. In other words, this haze, which would have been a major nuisance in a healthy eye, came with an added benefit in a keratoconus cornea. So under these circumstances, can we consider this reaction a complication?3

**Endothelial Damage**

Endothelial damage was reported a number of times in the literature. After examining the protocols used in all these cases, it was found that the technical properties of UV irradiation were not respected. The most common error was not measuring stromal thickness immediately before irradiation because the cornea may thin by up to 100 μm due to evaporation during riboflavin instillation.4

**Sterile Melting**

This complication was reported in a number of cases; all cases were associated with prolonged use of NSAR, which may increase MMP-9 expression and induce corneal melting.6

**Infectious Keratitis**

CXL with photoactivated chromophore for infectious keratitis (PACK-CXL) is seen as a potential new tool to combat infectious keratitis. PACK-CXL shares the same irradiation settings as CXL for keratoconus, so at the end of every CXL procedure for keratoconus, the surface of the cornea should, as a side effect, be free of all pathogens. Thus, any infection occurring in the postoperative period is due instead to poor handling of the open surface, similar to an infection after PRK.7-9

**References**

Management of Complications following Corneal Inlays

Enrique Barragan-Garza MD

I. Introduction

Complications with corneal inlays can occur at any time, and the patients must be followed consistently with thorough postoperative management. The most common complications include dry eye, decentration, epithelial ingrowth, and haze. Typically, complications are manageable with topical drops, but these additive technologies can also be easily removed. Patient selection, appropriate surgical technique, perioperative parameters, and regular follow-up examination are key when it comes to realizing the best outcomes.

II. Review of Inlays

A. The Kamra inlay uses the pinhole effect to increase the depth of focus.

B. The Flexivue Microlens is a refractive inlay that comes in 3 optical powers from 1.50 to 3.50 D.

C. The Raindrop Near Vision Inlay increases the central curvature of the cornea to improve near vision.

III. Raindrop Case Studies

I only have experience with Raindrop Near Vision Inlay and will present a few of the more common complications.

A. Diffuse lamellar keratitis (DLK)

As in LASIK surgery, DLK is also a potential complication with Raindrop surgery. The first case I will highlight was associated with the use of Durezol (difluprednate ophthalmic emulsion) 0.05% intraoperatively. The surgeon in this case used Durezol to check flap symmetry after implantation. Unfortunately, the flap required realignment and the drug got into the interface. At 6 hours following surgery, significant DLK was noted across the entire stromal interface, which required aggressive management (scraping, inlay replacement, and steroid treatment).

Lesson learned: No ophthalmic medications should be administered until after inlay and flap centration is adequate and no further flap manipulation is required.

B. Decentration

One month after inlay implantation, this patient experienced a significant IOP spike (> 10 mmHg) while on steroids, causing some corneal edema. The inlay subsequently decentred inferiorly. The surgeon relifted the flap and recentered the inlay with no further complications.

Lesson learned: Patients should be assessed for steroid responsiveness preoperatively.

C. Haze

At 9 months following inlay surgery, the patient experienced visual changes (decrease in near and distance) when compared to prior visits. Clinically, patient was noted to have steeper central keratometry and increased corneal opacity (haze) with Pentacam densitometry as well as slitlamp examination. Patient was placed on a 3-month steroid regimen, and diagnostic parameters returned to pre-haze levels (flatter central keratometry, improved visual acuities: better than 20/25, and less corneal opacity).

Lesson learned: Regular follow-up visits are critical in detecting changes to vision, topography, and slitlamp examination so that treatment can be given in a timely manner to minimize complications and improve outcomes.

D. Persistent haze

The patient in this case was lost to follow-up for 2 years. When the patient finally returned, a significant decrease in visual acuities and a hyperopic shift were noted. There was a decrease in Kpower, with an increase in central pachymetry. The patient was immediately explanted and allowed to heal for a period of time. Following explantation, the haze regressed, but the refraction remained hyperopic with poor vision. LASIK was performed to treat some of the hyperopia. Six months after LASIK treatment, the patient’s refraction reached close to plano and vision returned to baseline.

Lesson learned: Again, regular follow-up visits are critical to maintain good outcomes and healthy corneas. Patients should return to clinic every 6 to 12 months after the first year following surgery. Persistent complications should be treated aggressively and include explantation in some cases.

IV. Conclusion

Most complications related to corneal inlays are avoidable and manageable as long as patients are selected carefully and consistently followed. It is very important to screen patients for dry eye and eye diseases with a comprehensive exam preoperatively. Setting appropriate expectations for the patient will also aide in postoperative success. Closely following the recommended surgical technique and perioperative treatment parameters according to the manufacturer’s labeling will also improve safety outcomes. Regular follow-up visits are crucial to detect changes in visual acuity, refraction, topography, and slitlamp examination. In addition, patients need to be educated about returning to the clinic if new visual or ocular symptoms arise or drastic changes to their normal vision.
Curing Diplopia with IOLs:
A Controversial but Successful Strategy!

Robert H Osher MD

Decentered IOL: Managing with Suture

Iqbal K Ahmed MD
Decentered IOL: Managing with the Glued IOL Technique

Sadeer B Hannush MD

The “glued IOL,” a technique popularized by Amar Agarwal MD, has evolved over the past 5 years.

I. Advantages
A. Small self-sealing incision using a foldable IOL
   1. Well-formed globe throughout surgical case
   2. Less risk of iris prolapse
   3. Less chance of suprachoroidal effusion or hemorrhage
   4. Avoids complications of larger surgical wounds such as leakage, shallow anterior chamber, and astigmatism
B. No need for scleral sutures. Avoids suture-related complications: extrusion, cheese-wiring, breakage
C. Stable IOL
   1. Compartmentalizes eye into 2 chambers nicely
   2. No pseudophacodonesis

II. Disadvantages
A. Requires surgical expertise to inject the lens through the main surgical incision and avoid dropping the lens into the vitreous cavity. The surgeon should be familiar with the handshake technique, which includes injecting the lens with one hand and grabbing the haptic to exteriorize it through sclerotomy using the other hand, then delivering the trailing haptic into the eye and exteriorizing it through the other sclerotomy.
B. The surgeon should also be familiar with the use of fibrin sealant under scleral flaps and conjunctiva.

III. Procedure
A. Two peritomies, 180° apart, usually in the vertical hemimeridians
B. Pars plana or anterior chamber infusion cannula
C. Two partial-thickness limbal-based scleral flaps (3x3 mm) 180° apart under peritomies
D. Pars plana sclerotomy and anterior vitrectomy via pars plana, if indicated
E. Two sclerotomies with a 23-gauge MVR blade under the scleral flaps, 1.0-1.5 mm posterior to the limbus, again 180° apart
F. Prepare corneal incision for injectable 3-piece foldable IOL.
G. After explantation of decentered IOL, the new IOL is introduced into the anterior chamber with one hand, while a 23- or 25-gauge forceps is passed through the first sclerotomy site to grasp the leading haptic and externalize it. Grab and externalize the trailing haptic through the contralateral sclerotomy using the handshake technique.
   Note: If the decision is made to retain the decentered IOL, the haptics (only if PMMA, not acrylic) may be externalized in the same manner through the sclerotomies under the scleral flaps.
H. Centration is important, especially if using a multifocal lens.
I. Deliver IOL haptics into 26-gauge scleral tunnels for fixation.
J. Inject reconstituted fibrin sealant to close the scleral flaps and conjunctival peritomies.
K. Close the corneal incisions with 10-0 nylon suture, if not self-sealing.
L. Remove pars plana or anterior chamber infusion cannula.
M. The procedure may be combined with endothelial keratoplasty.

IV. Complications
   Complications include hyphema, decentration, optic capture (reverse pupillary block) and haptic disinsertion or extrusion.

V. Conclusion
Sutureless posterior chamber IOL scleral fixation is a novel approach for posterior chamber IOL implantation in the absence of adequate capsular support. The glued IOL technique nicely compartmentalizes the eye into anterior and posterior segments, and it avoids complications related to sutures, large incisions, and hypotony. It may be ideally suited for management of a decentered IOL in situ or after IOL exchange.
Pre-Descemet Endothelial Keratoplasty with Single-Pass 4-Throw Technique Pupilloplasty

Amar Agarwal MD

Introduction

The single-pass 4-throw pupilloplasty (SFT)\(^1\)\(^2\) is a simple technique of repositioning the iris structure and pupil reconstruction with a single-pass 4-throw technique, which entails intertwining thread around itself to act as a lock mechanism and ensure than the loop does not loosen (see Figures 1 and 2).

Among various techniques that have been described for pupil reconstruction, SFT is one of the newer techniques that can be employed for pupilloplasty. As the name suggests, a single pass of the 10-0 suture on a long-arm needle is passed through the iris tissue, followed by creation of a loop with 4 throws around it that slides inside the eye. This creates a helical configuration that prevents the suture from opening up.

A knot essentially consists of an initial approximating loop followed by a second throw of sutures that creates a securing loop. SFT technique employs the creation of only the initial approximating loop but it comprises 4 throws, thereby creating an intertwining of sutures that has a self-locking mechanism and prevents loosening of the suture loop.

Connection to Pre-Descemet Endothelial Keratoplasty or Endothelial Keratoplasty

The reason pupilloplasty is connected to pre-Descemet endothelial keratoplasty (PDEK) or, for that matter, any endothelial keratoplasty (EK) technique is that in eyes without a capsule and endothelial damage, one performs a glued IOL procedure. Now in such cases the pupil might be distorted and mydriatic. Air is infused in the anterior chamber (AC) for the PDEK graft fixation, and it goes into the vitreous cavity postoperatively. This creates an absence of air in the AC in the immediate postoperative period. However, air in the AC is essential to keeping the PDEK graft attached.

The main purpose of the SFT pupilloplasty is to keep the air in the AC once the pupil is made miotic, so that it does not migrate to the vitreous cavity. This then helps the graft remain attached with a good air fill in the AC (see Figure 3).
Figure 2. Animation demonstrating single-pass 4-throw pupilloplasty, part 2. A. Four throws are now done in the loop. B. The 2 ends of the suture are pulled so that the pupilloplasty is completed. C. Microscissor cuts the ends of the suture inside the eye. The other end of the pupil is also treated with the pupilloplasty technique. D. Miotic pupil created.

Figure 3. Preoperative and postoperative images of pre-Descemet endothelial keratoplasty (PDEK) with single-pass 4-throw pupilloplasty (SFT). A. Preoperative image of eye with pseudophakic bullous keratopathy. B. Postoperative image at 1 month following PDEK with SFT and glued IOL. Vision 6/18. C. Postoperative image at 2 months following PDEK with SFT and glued IOL. Vision 6/9.
Pre-Descemet Endothelial Keratoplasty

PDEK is a variant of the EK procedure that involves the creation of a type 1 bubble, created with a 30-gauge needle attached to an air-filled 5-mL syringe. This procedure has a theoretical advantage of safer manipulation of tissue and greater ease of deployment than has been encountered during the traditional Descemet membrane endothelial keratoplasty (DMEK) procedure.

EK as a technique has evolved from deep lamellar endothelial keratoplasty (DLEK) and transitioned to Descemet-stripping (automated) EK (DSEK/DSAEK) and further to DMEK. Being the latest entry into this horizon, PDEK is expected to have a broad acceptance due to its characteristics of rapid visual rehabilitation after PDEK is faster than in other EK techniques except DMEK, which involves pure DM transplantation.

Clinically, in our series we have observed that the incidence of graft dislocation and the rebubbling rate are less in PDEK than in DMEK, and that can probably be attributed to the addition of the PDL to the donor graft, which enhances the graft sustainability. The risk of donor tissue loss can be minimized by the eye banks if they supply premade, ready-to-use donor graft tissue.

Endoilluminator

We use the endoilluminator in most cases, especially if the cornea is hazy when performing SFT. This helps in visualization, giving an extra light source so that one can see the suture clearly.

Trocar AC Maintainer

Always have fluid in the eye when performing pupilloplasty. This helps maintain the AC very well rather than doing the same with viscoelastic. One can use a Trocar AC maintainer, an AC maintainer, or a retina trocar. But the principle is simple: if fluid is in the eye all the time, the AC does not collapse and one can perform the SFT easily.

Discussion

The knot is the most important part of the suture closure in vivo, essentially comprised of the initial approximation loop followed by a second pass that helps to secure a knot with the securing loop. Ideally an initial approximating loop is taken with either 2 or 3 throws, followed by a securing loop that helps to tie the knot. In our technique, only the approximating loop is taken, with 4 throws that create a helical configuration. Extra throws are not recommended as they only add bulk and do not add extra strength to the knot. Due to the passage of 4 throws, the suture takes up a helical pattern that prevents the sutures from slipping past each other and creates a self-locking mechanism.

An analogy is winding string around your arm: as the string is pulled along the arm, the string bites deeper into the flesh. The passage of 4 throws through 1 loop ensures proper interwring of the sutures, and a second securing loop is not essential to secure the apposition. Moreover, when the throws are being taken across the loop, twisting of the suture occurs every time a throw is passed from the loop. At the terminal end, a bud of around 1 mm is left on either side; cutting the suture end too close to the loop should be avoided, as if this is done the loop that is closest to the terminal end gets loosened and this might lead to partial opening of the helix on one side. In our cases, we did not notice any incidence of suture giving way or opening up leading to gaping in the iris tissue.

Advantages of SFT over Other Techniques

The main advantage of SFT is that one does only 1 pass. The main issue in pupilloplasty is the pass. Every time a pass is made one has to enter the eye, and there is a chance of endothelium damage or iris damage or tapping the IOL and producing a tilt or dislocation. In SFT we create the pass just once to form the mechanism.

Some techniques perform the tying of the knot by passing the sutures from slipping past each other and creates a self-locking mechanism. The passage of 4 throws through 1 loop ensures proper interwring of the sutures, and a second securing loop is not essential to secure the apposition. Moreover, when the throws are being taken across the loop, twisting of the suture occurs every time a throw is passed from the loop. At the terminal end, a bud of around 1 mm is left on either side; cutting the suture end too close to the loop should be avoided, as if this is done the loop that is closest to the terminal end gets loosened and this might lead to partial opening of the helix on one side. In our cases, we did not notice any incidence of suture giving way or opening up leading to gaping in the iris tissue.

SFT Pupilloplasty for Closed-Angle Glaucoma

In closed-angle glaucoma the SFT technique helps to pull the iris and open the angles.

References

The Unhappy Multifocal IOL Patient

David F Chang MD

IOL Scaffold: Managing the Nucleus When the Posterior Capsule Has Ruptured

Yuri McKee MD
Phakic IOL Complications
Alaa ElDanasoury MD

Introduction
Phakic IOLs (P-IOLs) have passed through many stages of innovation and development over the last 3 decades. Today they have a central place in refractive surgical practice and are considered a valuable option for patients seeking freedom from spectacles. It is of prime importance for refractive surgeons to be aware of potential complications of the P-IOL.

Available Designs
Two P-IOL designs are currently available: the iris-fixated lens (Artisan, Ophtec; Groningen, Netherlands) and the posterior chamber P-IOL (ICL, Staar Surgical; Nidau, Switzerland). Each design has its advantages and potential disadvantages.

Potential Complications of Iris-Fixated Phakic IOL
1. Endothelial damage: May occur in case of shallow anterior chamber. It is agreed that 2.8 mm of central anterior chamber depth calculated form the endothelium is safe.
2. Iris damage: This is an uncommon complication of iris-fixated IOLs and may be seen after many years of the surgery. It may lead to piercing of the iris and sagging of the implant.
3. Late dislocation due to trauma and/or poor enclavation
4. Decentration: Centration of iris-fixated phakic IOL is the responsibility of the surgeon, and in some cases a small decentration can lead to incapacitating edge glare, especially with large pupil diameter.
5. Low grade chronic uveitis
6. Postoperative astigmatism after non-foldable implants

Potential Complications of Posterior Chamber P-IOL

1. Sizing
Sizing remains the main unsolved issue in ICL surgery. White-to-white is the most commonly used method for sizing; it can be measured with calipers or with imaging devices including Orbscan (Bausch+Lomb; Rochester, NY), Pentacam (Oculus; Wetzlar, Germany) and IOLMaster (Carl Zeiss; Oberkochen, Germany). Many studies show no correlation between white-to-white measurements and sulcus diameter; however, clinical outcomes show that the rate of over- or undersizing using the white-to-white measurement is less than 5%. More recent studies evaluated the use of high-frequency ultrasound and reported more reliable results compared to white-to-white measurement.8-10

2. Lens-induced anterior subcapsular cataract
Although a rare complication, induced cataract remains an important complication of posterior chamber P-IOL. The most important cause of cataract development is surgical trauma during a faulty surgical procedure. The second cause is poor sizing leading to peripheral touch between the implant and the crystalline lens, leading to poor aqueous circulation and accumulation of metabolites. The recently introduced model with a central hole is believed to improve the aqueous circulation and minimize the possibility of metabolic cataract.

3. Postoperative IOP spikes
This may occur due to retained viscoelastic or, rarely, due to blockage of the central hole by inflammatory exudates in case of severe postoperative inflammation. This must be treated immediately by decreasing the IOP through evacuation of viscoelastic through a paracentesis or anterior chamber wash if needed. If not promptly treated it may end in fixed dilated pupil.

4. Rotation of undersized posterior phakic IOL
This usually has a negative impact on the postoperative refractive outcome and commonly needs lens exchange.

Selected Readings
SMILE to Frown
Ronald R Krueger MD

I. Why SMILE?
A. SMILE is rapidly growing in popularity as a next-generation laser vision corrective surgery.
B. The perceived benefits of SMILE include:
   1. Preservation of biomechanical tissue strength
   2. Less potential dry eye
   3. Smaller external incision size
   4. Less dependence on environmental variables

II. SMILE Risks?
A. Despite perceived benefits, SMILE involves a greater level of surgical skill and potential complications that are unfamiliar to refractive surgeons.
B. The risk and management of SMILE complications must be understood to fully equip new surgeons in optimally selecting and performing SMILE.

III. Experienced SMILE Surgeons
While I personally have limited experience with SMILE, I would like to acknowledge the following experienced surgeons, who have contributed to this presentation Dr. Soosan Jacobs (India), Dr. Enrique Graue (Mexico), Dr. Osama Ibrahim (Egypt), Dr. Pierre Bouchut (France), Dr. Renato Ambrosio (Brazil).

IV. What Can Go Wrong Intraoperatively?
A. During laser
   1. Suction loss
   2. Decentration
   3. Obstructive OBL or black spots
B. During dissection
   1. Incisional or central abrasion
   2. Difficult or incomplete dissection
   3. Torn or perforated cap
C. During extraction: Torn or partially retained lenticule

V. Personal SMILE Pearls for Success
A. Valium and verbal reinforcement calm the patient during the laser application.
B. Patient fixation on green light is key to centration (do many flaps before SMILE).
C. Define cap and lenticule interface in the same region (lenticule is often tough to find).
D. Dissect the cap first, then the lenticule with anchor tags to stabilize lenticule till complete.
E. A drop-on dissector makes tissue less sticky.
F. The more you do, the easier it gets …

VI. Conclusion
A. SMILE is growing in popularity, so it is important for prospective surgeons to know how to manage its potential complications.
B. Suction loss can usually be managed by redocking and recutting.
C. Difficult dissections must be understood and if too difficult aborted.
D. Extracted lenticules must be carefully inspected after removal to ensure there is no missing part.
LASIK Nightmares

*Sonia H Yoo MD*

- 36-year-old male status post aborted LASIK 6 months ago due to incomplete flap
- BCVA 20/50, vision worsening
- Treatment: LASIK flap amputation with phototherapeutic keratectomy and mitomycin C

Inlays: Pitfalls and Problems

*George O Waring IV MD*
Ciliary Muscle Electrostimulation to Restore Accommodation

Luca Gualdi MD

Purpose
To report preliminary results on Ciliary Muscle Electrostimulation Cycles to Restore Accommodation (CMERA) on emmetropic patients with early presbyopia.

Methods
In a prospective, randomized trial, a group of patients from 40 to 51 years old was treated by the CMERA procedure, and a group of age- and refraction-matched patients served as untreated controls. All patients were emmetropes and needed near sphere add between +0.75 and +1.50. Patients carrying a pacemaker or affected by epilepsy were excluded because of possible electrical interactions; also excluded were patients with ocular pathologies or under specific treatments that could possibly influence accommodation.

The protocol consisted of 4 sessions (1 every week within a 1-month period) of bilateral pulsed (2 secs on; 6 secs off) microelectrostimulation with 26 mA for 8 min total time, using a commercially available medical device called Ocufit (Sooft, Fidia Italia CE051). LogMAR, uncorrected distance visual acuity (UDVA) for each eye, uncorrected near (40 cm) visual acuity in each eye (UNVA) and with both eyes (UNVA O.U.), reading speed (number of words read per minute at 40 cm), contrast sensitivity, and near vision in dim light conditions were taken preoperatively and 2 weeks after each session. Overall satisfaction (0-4 scale) was assessed 2 weeks after the last session.

Objective data were studied by the accommodation module of Tracey, OPD scan, Nidek AR1-A monocular and Grand Seiko WAM 550 binocular autorefractor, and by the Pentacam HD, CorVis and ultrasound biomicroscopy.

Results
Bilateral and monocular UNVA and reading speed were stable in the control group, while they continuously improved in the treated group (Friedman, $P < .00001$). Post hoc significant differences were found for monocular and binocular UNVA after the second treatment and after the first treatment considering words read per minute ($P < .001$). The objective measurements correlated with the subjective data, confirming the efficacy of CMERA to restore accommodation in early presbyopic and emmetropic eyes. However, since CMERA is a passive exercise, the effect of electrostimulation is expected to last for a limited time and then progressively regress. To maintain the benefit, it is necessary to periodically repeat the treatment, which requires the development of customized programs based on the individual response related to the observed effect.
**Conclusions**

Ciliary muscle electrostimulation is a new, noninvasive procedure for people who don’t want to start with near vision glasses and want to avoid the risks of possible side effects or complications related to the most common corneal, scleral, or lens-based refractive surgeries. Electrostimulation works like training in physiotherapy, so that best results are expected for young presbyopic patients (40 to 50 years), when the ciliary muscle starts needing more strength to move a stiffer and bigger lens. Also, there should be an age limit for the efficiency of such treatment.

Further studies are under way in our clinic (and several others) in order to optimize the electrostimulation parameters (time, voltage, device, enhancing eye drops) to improve these results.

**Selected Readings**

Femto Lentotomy: Does It Work?
Accommodation Restoration: An Answer for Our Presbyopic Patients
Sunil Shah MBBS

I. Accommodation Restoration: A Lens-Based Approach
A. Finite element model included overlapping individual fibers and suture lines
   1. Preclinical studies with the Lensar Laser System (Lensar) were conducted in animal and human cadaver eyes to determine the accommodative potential of laser lens softening.
   2. In these studies, the crystalline lens was placed on a rotating pedestal to simulate the pulling force of the zonules, a technique known as the spinning test. The reduction of lens thickness with rotation (ie, polar strain) defined the deformability of the lens; in all cases, the effect was age-dependent.
   3. The mean change in the human cadaver lens group, 5.80 ± 2.80 D standard deviation (SD), suggests that the laser softening treatment works. Furthermore, these studies suggested that the procedure is safe and would not induce cataract formation.

II. Accommodation Restoration: Prototype and Historical Results
A. Lensar conducted a clinical study of the Lensar Femtosecond Laser System at 2 sites, with Sunil Shah MBBS at the Midland Eye in Solihull, United Kingdom, and with Harvey Uy MD at the Asian Eye Institute in Makati City, Philippines.
B. An initial feasibility study was conducted at the Philippines site in 2010 in 1 eye each of 80 patients scheduled for cataract surgery. The protocol called for a 1-month follow-up study of the patients after the femtosecond laser treatment before the patients elected to proceed with lens removal for cataract surgery.
C. The follow-up testing included objective accommodation measurements with a Grand-Seiko autorefractor, subjective accommodation testing with the push-down method, and testing of distance corrected near visual acuity.
D. Improvement in objective accommodation was observed in 33.3% of patients at 1 week, and 53% showed improved subjective accommodation. Improvement in distance-corrected near visual acuity (DCNVA) was observed in 37.3% of patients at 1 week and 40.8% at 1 month, with a 31-letter mean improvement.
E. Proof of concept (2014), Sunil Shah
   1. Enrolled patients have elected to undergo early cataract or lens extraction surgery, with the cataract not exceeding LOCS II grade 1 or LOCS III nuclear grade 1.4. All patients are between the ages of 40 and 65 and have BCVAs of 20/40 or better in the eye to be treated and no signs of amblyopia.
   2. Despite the broad inclusion criteria of this cohort, early results in 29 patients with 1-month follow-up are promising. The percentage of eyes with best DCNVAs (BDCNVAs) of 20/40 or better improved from 7.7% at baseline to 38.5% at 1 month in the nonemmetropic group and from 0% to 100% in the emmetropic group. Additionally, the mean monocular preferred viewing distance at near changed from 50.3 to 46.3 cm (mean reduction: 3.92 cm) in the non-emmetropic group and from 45.8 to 37.2 cm (mean reduction: 8.66 cm) in the emmetropic group.
   3. A typical case from the study is that of a 50-year-old man who underwent laser lens softening in his left eye. At 1 month postoperative, he experienced significant improvement from baseline in median values for near UCVA (from 12 to 27 letters logMAR) and for BDCNVA (from 53 to 58 letters logMAR).
F. Proof of concept (2014), Harvey Uy
   1. A feasibility study of the lens-softening procedure in 80 eyes of 80 patients less than 55 years of age with mild cataract (LOCS III grade 1 or 2) and distance BCVA of 20/40 or better was then conducted in 2010 at the Asian Eye Institute in Makati City, Philippines.
   2. The patients enrolled, who had previously elected to have cataract surgery, agreed to a minimum of 1 month follow-up of the laser-softening procedure before proceeding with lens removal and IOL implantation.
   3. At 1 week after the laser procedure, 33.3% of patients showed improvement in objective accommodation (as measured with the WR-5100K Autorefractor; Grand Seiko), and 53% showed improvement in subjective accommodation (using the push-down method).
4. BDCNVA improved in 37.3% of patients in the first week and in 40.8% by 1 month. In patients who experienced an increase in objective and subjective accommodation over baseline, the maximum improvements at 1 month were 1.50 and 2.30 D, respectively. Also in this group at 1 month, the mean improvement in distance BDCNVA was 31 letters logMAR.

5. In 1 patient enrolled in the feasibility study who chose not to proceed with IOL implantation following the lens-softening treatment, there was no sign of significant cataract progression at 5 years postoperative. The experience of this patient demonstrates the concept mentioned above.

G. Phase III (2015), Harvey Uy

1. Following this preliminary study, a study was initiated starting in January 2015 at the Pacific Eye and Laser Institute in Makati City, Philippines, with Harvey Uy MD, in 37 eyes of 37 patients aged 45 to 60 years who had elected to have cataract surgery with IOL implantation. In this study, follow-up was for a maximum of 6 months. The contralateral eye, untreated, served as a control. Several most promising laser patterns were used. Laser treatment variables included laser power, pattern type, and placement in the lens.

2. Objectively measured accommodative amplitude (iTrace aberrometer). Subjective accommodation, improvements in DCNVA. Wavefront analysis of factors that may improve accommodation or DCNVA through alterations to the aberrations of the eye.

3. Results pending.

III. Conclusion

A. Femtosecond laser treatment of the presbyopic lens offers a promising, noninvasive approach to reduce lens stiffness, to restore accommodation, and to improve DCNVA to the presbyopic eye.

B. Historical clinical studies in presbyopia show:

1. Proof of concept
2. Improved objective accommodation in a proportion of subjects
3. Improved subjective accommodation in a proportion of subjects
4. Improved BDCNVA in a proportion of subjects

C. Current studies in investigation

1. Improvement in results through utilization of the commercial Lensar Laser system
2. Enhanced algorithms for enhanced effect
3. Factors affecting variable response
Laser Blended Vision

Dan Z Reinstein MD

Introduction

There has recently been a tremendous increase in interest in surgical presbyopic correction. The effective treatment of presbyopia combined with any refractive error has proven to be a significant challenge for refractive surgeons. Traditionally, the principles used for monovision contact lenses have been applied to corneal refractive surgery. However, many of the same limitations found with monovision contact lenses applied to monovision induced by refractive surgery, including loss of fusion and stereovision. Multifocal corneal ablation profiles have also been suggested; however, although an overall improvement in visual acuity has been recorded for both near and distance vision, the efficacy has remained relatively low and safety and quality of vision have been compromised. A better solution, offering improved visual results and greater tolerance, is still required. This presentation describes the use of corneal nonlinear aspheric ablation profiles to increase depth of field in both eyes, combined with micromonovision, to treat presbyopia in emmetropic, myopic, and hyperopic patients.

Laser Blended Vision

To better understand the way laser blended vision works, instead of viewing presbyopia as the inability to accommodate, it is helpful to consider it as a decrease in depth of field. This decrease can be overcome, at least in part, by using an optimized ablation profile that increases the depth of field of each eye without significantly compromising visual quality, contrast sensitivity, or night vision. The optimization is based on the patient age, refraction, preoperative spherical aberration, tolerance for anisometropia, and treatment centered on the corneal vertex.

It is known that one way of increasing the depth of field is to increase the amount of corneal spherical aberration independent of the zonal power shift that would be created by calculating the sphere for a particular zone in a cornea with spherical aberration. Based on that knowledge, during early work, the initial aim was to be able to adjust depth of field enough to provide clear vision from distance through intermediate to near, creating an eye that could see 20/20 at distance and that would also see a computer screen and read J1.

However, it was soon realized that while spherical aberration could be increased, visual quality and contrast sensitivity can be compromised by large amounts of spherical aberration. This implied that there is a tolerable level of spherical aberration within which it provides a beneficiary increase in depth of field. It was discovered that, with photopic pupil diameters, the depth of field could be safely increased to 1.50 D for any starting refractive error. Given a 1.50-D depth of field, it would not be possible to get full distance and full near vision monocularly; therefore, based on the time-tested concept of monovision, the nondominant eye was set up to be slightly myopic, so that the depth of field of the predominantly distance (dominant) eye was able to see at distance down to intermediate, while the predominantly near (nondominant) eye was able to see in the near range and up to intermediate. In the intermediate region both eyes had similar acuity, an optimal situation for stereopsis, and this draws on the knowledge of binocular fusion processing—the horopter: a volume centered on the fixation point that contains all points in space which are integrated in the conscious mind to create the perception of a single image. Monovision, or in this case, micromonovision, draws on the inherent cortical processes of neuronal gating and blur-suppression (the ability to direct conscious attention to the specific area within the entire visual field of both eyes with the best image quality). This is in contrast to other attempts to treat presbyopia that try to induce a multifocal cornea with 2 distinct focal points.

A further component is the increase in depth of field afforded by pupil constriction during accommodation, a component that persists even in eyes that have lost the ability to change crystalline lens power during the accommodative effort. The combination of controlled induced corneal aberrations and pupil constriction gives a significant increase in depth of field on the retinal image, albeit not a perfect image. However, intraretinal and cortical processing and edge detection are the final component working in laser blended vision: the pure retinal image, which is modified by spherical aberration, is further enhanced by central processing to yield the perception of clear and well-defined edges.

In principle, enhanced depth of field can be achieved through the introduction of either positive corneal spherical aberration, in which corneal power increases with zonal diameter, or negative aberration, in which power decreases with distance from the corneal vertex. Most patients have some nascent positive spherical aberration before treatment. A standard myopic ablation induces positive spherical aberration, which will add to the pre-existing positive spherical aberration. The important thing is to control the induction of spherical aberration to avoid increasing the spherical aberration above the tolerance threshold, which can cause loss of contrast sensitivity and night vision disturbances and can result in a topographic central island. To account for this, the nonlinear aspheric ablation profile includes a precompensation factor for the induction of spherical aberration.

A standard hyperopic ablation induces negative spherical aberration, but it is unlikely that the spherical aberration will be increased above the tolerance threshold because most patients start with some positive spherical aberration and the range of hyperopic treatments is smaller than the range of myopic treatments. In emmetropic patients, you cannot rely on the induction of spherical aberration by the ablation, so the spherical aberration component is increased, but this has an impact on the refractive accuracy. As emmetropic patients have high expectations and low tolerance to refractive inaccuracy, the best option is to increase the depth of field somewhat and make sure that the micromonovision component is as accurate as possible. The range of ablation profiles, which also take age and preop spherical aberration into account, are referred to as nonlinear aspheric ablation profiles, since the spherical aberration component is governed by a nonlinear function.
Results

The outcomes using laser blended vision with the MEL 80 excimer laser (Carl Zeiss Meditec; Jena, Germany) have been published for myopia up to −8.50 D,8 hyperopia up to +5.75 D,9 and emmetropic patients.10 All treatments were performed as bilateral simultaneous LASIK. Inclusion criteria were medically suitable for LASIK, presbyopic with corrected distance visual acuity (CDVA) no worse than 20/25 in either eye, and tolerance of at least −0.75 D anisometropia. The standard micromonovision protocol corrected the dominant eye to plano and the non-dominant eye to −1.50 D irrespective of age.

At 1 year follow-up, binocular uncorrected distance VA (UDVA) was 20/20 or better and binocular uncorrected near VA was J2 or better in 95%, 77%, and 95% of patients, respectively. Retreatment rate was 19%, 22%, and 12%, respectively, although this would have been 5%, 6%, and 4% had the criteria for a retreatment been 20/32. The safety in terms of CDVA and contrast sensitivity was the same as for standard LASIK, with no eyes losing more than 1 line. Mean postoperative mesopic contrast sensitivity was either the same or slightly better than preoperatively at 3, 6, 12, and 18 CPD for all 3 populations. Stereo acuity, although slightly reduced, has been shown to be maintained at a functional level of between 100-400 seconds.

Conclusion

In conclusion, the combination of micromonovision with increased monocular depth of field through appropriate non-linear aspheric ablation profiles improves visual outcomes substantially in comparison with the conventional monovision approach. Trials show that laser blended vision is effective with presbyopic patients having refractive errors between +5.75 and −9.00 D, including emmetropic presbyopes. With the safety advantages of modern femtosecond LASIK, the rapid bilateral surgical procedure and the recovery time of a few hours, patient satisfaction is extremely high. Laser blended vision benefits from all of the wow-factors of LASIK, with the ability to offer easy enhancement of vision if necessary in the future.

References

Picking Up Good Vibrations: The Mini Well Extended Depth of Focus IOL

Gerd U Auffarth MD

Introduction
Treating presbyopia has become a key focus of IOL development in recent decades. Different optical designs have been developed to facilitate multifocality, including the refractive, the diffractive, the refractive-diffractive, and the apodized-diffractive pattern. One of the more recent developments in this field of research has been extended depth of focus IOLs (EDOF-IOLs), also referred to as extended range of vision IOLs (EROV-IOLs), which aim to provide a continuous range of vision instead of multiple distinct foci.

The IOL
The Mini Well Ready is a single-piece, preloaded, multifocal IOL made of acrylic copolymer. The biconvex aspheric optic has a diameter of 6 mm and is divided into 3 annular optical zones, an outer monofocal zone and 2 inner zones, with spherical aberrations of opposite signs and an equivalent addition of +3.0 D corresponding to an addition of +2.4 D at the spectacle plain.

Study
After bilateral implantation of the Mini Well Ready progressive multifocal IOL, uncorrected (UDVA) and corrected (CDVA) distance visual acuities, uncorrected (UNVA), distance corrected (DCNVA), and best corrected (CNVA) near visual acuities, and uncorrected (UIVA) and distance-corrected (DCIVA) intermediate visual acuities, as well as binocular defocus curves, were determined. Reading acuity was evaluated using an electronic reading desk both at fixed distances and at the patient’s preferred near and intermediate distances. Contrast sensitivity in photopic and mesopic conditions was measured with a functional vision analyzer. In addition, a subjective visual symptoms and quality of life questionnaire and a halo and glare simulator were administered. Thirty-two eyes of 16 patients were enrolled.

Median postoperative monocular UDVA was 0.13 logMAR (range: 0.08 to 0.42 logMAR), median CDVA was −0.01 logMAR (range: −0.20 to 0.22 logMAR), median UIVA at 80 cm was −0.05 logMAR (range: −0.18 to 0.58 logMAR), and median UNVA at 40 cm was 0.14 log MAR (range: −0.10 to 0.64 logMAR).

The binocular reading desk examinations resulted in an uncorrected reading acuity of 0.10 logMAR at 40 cm and 0.11 logMAR at 80 cm. Patients preferred an intermediate reading distance of approximately 60 cm (median: 62.8 cm) over the predetermined intermediate distance of 80 cm, which allowed them to read smaller letter size but did not improve reading acuity. Patients reported a high rate of spectacle independence and satisfaction in everyday life and little to no disturbing photic phenomena.

Conclusion
The Mini Well Ready IOL provided good postoperative functional results at far and intermediate distances and improved the visual and reading acuity at reading distance while causing little to no disturbing photic phenomena.
A Kamra in the Eye: The Small-Aperture Extended Depth of Focus IOL

Simonetta Morselli MD

My presentation explains the working principle of the small-aperture IOL (IC8 AcuFocus) in the eye. I was involved in an FDA study where 8 patients affected by cataract were randomly selected. I will present some results on visual acuity for near intermediate and distance, contrast sensitivity, and subjective observations of the patient implanted with this IOL. Also I will present some challenging cases solved with this type of IOL. One eye with previous decentered corneal refractive treatment was successfully implanted with IC8 IOL, and 2 eyes affected by high astigmatism after PKP. This IOL is very useful also for presbyopia correction after cataract surgery and also for challenging cases.
The FluidVision Accommodating IOL

*Douglas Koch MD*

I. FluidVision Accommodating IOL (A-IOL): Overview
   A. The FluidVision A-IOL is the first true shape-changing, fluid-driven IOL.
   B. Fluid movement translates into a true shape change, for a seamless change in vision from near to distance.
   C. Lens body is made from a proprietary hydrophobic acrylic.
   D. Lens and hollow haptics are filled with a proprietary refractive index-matched silicone fluid.
   E. Lens is implanted in 1 step into the capsular bag through a 3.5-mm incision with the PowerJet injector system.
   F. Just launched new second-generation foldable FluidVision lens into clinic.

II. Mechanism of the FluidVision A-IOL
   A. When the eye moves to its natural accommodated state, the capsular bag squeezes fluid from the haptics at the periphery of the lens into the center.
   B. This inflates the lens, giving near vision.
   C. When the eye moves to its disaccommodated state, the capsular bag squeezes fluid back into the haptics, giving far vision.

III. Evolution of the A-IOL
   A. Non-optical proof of concept in blind eyes
   B. Nonfoldable study
   C. Foldable FluidVision single and multicenter studies
   D. FluidVision second-generation foldable

IV. Excellent Clinical Outcomes with Prior Generation
   A. Stable distance, intermediate, and near visual acuities
   B. Stable accommodative function

V. Multicenter Study Design with Second-Generation A-IOL
   A. Prospective, single-arm, multicenter clinical study
   B. Six sites in South Africa currently enrolling patients
   C. Twenty-four patients recently received monocular implants of the new FluidVision A-IOL through a 3.5-mm viscoelastic driven insertion system (PowerJet injector).
   D. Straightforward surgical technique
   E. Early results are promising

VI. Large Objective Accommodation Amplitude with Second-Generation FluidVision
   Alternating 2.5 and 5.0 D stimulation gives 3 to 4 D objective accommodation.

VII. Conclusions
   A. Successful introduction of new second-generation foldable FluidVision lens into clinic
   B. Straightforward surgical technique
   C. Early results are promising.
   D. Excellent objective accommodation observed
   E. Issues to address
      1. Refractive accuracy
      2. Long-term results
Detection of Keratoconus with a New Biomechanical Index

Riccardo Vinciguerra MD, Renato Ambrósio Jr MD PhD, Ahmed Elsheikh PhD, Cynthia J Roberts PhD, Bernardo Lopes MD, Emanuela Morenghi PhD, Claudio Azzolini MD, Paolo Vinciguerra MD

Purpose
To evaluate the ability of a new combined biomechanical index called the Corvis Biomechanical Index (CBI) based on corneal thickness profile and deformation parameters to separate normal from keratoconic patients.

Methods
658 patients (329 eyes in each database) were included in this multicenter retrospective study. Patients from 2 clinics located on different continents were selected to test the capability of the CBI to separate healthy and keratoconic eyes in more than one ethnic group using the Corvis ST (Oculus Optikgeräte GmbH; Wetzlar, Germany). Logistic regression was employed to determine, based on Database 1 as the development dataset, the optimal combination of parameters to accurately separate normal from keratoconic eyes. The CBI was subsequently independently validated on Database 2.

Results
The CBI included several dynamic corneal response parameters: deformation amplitude ratio at 1 and 2 mm, applanation 1 velocity, standard deviation of deformation amplitude at highest concavity, Ambrósio’s Relational Thickness to the horizontal profile, and a novel stiffness parameter. The receiver operating characteristic curve analysis of the training database showed an area under the curve of 0.983. With a cut-off value of 0.5, 98.2% of the cases were correctly classified with 100% specificity and 94.1% sensitivity. In the validation dataset, the same cut-off point correctly classified 98.8% of the cases with 98.4% specificity and 100% sensitivity.

Conclusions
The CBI was shown to be highly sensitive and specific to separate healthy from keratoconic eyes. The presence of an external validation dataset confirms this finding and suggests the possible use of the CBI in everyday clinical practice to aid in the diagnosis of keratoconus.

Biomechanical Changes Associated with LASIK Flap Creation and Rapid Crosslinking Measured with Brillouin Microscopy

Giuliano Scarcelli PhD and Brad Randleman MD

1. Measured mechanical effect of LASIK and rapid cross-linking (CXL) on the cornea
2. Porcine eyes (N = 11); each eye served as its own control.
3. Three conditions
   a. Virgin
   b. After microkeratome flap-cut
   c. After rapid CXL
4. Evaluated stiffness with novel Brillouin microscopy
   a. There was a statistically significant reduction of Brillouin-measured stiffness after LASIK flap creation compared to virgin corneas.
   b. There was no statistically significant difference between rapid CXL and flap-cut corneas.
5. Evaluated depth-dependence of stiffness behavior with Brillouin microscopy
   a. There was a statistically significant reduction of Brillouin-measured stiffness in the anterior portion of the stroma after LASIK flap creation compared to virgin corneas.
   b. There was no statistically significant difference in Brillouin-measured stiffness in central and posterior portion of the stroma after LASIK flap creation compared to virgin corneas.
6. Hydration changes may influence early Brillouin measurements and should be taken into account when interpreting the impact of flap creation on corneal biomechanics.
7. Noncontact Brillouin microscopy could become a useful monitoring tool to evaluate the biomechanical impact of corneal refractive procedures and corneal CXL protocols.
Preliminary Evidence of Successful Near Vision Enhancement with a New Technique: Presbyopic Allogenic Refractive Lenticule (Pearl) Corneal Inlay Using a SMILE Lenticule

Soosan Jacob FRCS

Introduction
Presbyopia is the most common refractive error and effects everyone during their lifetime. Corneal inlays are a favored modality, especially for patients without significant lens opacity. These are easy to implant, adaptable, and reversible.

Background Observations
Currently available corneal inlays for presbyopia are classified as small-aperture inlays (Kamra, Acufocus; CA), shape change inlays (Raindrop inlay, Revision Optics; CA), refractive optic inlays (Flexivue Microlens, Presbia; CA), and Icolens (Neoptics AG; Hunenberg, CH). All have the disadvantage of utilizing synthetic material and may therefore be associated with complications. In this presentation, I would like to discuss a technique that I have developed— the Presbyopic Allogenic Refractive Lenticule (PEARL) inlay—which uses a femtosecond laser–carved allogenic corneal inlay for the treatment of presbyopia.

The PEARL inlay is prepared from a lenticule obtained from small-incision lenticule extraction (SMILE) surgery for between −2.5 and −3.5 D myopia. The lenticule is cut and fashioned into shape and inserted into a pocket within the presbyopic cornea to lie over the coaxially sighted light reflex. Prolateness induced by the inlay induces spherical aberration and provides increased depth of focus, thereby improving near vision. The small size of the inlay allows peripheral rays to pass through the pupil, maintaining good uncorrected distance vision. We had encouraging results with this technique.
Comparative Analysis of the Clinical Outcomes of SMILE and Wavefront-Guided LASIK in Low and Moderate Myopia

Mounir A Khalifa MD PhD, Ahmed Ghoneim MD PhD, Mohamed Shafik Shaheen MD PhD, Mohamed G Aly MD PhD, David P Piñero PhD

Purpose
To compare the clinical outcomes of small incision lenticule extraction (SMILE) and wavefront-guided LASIK (WFG LASIK) in eyes with low and moderate myopia.

This was a prospective, comparative study enrolling 110 eyes with low and moderate myopia (spherical equivalent ≤ 6.00 D). Two groups were differentiated according to the surgical technique used: the WFG LASIK group included 51 eyes (51 patients) undergoing WFG LASIK using the Star S4IR excimer laser and the iDesign aberrometer (Abbott Medical Optics; Abbott Park, IL), and the SMILE group included 59 eyes (59 patients) undergoing SMILE with the VisuMax platform (Carl Zeiss Meditec; Jena, Germany). Visual, refractive, aberrometric, and contrast sensitivity outcomes were evaluated during a 6-month follow-up.

Results
Mean efficacy index was 0.92 ± 0.11 and 1.12 ± 0.17 in the SMILE and WFG LASIK groups, respectively (P < .001). Postoperative spherical equivalent was within ±0.50 D in 81.54% and 98% of eyes in the SMILE and WFG LASIK groups (P < .001), and postoperative cylinder was 0.50 or below in 84.7% and 100% of eyes, respectively (P = .038). Mean safety index was 0.98 ± 0.08 and 1.20 ± 0.14 in the SMILE and WFG LASIK groups (P < .001), with losses of lines of corrected distance visual acuity in 6.8% and 0.0% of eyes, respectively. Higher increase in higher order (P < .001) and coma (P < .001) root mean square and higher decrease in contrast sensitivity for 6, 12, and 18 cycles / degree (P ≤ .001) were observed after SMILE.

Conclusions
SMILE and WFG LASIK are efficacious and safe procedures for the correction of low and moderate myopia, but WFG LASIK allows a more predictable outcome and better aberrometric control.

Laser-Assisted Capsulotomy Centration: A Prospective Trial Comparing Pupil Centration with OCT-Based Scanned Capsule Centration

Tim Schultz MD FEBO, Nikolaos Tsiampalis MD, H Burkhard Dick MD PhD

Purpose
To investigate different capsulotomy centration methods for femtosecond laser–assisted cataract surgery. The overlap between IOL optic and lens capsule was measured with different centration methods and IOL types.

Methods
This was a prospective randomized clinical trial. Patients with cataract scheduled for femtosecond laser–assisted cataract surgery were assigned to 1 of 4 treatment groups: OCT-based scanned capsule centration (SCC) and 3-piece IOL (SCC with 3-piece IOL), scanned capsule centration and plate-haptic IOL (SCC with plate-haptic IOL), pupil centration (PC) and 3-piece IOL (PC with 3-piece IOL), or PC and plate-haptic IOL (PC with plate-haptic IOL). At the end of surgery, the overlap between the IOL optic and capsular bag was measured.

Results
The results of 160 patients were evaluated ($n = 40$ in each group). There was no difference in age ($P = .27$), sex ($P = .18$), the number of treated left and right eyes ($P = .64$), or cataract grade ($P = .06$). With the new SCC method (capsulotomy diameter: 5 mm), a complete overlap was achieved in all cases in both SCC groups. The overlap was also complete in all cases with PC and plate-haptic IOLs. In the PC with 3-piece IOL group, the overlap was incomplete in 3 eyes.

Conclusions
The SCC method helps to achieve a 360° overlap in all eyes independent of the IOL type. A complete 360° overlap was achieved in all cases up to a calculated capsulotomy diameter of 5.1 mm with this new method.

In Vivo Brillouin Microscopy in Keratoconus Corneas

Theo Seiler MD PhD, Peng Shao PhD, and Seok-Hyun Yun PhD

Purpose
To evaluate stiffness in vivo in crosslinked and non-crosslinked keratoconus corneas using Brillouin microscopy.

Methods
Brillouin-shift maps were acquired (Brillouin Optical Scanner System [BOSS], Intelon Optics) in corneas with progressive keratoconus and in crosslinked corneas (> 12 months postop). In addition, a longitudinal study was performed in 5 eyes up to 3 months after crosslinking. Brillouin shifts were correlated to Scheimpflug parameters.

Results
A significant correlation was found between maximal posterior float and the weakest location in progressive keratoconus corneas. Crosslinked corneas are significantly stiffer than non-crosslinked corneas. The temporal course of CXL revealed a remodeling process, ongoing for at least 4 years.

Conclusion
In vivo Brillouin microscopy confirmed the stiffening effect of crosslinking and may become a valuable tool in corneal diagnostics, in particular in identifying weak corneas prior to laser corneal surgery.
Hyperopia Correction with SMILE Lenticules: A Comparison between Clinical Data and Biomechanical Simulations

Michael Mrochen PhD, Daniel Boss, Harald Studer, David Muller PhD

Purpose
To simulate corneal power changes after implantation of small-incision lenticule extraction (SMILE) lenticules for hyperopia correction within a pocket.

Methods
The early postoperative corneal topography (anterior and posterior, as well as pachymetry) for 5 hyperopic lenticules (2.0 D, 4.0 D, 6.0 D, and 8.0 D) with an optical zone of 6.3 mm were predicted using biomechanical simulations. The simulation results were compared to the refractive outcomes reported by Ganesh and Brar.

Results
The simulations explain the clinical outcomes with an uncertainty of about ±0.25 D when comparing the 1-year simulation results with the actual achieved clinical refractive changes. Linear regression analysis resulted in an R2 of better than 0.988, demonstrating a low variability within the clinical data set.

Conclusion
Simulations of hyperopic implants are a helpful method to predict refractive changes of the anterior corneal surface after SMILE lenticule implantations.
The Light for Sight Study: Prevalence of Keratoconus among Children and Adolescents in Riyadh

Emilio A Torres Netto MD, Wafa M Al-Otaibi MSc, Nikki Hafezi MAS IP ETHZ, Sabine Kling PhD, Haya M Al-Farhan PhD, J Bradley Randleman MD, Farhad Hafezi MD PhD

Purpose
To assess the prevalence of keratoconus (KC) in children and adolescents in Saudi Arabia

Methods
Prospective, cross-sectional study from subjects between 6 and 23 years old who were seen for a non-ophthalmic appointment. Rotational Scheimpflug system was used, and 2 masked examiners (BR and ET) established the diagnosis. Cohen kappa coefficient (κ) was used to analyze the inter-rater agreement.

Results
The total number of participants was 589 (1178 eyes). The κ was 0.815, which describes a high degree of agreement. The final prevalence was 4.41% (CI, 2.71-5.98), which represents 1:23 patients.

Conclusion
The prevalence of KC among children and adolescents of Saudi origin is considerably higher than numbers reported from earlier studies, and from similar studies in other countries.
Collagen Crosslinking for Treatment of Refractory Infectious Keratitis

Ashraf H El Habbak MD and Mohamed Awwad MD

Purpose
To evaluate the efficacy of riboflavin / ultraviolet A in the treatment of refractory infectious keratitis

Methods
Ten eyes with refractory infectious keratitis that did not respond to topical and systemic antibiotic therapy were treated with riboflavin and ultraviolet A corneal collagen crosslinking (CXL). BCVA and ocular pain were evaluated pre- and post-CXL. Corneal swabs for bacterial culture and sensitivity were obtained pre- and post-CXL. Follow-ups were scheduled at 1 week and 1 and 3 months after treatment.

Results
Progression of keratitis was arrested in all cases. BCVA improved from 0.210.27 before CXL to 0.170.23 three months after treatment. Pain improved in all cases.

Conclusion
CXL is a good option for treatment of refractory infectious keratitis.
Topography-Guided Astigmatism Correction during Laser-Assisted Cataract Surgery

Harvey S Uy MD and Sunil Shah MD

Purpose
To evaluate the effectiveness of topography-guided (TG) astigmatic keratotomy (AK) or toric IOL (tIOL) placed along TG-laser-created intrastromal alignment marks for astigmatism correction among eyes undergoing laser-assisted cataract surgery (LACS).

Methods
Prospective series of 60 eyes that underwent astigmatism correction using uploaded topography data to guide femtosecond laser AK (n = 30), or tIOL alignment marking (n = 30). Astigmatism reduction was determined by comparing preoperative keratometric astigmatism (PKA) with postoperative refractive astigmatism (PRA).

Results
Among AK eyes, PRA of 0.25 D was achieved vs. PKA of 0.76 D, for a reduction of 67% (P < .0001). In eyes that received tIOL placed along TG alignment marks, PRA of 0.40 D was achieved vs. PKA of 1.65 D, for a reduction of 76% (P < .0001).

Conclusion
TG-AK or TG-tIOL alignment marks appear to be effective adjunctive procedures for reducing astigmatism among eyes undergoing LACS.
Effectiveness of 3% Trehalose on the Re-epithelialization and Tolerability after Photorefractive Keratectomy

Arturo J Ramirez-Miranda MD, Edgar Adrian Gonzalez, MD, Enrique O Graue Hernandez MD, Alejandro Navas MD, Denise Loya MD, Jorge E Valdez-Garcia MD, and Julio Hernandez Camarena MD

Purpose
To compare the effectiveness of 3% trehalose solution (Thealoz) in the re-epithelization rate and alleviation of the local symptoms of post-PRK discomfort.

Methods
Randomized, parallel group study. Subjects who underwent PRK were divided into 2 groups: Group A included 30 patients treated with 3% trehalose and Group B included 30 patients with carboxymethylcellulose. Epithelial defect size was measured at postoperative days 1, 3, and 7.

Results
Twenty-four hours after PRK, the trehalose group had a mean area of epithelial defect of 36.23 mm² vs. 41.15 mm² in control group ($P = .318$); at 72 hours, 0.10 mm² vs. 0.83 mm² ($P = .819$), respectively. At 120 hours, 100% of trehalose group eyes had no epithelial defect, compared to 90.5% in the control group.

Conclusion
3% trehalose may improve the re-epithelization rate after PRK.
# Refractive Surgery E-posters

**Friday–Tuesday, Nov. 10-14**

**La Nouvelle Orleans Lobby**

View at the E-poster terminals or www.aao.org/mobile.

E-posters are not eligible for CME credit.

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* Indicates that the presenter has financial interest. No asterisk indicates that the presenter has no financial interest.
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**The Journal of Refractive Surgery’s Hot, Hotter, and Hottest—Late Breaking News**

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E-poster Abstracts

Corneal Refractive Surgery

Long-term Results of Accelerated Corneal Collagen Crosslinking in Pediatric Keratoconus
Abstract #: RP30053350
Senior Author: Ebru Toker MD
Coauthors: Semra Turhan MD, Berru Yargi MD
Purpose: To assess the efficacy and safety of accelerated corneal collagen crosslinking (A-CXL) in pediatric patients with keratoconus. Methods: Nineteen eyes (14 patients) underwent epi-off A-CXL (9 mW/cm² /10 min. / 5.4 J) under local anesthesia. Visual acuities (uncorrected and corrected distance VA), refractive errors, keratometric values, and pachymetry were recorded before and after treatment. Results: Mean age of the patients was 16.2 ± 1.7 years (12-18 years), and the mean follow-up was 21.5 ± 10.5 months (12-36 months). After treatment, K1, K2, Kmean, and Kmax (Δ = −0.72 D, −0.84 D, −0.97 D, and −0.83 D, respectively; all P < .05) significantly improved compared to the baseline. In 89.5% of pediatric patients, keratoconus regressed (52.7%) or stabilized (36.8%). No significant changes were observed in other parameters. No complications were recorded. Conclusion: A-CXL treatment appears to be effective in stabilizing keratoconus progression in pediatric patients and may be a good alternative to the conventional protocol because of its shorter duration and better tolerability.

Femto-Assisted Crosslinking Better than Conventional: Proof of Concept of “The Deeper, the Better”
Abstract #: RP30053381
Senior Author: Lional Raj Daniel Raj Ponniah MD
Purpose: To compare femto-assisted crosslinking (F-CXL) with conventional CXL, and prove the concept that deeper crosslinking better damps progression. Methods: F-CXL (creation of bed, 8-mm diameter, at 140 microns, into which riboflavin is infused and subsequent UVA) was compared with conventional CXL (C-CXL). Visual acuities, central corneal thickness, Kmax, astigmatism, and demarcation line were analyzed. Follow-up: 1 year. Results: Seventeen F-CXL and 21 C-CXL were enrolled. UCVA improved by 2 and 1 lines in the F-CXL and C-CXL groups. Central corneal thickness was maintained in F-CXL and reduced by 25 microns in C-CXL. Astigmatism was reduced by 0.25 D in F-CXL and increased by 0.27 D in C-CXL. Demarcation line at 1 month was 403 ± 34.1 microns deep in F-CXL versus 243 ± 15.9 microns in C-CXL (P < .001). No endothelial changes in either. Conclusion: Crosslinking of posterior stroma deeper than 250 microns could only be achieved with F-CXL and is better than conventional.

Corneal Stromal Antibiotic Implants: A Novel Therapy for Posterior Corneal Infection
Abstract #: RP30053385
Senior Author: Lional Raj Daniel Raj Ponniah MD
Purpose: To demonstrate the efficacy of implantable intracorneal sustained-release antibiotics in posterior corneal infections. Methods: Posterior corneal infections and abscesses, documented clinically and by anterior segment OCT, were subjected to stromal implantable antimicrobials. A deeper corneal plane was fashioned by femto lasers with 1-2 incisions for antimicrobial implants. Healing was analyzed daily using OCT and slitlamp. Implants were removed in 3-5 days and reimplanted if required. Results: Nine cases were enrolled—4 fungal and 5 bacterial. Healing started in 1-3 days. Two cases were reimplanted and subsequently healed. Reduced frequency / no topical antimicrobials were used. No surface toxicities were noted. Conclusion: Corneal stromal antibiotic implants are effective in deep corneal infections and abscesses in terms of drug penetration and reduced surface toxicities.

The Learning Curve of Small- Incision Lenticule Extraction
Abstract #: RP30053390
Senior Author: Tommy Chung Yan Chan FRCS(Ed) MBBS
Coauthors: Alex Ng, George P M Cheng MD, Victor Chi Pang Woo MBBS, Vishal Jhanji MD
Purpose: To investigate the effect of learning curve for small-incision lenticule extraction (SMILE) during the first 2 years of experience. Methods: The initial 100 patients since the surgeon started operating independently were considered as Group 1; the recent 100 patients were considered as Group 2. Visual and refractive outcomes were compared at 1 week and 6 months postoperatively. Results: Efficacy index was better in Group 2 at 1 week but similar between groups at 6 months. The safety index was higher in Group 2 at 1 week and at 6 months postoperatively. Vector analysis showed that postoperative residual astigmatism and misalignment of astigmatic correction were lower in Group 2 than in Group 1 (P ≤ .039) at 1 week and 6 months. The duration of docking and the duration of lenticule extraction were shorter in Group 2 (P ≤ .034). Conclusion: Our study showed that faster visual recovery, better safety profile, and more accurate astigmatic correction could be attained with increasing surgical experience.
Intracorneal Ring Segment Implantation: Comparison of Intrastromal Tunnel Depth Predictability in Manual and Femtosecond Laser-Assisted Surgery

Abstract #: RP30053414
Senior Author: Tiago P T Monteiro MD
Coauthors: Nuno Franqueira, Fernando Faria Correia MD, Carlos Lisa MD PhD, Jose F Alfonso MD

Purpose: To compare the predictability of intrastromal tunnel creation for Ferrara-type intracorneal ring segment (ICRS) implantation between manual technique and femtosecond laser.

Methods: Major data collected were intended depth thickness and postoperative ICRS depth achieved as measured by a swept source anterior segment OCT (CASIA SS-1000, Tomey Corp.; Nagoya, Japan) at 3 points for each segment (proximal, central, and distal end of the implant). Results: We included 105 eyes in the manual group and 53 eyes in the femtosecond group. All eyes in the manual group presented a significantly shallower tunnel after surgery: −40.86 ± 69.02 µm at proximal and −26.52 ± 73.21 µm at the ICRS distal end (P < .05). In the femtosecond group, we did not observe any difference between the intended and the achieved depth of implantation: −4.24 ± 11.89 µm proximal and −8.09 ± 11.90 µm distal (P > .05).

Conclusion: ICRS implantation assisted by a femtosecond-laser device is a more accurate and predictable procedure than ICRS implantation with a manual dissection technique.

Comparison of 2 Femtosecond Lasers for Myopia Correction: IntraLase vs. Victus—Refractive Results and Flap Morphology

Abstract #: RP30053417
Senior Author: Isabel Rodriguez-Perez MHSA
Coauthors: Carmen Bouza-Miguens, Montserrat Garcia-Gonzalez MD, Cesar Villa-Collar, Miguel A Teus MD

Purpose: To compare the 3-month postoperative results and flap thickness (FT) homogeneity of 2 femtosecond (FS) lasers: the IntraLase and the Victus. Methods: Prospective, observational study. Consecutive eyes underwent FS-LASIK (31 eyes using IntraLase vs. 16 eyes using Victus) and the same Allegretto excimer laser to correct myopia. FT was measured at 16 points along the horizontal axis using an anterior segment OCT (Spectralis). To evaluate FT homogeneity, we calculated the difference between the maximum and the minimum thickness point of each flap. Results: At 3 months postop, the uncorrected distance visual acuity, residual refraction, efficacy, safety, and predictability were significantly better with the IntraLase (P = .01). The difference between the maximum and the minimum FT points in each flap was significantly lower with IntraLase (22 ± 8.3 µm) than with Victus (35.7 ± 16.9 µm; P = .0007).

Conclusion: The better FT homogeneity obtained with the IntraLase could explain the better visual and refractive outcomes obtained.

Early Results of Small-Incision Lenticule Extraction for Correction of Myopia

Abstract #: RP30053418
Senior Author: Shamik Bafna MD
Coauthors: William F Wiley MD, Jeffrey Augustine OD

Purpose: To evaluate the learning curve and the rate of recovery of visual acuity after small-incision lenticule extraction (SMILE) in one center’s first 60 eyes. Methods: Sixty eyes with myopia ranging from −2.50 to −9.50 D underwent SMILE by 2 surgeons. The average preoperative refraction was −6.07 D. Uncorrected visual acuity (UCVA) was measured at 1 day, 1 week, and 3 months following surgery. Results: At 1 week, 93% of eyes had 20/25 or better UCVA. By 1 month, 20/20 or better UCVA was seen in 53% at 1 day, 77% at 1 week, and 88% at 3 months. By 20/20 or better UCVA was seen in 30% at 1 day, 66% at 1 week, and 76% at 3 months. At 1 month, the average refraction was −0.35 D. No treatment-related adverse events occurred. Conclusion: SMILE is a safe and effective method to correct myopia. The uncorrected vision tends to improve over time.

A Comparison of 3 Different Femtosecond Lasers: Visual Acuity and Optical Density Evolution during Follow-up

Abstract #: RP30053419
Senior Author: Alberto Parafita MD
Coauthors: Vanessa Blazquez-Sanchez, Carmen Bouza-Miguens, Rafael Canones-Zafra MD, Miguel A Teus MD

Purpose: To compare visual outcomes and stromal flap optical density (FOD) using 3 femtosecond lasers: iFS 150, FS200, and LenSx. Methods: Observational, prospective cohort study. Thirty-six eyes were included in each group. Uncorrected distance visual acuity (UDVA) and anterior segment OCT (Spectralis) were done at each postop visit. Results: At 1 day postop, significant differences were found in UDVA between the iFS, LenSx, and FS200 (1.05 ± 0.2 vs. 1.07 ± 0.1 vs. 0.94 ± 0.2; P = .004). FOD was lower in iFS eyes (134.5 ± 26.6 vs. 158.9 ± 18.6 vs. 149.8 ± 27.9; P = .0002). At 1 week, iFS and LenSx provided better UCVA than did the FS200 (1.08 ± 0.16 vs. 1.09 ± 0.16 vs. 0.93 ± 0.18; P = .0001), and FOD was still lower in the iFS group (143.9 ± 26.0 vs. 160.1 ± 20.9 vs. 147.6 ± 32.6; P = .04). At 1 and 3 months postop, UDVA and FOD were similar in all groups. Conclusion: iFS and LenSx obtain better UCVA than FS200 in the early postoperative period. FOD of the flap stroma is initially lower with iFS, and it increases over time. LenSx and FS200 flaps have higher FOD than does iFS, that decreases during follow-up.
Six-Month Outcomes from a Prospective, Randomized, Eye-to-Eye Comparison of Wavefront-Guided and Wavefront-Optimized PRK in Myopes
Abstract #: RP30053440

Senior Author: Ryan Gregory Smith BA MD
Coauthor: Edward E Manche MD

Purpose: To compare wavefront-optimized (WFO) and wavefront-guided (WFG) PRK in myopes. Methods: Thirty-two eyes from 16 participants were prospectively randomized to receive WFO or WFG PRK with the WaveLight Allegretto Eye-Q 400-Hz excimer laser (Alcon, Inc.). Main outcome measures included uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), < 5% and < 25% contrast sensitivity, and WF aberrometry data. Current data were analyzed 6 months postoperatively, with final outcomes targeted at 1 year. Results: There was no statistical significance (P > .05) between the WFO and WFG PRK groups in achieving a refractive error within ±0.25 D of emmetropia, postoperative UDVA of ≥ 20/16 or ≥ 20/20, the frequency with which the groups lost 1 or 2 or more lines or maintained their preoperative CDVA, overall UDVA and CDVA, contrast sensitivity, astigmatism, and coma, trefoil, or higher-order root mean square error. Conclusion: WFO and WFG PRK using the Alcon excimer laser platform provide similar results in myopic patients at 6 months postoperative follow-up.

The Biomechanical Effect of LASIK + Corneal Crosslinking in Rabbits
Abstract #: RP30053443

Senior Author: Theo Guenter Seiler MD
Coauthor: Irene E Kochevar PhD

Purpose: To determine the efficacy of interface bonding with corneal crosslinking (CXL) after LASIK in rabbits. Methods: 100-µm LASIK-flaps were created bilaterally in 12 rabbits using a femtosecond laser. After the dissection, 1 eye per animal received CXL of the interface using 0.5% riboflavin and UVA-light with an irradiance of 30 mW/cm² and a radiant exposure of 8.1 J/cm², whereas in the fellow eye the flap was lifted and the interface floated with BSS. Three months postoperatively, the rabbits were euthanized and peel-tests and extensometry were performed. Results: Peel-tests revealed a significantly stronger adhesion of the flap in LASIK+CXL-treated eyes compared to LASIK (P < .05). Extensometry did not show a difference between the groups. Conclusion: Interface bonding after LASIK+CXL increases the adhesion between the flap and the stromal bed; however, the compensation for the biomechanical defect induced by LASIK is questionable.

Correlation of Suction Time with Posterior Segment Changes after Femtosecond LASIK
Abstract #: RP30053451

Senior Author: Devesh Kumawat Jr MBBS
Coauthors: Jeewan S Titiyal MD, Manpreet Kaur MD, Namrata Sharma MD MBBS, Pranita Sahay Sr MBBS MD

Purpose: To study the posterior segment changes in myopia after femtosecond LASIK and correlate them with the suction time. Methods: Prospective evaluation of 142 myopic eyes (spherical equivalent refraction [SEQ] range: -1 to -12 D) undergoing femtosecond LASIK was undertaken. Intraoperative total suction time was noted. Uncorrected distance visual acuity (UDVA), corrected distance VA, manifest refraction, vitreoretinal changes, retinal nerve fiber layer (RNFL) thickness, and macular volume (spectral domain OCT) were evaluated at baseline and at 1 and 6 months after LASIK. The posterior segment changes were correlated with suction time. Results: Mean baseline SEQ was -4.33 ± 2.01 D. LogMAR UDVA of ≤ 0 (≥ 20/20) was achieved in 89.6% and 93.8% eyes at 1 and 6 months, respectively. No significant change was seen in RNFL thickness, macular volume, or peripheral retina post-surgery (P > .5). There was no significant correlation between intraoperative suction time and RNFL changes (r = 0.049, P = .560). Conclusion: Intraoperative suction time did not correlate with RNFL changes after femtosecond LASIK. There were no adverse effects on posterior segment.

Corneal Shape and Optical Properties: What Is the Ideal Wavefront Error Representation for Clinical Use?
Abstract #: RP30053454

Senior Author: Jens Buehren MD
Coauthor: Thomas Kohnen MD PhD FEBO

Purpose: To compare the efficacy of wavefront error (WFE) representations to describe both corneal shape and image quality. Methods: From tomography scans of 792 normal eyes, corneal WFEs were calculated. From 27 Zernike coefficients, a principal component analysis was performed. For comparison, WFEs were described with Zernike coefficients, with the root mean square (RMS) of Zernike orders 2-6 (orders) and with the RMS of all lower orders, coma, spherical, and residual aberrations (LCSR). For each WFE, the optical quality metric VSOTF was computed. The number of components to explain 95% of the VSOTF variance was compared. Results: Peel-tests revealed a significantly stronger adhesion of the flap in LASIK+CXL-treated eyes compared to LASIK (P < .05). Extensometry did not show a difference between the groups. Conclusion: Interface bonding after LASIK+CXL increases the adhesion between the flap and the stromal bed; however, the compensation for the biomechanical defect induced by LASIK is questionable.
Three-Dimensional Corneal Collagen Crosslinking Demarcation Band to Evaluate Corneal Flattening Effect from Treatment: Pilot Study

Abstract #: RP30053463

Senior Author: Dan Wen MD PhD
Coauthors: Sonia H Yoo MD, Ibrahim Osama Sayed-Ahmed MBBCh MD, Amr ElSawy, Mohamed Abdel-Mottaleb PhD, Mohamed F Abou Shousha MD

Purpose: To evaluate the correlation between 3-dimensional (3-D) corneal collagen crosslinking (CXL) demarcation band tomography maps and localized treatment flattening effect.

Methods: 3-D tomography maps of demarcation band thickness and depth were created from high-definition OCT (HD-OCT) images of 5 patients who underwent CXL 1 month earlier. Each map was divided into 18 regions (90 regions total). Correlations between demarcation band depth and thickness and localized corneal curvature changes were evaluated. Results: There was significant negative correlation between depth of demarcation band and the localized postoperative flattening effect ($R = 0.5, P < .001$). Significant positive correlation was noted between demarcation band thickness and localized postoperative flattening effect ($R = 0.5, P < .001$). Conclusion: 3-D CXL demarcation band tomography maps can be created from HD-OCT images. Shallower and thicker demarcation bands are accompanied by more localized postoperative flattening effect.

Epithelial Remodeling after Accelerated Corneal Crosslinking

Abstract #: RP30053467

Senior Author: Ilyse D Haberman MD
Coauthors: Alvaro Fidalgo MD, Sang Woo Kim, J Bradley Randleman MD

Purpose: To evaluate changes in corneal epithelial thickness after accelerated corneal crosslinking (A-CXL) in eyes with keratoconus using spectral domain OCT (SD-OCT). Methods: Prospective interventional study using anterior segment SD-OCT to compare regional corneal epithelial thickness in eyes with keratoconus before and 1, 3, 6, and 12 months after A-CXL. Results: Prior to A-CXL, epithelium was thinnest in the inferior inner and outer temporal regions. Twelve months after A-CXL, epithelium was significantly thinner in the outer nasal, inner nasal, outer inferonasal, inner inferonasal, outer inferior, outer inferotemporal, and outer temporal regions ($P < .05$). There was no change in these regions from 6 to 12 months. Epithelial thickness standard deviation was reduced by 3 months ($P = .09$) and remained stable at 1 year ($P = .009$). Conclusion: Significant epithelial remodeling occurs after A-CXL. Epithelium becomes thinner in preoperatively thicker regions, becomes more regular over the first 6 months, and stabilizes by 1 year.

Long-term Outcome of Intrastromal Corneal Ring Segment in Keratoconus

Abstract #: RP30053468

Senior Author: Choun-ki Joo MD
Coauthors: Mihyun Choi MD, Minji Kang, Ji-hye Lee MD, Young-Sik Yoo, Woong-Joo Whang MD

Purpose: The aim of this study was to evaluate the effect of intrastromal corneal ring segment (ICRS) in keratoconus over 5 years. Methods: Retrospective chart review; 23 eyes included. Visual acuity, refraction, keratometer, thinnest corneal thickness, and higher-order aberration were evaluated preoperatively and at 2 months and at 1, 3, and 5 years postoperatively. Results: Uncorrected and best corrected visual acuity were improved and maintained until 3 years ($P < .05$). Spherical equivalent and keratometer were improved at 2 months and maintained until 3 years, but it then worsened to levels similar to preoperatively ($P < .05$). Vertical coma was improved consistently for 5 years ($P < .05$). Conclusion: ICRS in keratoconus is effective in correcting astigmatism and visual acuity for 3 years and also helpful in halting the progression for 5 years.

Effect of Corneal Inlay Implantation Depth on Visual Outcomes

Abstract #: RP30053471

Senior Author: Jay Stuart Pepose MD PhD

Purpose: To evaluate the effect of small-aperture corneal inlay implantation depth on visual outcomes. Methods: A retrospective evaluation of 166 presbyopic emmetropes implanted monocularly in the nondominant eye. A femtosecond laser-created pocket was created at a depth of between 200 and 270 μm. The total corneal thickness of the patients was between 500 and 640 μm (mean: 553 ± 28 μm). Patients were stratified into 2 groups based on pocket depth: < 40% total corneal thickness (Shallow) and > 40% total corneal thickness (Deep). Visual acuity, corneal hazy, and removal rate were compared between groups at 3 years postop. Results: The Deep group achieved 1 line greater uncorrected near visual acuity than the Shallow group at 5 years. Six percent of patients in the Shallow group experienced hazy formation, vs. 3% in the Deep group. No inlays were removed from the Deep group, vs. 2% of the Shallow group. Conclusion: Deep implantation of a corneal inlay results in better visual acuity, less incidence of haze formation, and lower removal rate than Shallow implantation.

Sequential Customized Therapeutic Keratectomy for Severe Salzmann Corneal Nodular Degeneration: Long-term Follow-up

Abstract #: RP30053476

Senior Author: Paolo Vinciguerra MD
Coauthors: Fabrizio I Camesasca MD, Silvia Trazza, Ismael Zaed, Riccardo Vinciguerra MD

Purpose: To report long-term outcome of sequential customized therapeutic keratectomy (SCTK) for Salzmann nodular degeneration (SND) causing severe visual acuity reduction. Methods: Twelve eyes of 7 patients with SND (mean age: 68.57 years) underwent mechanical pannus removal and excimer laser SCTK. Mean preoperative visual acuity (VA) was 0.60 ± 0.77 logMAR with 3.48 D sphere, −1.73 D cylinder mean correction. Mean pupillary K was 43.09 D, and mean pachymetry was 561.18 ± 53.38 μm. Results: Four years after surgery, mean VA was 0.16 ± 0.64 logMAR with +1.25 D sphere, −1.73 D cylinder mean correction. Mean pupillary K was 42.08 D, and mean pachymetry was 561.18 ± 53.38 μm. No patient underwent corneal transplant, and no disease recurrence was observed. Conclusion: Four years after SCTK, eyes showed improved VA and stable refraction. More invasive procedures, such as penetrating keratoplasty or deep anterior lamellar keratoplasty, were avoided.
Difficult Lenticule Extraction in Learning Curve of Small-Incision Lenticule Extraction
Abstract #: RP30053479

Senior Author: Jeewan S Tilial MD
Coauthors: Manpreet Kaur MD, Anubha Rathi, Ruchita Clara Falera
Purpose: To describe management of difficult lenticule extraction observed during the initial learning curve of small-incision lenticule extraction (SMILE). Methods: Prospective evaluation of 100 eyes with myopia (spherical equivalent −1 to −10 D) undergoing SMILE was undertaken. Management and outcomes of cases with difficult lenticule extraction were noted. Results: Difficult lenticule extraction was observed in 9% of cases (9/100). It resulted in anterior cap tear (1%), side cut tears (4%), partially retained lenticule (1%), and completely retained lenticule (2%). Its incidence decreased from 16% (8/50) in the initial 50 cases to 2% (1/50) in the next 50 cases. Two eyes with completely retained lenticule were retreated with flap-based excimer laser ablation after 3 months. Optimal visual and anatomical outcomes could be achieved in all cases. Conclusion: Lenticule dissection and extraction leads to a multitude of complications and delayed visual recovery, although eventual outcomes are satisfactory.

Visual, Refractive, and Aberrometric Outcomes of a New Asymmetric Intracorneal Ring Segment
Abstract #: RP30053481

Senior Author: Jorge L Alió MD PhD
Coauthors: Alfredo Vega-Estrada MD, Elisabet Chorro PhD, Rafael Barraquer MD PhD
Purpose: To analyze the results of a new intrastromal corneal ring (V-R Technology) for keratoconus treatment. Methods: Prospective study including 21 eyes. Ophthalmic examination included uncorrected distance (UDVA) and corrected distance visual acuity (CDVA), refractive status, and corneal aberrations. An asymmetric 340° arc length intracorneal ring segment was implanted; follow-up was 12 months. Results: UDVA and CDVA (decimal scale) went from 0.18 ± 0.25 and 0.37 ± 0.29 preoperatively to 0.22 ± 0.21 and 0.41 ± 0.15 postoperatively, respectively (P < .05). Spherical equivalent was −9.63 ± 6.23 D preoperatively and −5.74 ± 5.60 D postoperatively (P > .05). Total higher-order aberrations went from 10.93 ± 8.61 µm to 5.81 ± 5.39 µm (P = .05). Conclusion: The new V-R technology improves the visual, refractive, and aberrometric variables in keratoconus patients.

Identification of Optimal Optical Zone to Transitional Zone Ratio in Refined Single-Step Transepithelial PRK
Abstract #: RP30053485

Senior Author: Soheil Adib-Moghaddam MD
Coauthor: Saeed Soleiman-Jahi MD PhD
Purpose: To investigate the optimal range of optical zone to transitional zone (OZ-to-TZ) ratio based on postoperative quality of vision. Methods: An 18-month follow-up study of 138 eyes with myopia ± astigmatism undergoing refined single-step transepithelial PRK. Multiple regression modeling and ROC curve analyses were used. Results: Adjusting for other parameters, using OZ-to-TZ ratios of 4-5, or > 7, resulted in better results compared to OZ-to-TZ ratio < 4 (P < .05). Ratios in the range of 5-6 had results similar to ratios < 4 (P ≥ .6). According to ROC curve analysis, range cut-off value of 4.4 has acceptable validity in predicting better outcomes. Conclusion: We found that OZ-to-TZ ratios in ranges of 4-5 or > 7 result in better outcomes.

An OCT-Based Comprehensive Classification System of Corneal Shape Irregularities
Abstract #: RP30053489

Senior Author: David Huang MD PhD
Purpose: To develop a classification system of corneal shape irregularities based on OCT’s unique ability to map epithelial thickness, pachymetry, and anterior / posterior topography. Methods: Four types of corneal irregularities were studied: (1) forme fruste keratoconus (FFK), (2) epithelial deformation (warpage), (3) stromal subtraction (dystrophy), and (4) nonectatic stromal distortion (PK). Corneal maps were obtained by a commercial OCT system (Avanti). Epithelial pattern standard deviation (Epi-PSD) and 4 novel composite indices were calculated. Results: The study included 15 normal, 45 keratoconus, 8 FFK, 11 warpage, 5 granular dystrophy, and 2 post-PK eyes. Epi-PSD was normal for all control eyes and abnormal for 96.1% of irregular eyes. Classification was correct in 100% of keratoconus eyes, 71% of FFK (100% for pure FFK and 50% for FFK + contact lenses), 100% of warpage, 80% of granular dystrophy, and 100% of post-PK eyes. Conclusion: The OCT-based classification was accurate except in mixed types.

Small-Aperture Inlay Implantation for Correction of Presbyopia: Six-Month Outcomes
Abstract #: RP30053495

Senior Author: William F Wiley MD
Purpose: To evaluate change in visual acuity over 6 months following small-aperture inlay surgery. Methods: 223 patients (107 male, 91 female; mean age: 52 years) were implanted with a Kamra inlay (AcuFocus) in a femtosecond laser–created corneal pocket in the patient’s nondominant eye. Monocular unaided acuity at distance (UDVA) and near (UNVA) were measured out to 6 months. Results: UDVA in the inlay eye was 20/40 or better in 60% at 1 day, in 77% at 1 month, and in 97% at 6 months. UNVA was 20/40 or better in 40% at 1 day, in 92% at 1 month, and in 95% at 6 months. UDVA of 20/25 or better was observed in 33% at 1 day, in 43% at 1 month, and in 61% at 6 months. UNVA of 20/25 or better was achieved by 15% at 1 day, 55% at 1 month, and 63% at 6 months. Conclusion: Unaided acuity continues to improve with time following inlay implantation.
Maximizing Visual Recovery with Same-Day LASIK and a Small-Aperture Inlay
Abstract #: RP30053498
Senior Author: Ronald Luke Rebenitsch MD
Purpose: To determine if same-day LASIK and small-aperture inlay can improve visual recovery and results over inlay alone.
Methods: Ongoing study of over 110 patients undergoing same-day LASIK and small-aperture inlay. Over 50% have at least 6-month data as of current date. LASIK was performed in the dominant eye if not already plano. Visions were recorded at preop and at 1 day, 1 week, 1 month, 3 months, and 6 months postop. Results: Monocular geometrically averaged uncorrected distance visual acuity at the above time points were the following: 20/38, 20/30, 20/29, and 20/27. Binocular geometrically averaged uncorrected near visual acuity were the following: 20/98, 20/80, 20/30, 20/28, 20/29. Conclusion: Same-day LASIK + small-aperture inlay not only improves visual results over previous reports of inlay placement alone, but it also increases the speed of visual recovery.

Comparison of Corneal Wavefront Aberrations before and after Treatment of Transepithelial Crosslinking (Epi-On) vs. Stromal Crosslinking (Epi-Off) in Subjects with Progressive Keratoconus
Abstract #: RP30053500
Senior Author: Ricardo Blas MD
Coauthors: Alejandro Navas MD, Arturo J Ramirez-Miranda MD, Enrique O Graue Hernandez MD
Purpose: To compare the values of corneal wavefront aberrations in subjects with keratoconus before and after epi-on and epi-off crosslinking (CXL) procedures. Methods: Prospective, comparative, nonrandomized, interventional study of 36 eyes of 22 subjects. Epi-off (20 eyes) or epi-on (16 eyes) CXL techniques were performed. The uncorrected and corrected distance visual acuities, keratometric values, root mean square (RMS), and vertical coma were determined at baseline and at 12 months postoperatively. Results: A total of 36 eyes with documented progressive keratoconus were included. The RMS and vertical coma pre- and postoperative values were compared, being statistically significant only in the epi-off group (P = .03) at the 12-month follow-up. Conclusion: Results of CXL at 12 months show that both procedures are safe. Epi-off CXL may be effective in halting the progression of keratoconus and aberrometric changes due to ectatic disorders, resulting in an improvement in RMS corneal wavefront aberrations.

Regional Epithelial Thickness Changes after Combined Intracorneal Ring Segments Placement and Collagen Crosslinking
Abstract #: RP30053504
Senior Author: Claudia E Perez-Straziota MD
Coauthors: Karolinne M Rocha MD, Yaron S Rabinowitz MD, Ronald N Gaster MD FACS, Jorge Haddad MD
Purpose: To assess epithelial thickness profile changes after combined intracorneal ring segment (ICRS) and standard collagen crosslinking (CXL) for the treatment of keratoconus. Methods: Retrospective analysis of OCT epithelium measurements in 20 eyes 1, 3, 6, 12, 24, and 36 months after combined ICRS and standard CXL. Results: There was significant thinning super-riorly, up to 10 microns by Month 3, with subsequent inferior thickening, up to 9 microns by Month 6, with no changes after Month 12. Corneal epithelial thickness standard deviation did not change significantly after treatment. Conclusion: Epithelial thickness remodeling after combined ICRS and CXL minimally improves surface regularity.

Topical Treatment of Presbyopia
Abstract #: RP30053512
Senior Author: Felipe A Soria MD
Coauthors: Veronica Vargas MD, Felipe Vejarano, Antonio Renna PhD, Jorge L Alió MD PhD
Purpose: To analyze a novel topical therapy (FOV tears) for presbyopia. Methods: Thirty-two patients were given 1 drop of the new therapy binocularly every 8 hours. The corrected and uncorrected distance visual acuities, uncorrected near visual acuity, and best corrected late-night visual acuity were assessed prior to the administration of the eye drop and 1 week after administration. Results: There was an improvement of 1-3 lines from baseline in near uncorrected visual acuity in 96.8% of the patients without affecting the distance vision. 15.6% reported headaches of borderline tolerance. Conclusion: This novel treatment has the advantage of being noninvasive; it is binocularly instilled and does not rely on monovision.

Intraocular Refractive Surgery
Evaluation of a Novel Enhanced Depth of Field IOL
Abstract #: RP30053354
Senior Author: Florian T A Kretz MD
Coauthors: Matthias Mueller PhD, Detlev R H Breyer MD, Karsten Klabe MD, Hakan Kaymak MD, Gerd U Auffarth MD, Matthias Gerl
Purpose: To evaluate postoperative functional results after binocular implantation of a novel enhanced depth of focus IOL (EDOF-IOL). Methods: In a prospective study, patients received an EDOF-IOL (AT Lari 809MP, Carl Zeiss Meditech; Germany) binocular during cataract surgery. Pre- and postoperatively, monocular and binocular functional results (uncorrected distance and intermediate visual acuity, corrected distance VA, distance-corrected near VA, uncorrected near VA, and defocus curve) were evaluated. Results: Postoperative binocular visual acuity for distance and intermediate was exceptional, with a high satisfaction for near function. Binocular defocus curve analysis shows very high values for distance to −2 D, with still functional near vision. Conclusion: The new EDOF-IOL offers better results for intermediate visual acuity, with less photic phenomena than regular trifocal IOLs.
Comparison of IOL Calculations in Post–Refractive Surgery Cataract Eyes Using an OCT-Based Formula and the ASCRS IOL Calculator

Abstract #: RP30053365

Senior Author: Neeraj Singh Chawla
Coauthors: Saneha Kaur Chaillert Borisuth, Navaneet S C Borisuth MD PhD

Purpose: Single-surgeon retrospective analysis comparing an OCT-based IOL formula to the ASCRS IOL calculator in post–refractive surgery eyes undergoing phacoemulsification (PE) with standard (SV) and premium IOL (P-IOL) implants.

Methods: We analyzed 70 eyes of 44 patients undergoing SV (n = 39) or P-IOL (n = 14 toric, 17 multifocal) implantation. Postop refractive data were used to compare back-calculated optimum IOL powers (BCO) and to derive the absolute prediction error (AE).

Results: BCO was most accurate for the Barrett TrueK (0.43), ASCRS average (0.44), OCT (0.47), Masket (0.49), Modified Masket (0.56), Haigis-L (0.56), and Shammas (0.64). Eighty-four percent and 100% of eyes were within ±0.5 D and ±1 D of target refraction, respectively.

Conclusion: The Barrett TrueK, average ASCRS, and OCT-based formulas most effectively predicted refractive outcomes, although all the formulas performed well in post–refractive surgery IOL implantation.

The Long-term Outcomes of Iris Fixation of 3-Piece Foldable IOL in Aphakia, Lens Subluxation, or IOL Dislocation

Abstract #: RP30053386

Senior Author: Yasar Kucuksumer MD
Coauthors: Cigdem Altan MD, Kadir I Cankaya, Can Kocasarac

Purpose: To evaluate the long-term outcomes of iris-fixation technique with a 3-piece foldable posterior chamber IOL (PC-IOL) for treatment of aphakia, lens subluxation, and dislocated IOL.

Methods: Forty-two eyes of 42 consecutive patients were enrolled in this retrospective, noncomparative, interventional case series. All patients underwent iris-fixated foldable PC-IOL implantation with PC-9 Prolene suture. The patients with less than 6 months follow-up were excluded. Main outcome measures included change in visual acuity (VA) and complications.

Results: The mean follow-up time was 17.2 months. There was no intraoperative complication except minor hemorrhage. The VA improved from 0.14 ± 0.17 to 0.38 ± 0.32 (≥ 0.001). The early postoperative complications were corneal edema in 7, positive Seidel test in 2, and hyphema in 2 eyes. The late postoperative complications were IOL decentralization in 2 and glaucoma in 3.

Conclusion: The iris-fixation technique with a foldable PC-IOL is safe and effective in the long term.

Correlation between Intraoperative OCT and Optical Biometry

Abstract #: RP30053404

Senior Author: Jorge Haddad MD
Coauthors: Karolinne M Rocha MD, George O Waring IV MD, Kaileen Yeh BA

Purpose: To correlate clinical parameters and optical biometry measurements (IOLMaster, Carl Zeiss) with intraoperative anterior segment OCT (Catalys, J&J).

Methods: Optical biometry measurements (axial length, corneal power, and anterior chamber depth) were correlated with intraoperative anterior segment OCT parameters: lens thickness (LT), lens meridian position, anterior chamber depth (ACD), aqueous depth (AD), and central corneal thickness (CCT).

Results: 588 eyes were enrolled in this study. A positive correlation was observed between lens meridian position and ACD (Pearson correlation coefficient = 0.58, P < .001), and a positive correlation was observed between axial length and ACD (Pearson correlation coefficient = 0.45, P < .001).

Conclusion: Intraoperative anterior segment OCT measurement of lens thickness and lens meridian position may have future implications for predictive biometric modeling, IOL sizing, and effective lens position.

Repeatability of White-to-White Measurement and Its Comparison with Sulcus Diameter to Evaluate Appropriateness of Selected Implantable Collamer Lens Size

Abstract #: RP30053453

Senior Author: Rajesh Sinha MBBS
Coauthors: Malikireddy Sravanrhi Jr MD, Jeewan S Titiyal MD, Tushar Agarwal MD, Sudarshan K Khokhar MD FRCS(Ed), Namrata Sharma MD MBBS

Purpose: To study the posterior segment changes in myopia after femtosecond LASIK and correlate them with the suction time. Methods: Prospective evaluation of 142 myopic eyes (spherical equivalent refraction [SEQ] range: −1 to −12 D) undergoing femtosecond LASIK was undertaken. Intraoperative total suction time was noted. Uncorrected distance (UDVA) and corrected distance (CDVA) visual acuities, manifest refraction, vitreoretinal changes, retinal nerve fiber layer (RNFL) thickness, and macular volume (spectral domain OCT) were evaluated at baseline and 1 and 6 months after LASIK. The posterior segment changes were correlated with suction time.

Results: Mean baseline SEQ was −4.33 ± 2.01 D. LogMAR UDVA of ≤ 0 (≥ 20/20) was achieved in 89.6% and 93.8% of eyes at 1 and 6 months, respectively. No significant change was seen in RNFL thickness, macular volume, or peripheral retina post-surgery (P > .5). There was no significant correlation between intraoperative suction time and RNFL changes (r = 0.049, P = .560).

Conclusion: Intraoperative suction time did not correlate with RNFL changes after femtosecond LASIK. There were no adverse effects on the posterior segment.
**Post-LASIK Ectasia and Pigmentary Glaucoma**

**Abstract #: RP30053458**

**Senior Author: Ana Laura Caiado Canedo MD**

**Coauthors: Isaac Ramos MD, Marcella Q Salomão MD, Rosane Oliveira Correa MD, Renato Ambrosio Jr MD PhD**

**Purpose:** To present a case of post-LASIK ectasia associated with pigmentary glaucoma. **Methods:** A 31-year-old man presented due to progressive myopic regression and visual impairment after LASIK O.U. No previous ocular disease, and negative family history of glaucoma. Uncorrected distance visual acuity (UDVA) was 20/60 O.D. and 20/80 O.S. Corrected distance VA was 20/20 O.D. with –2.0, and 20/50 O.S. with –1.25. Ectasia was confirmed by Pentacam HR corneal tomography O.U., being more advanced O.S. Pigment dispersion syndrome was detected by slitlamp biomicroscopy with Krukenberg spindle. Goldman applanation tonometry was 18 mmHg O.U. Corneal compensated IOP by Ocular Response Analyzer was 49.1 and 44.4, and IOP by Corvis ST was 52.5 O.D. and 61.5 O.S. One day after timolol and topical carbonic anhydrase inhibitor, IOP was reduced O.U., with flattening and regularization of the cornea and improvement in UDVA to 20/30 O.D. and 20/40 O.S. **Conclusion:** Post-LASIK ectasia may present with secondary glaucoma, and reduction of IOP may dramatically change corneal shape. Refractive surgeons must be aware of the importance of proper IOP assessment after laser vision correction.

**Femtosecond Laser–Assisted Cataract Surgery and Conventional Phacoemulsification in Post-Vitrectomized Eyes**

**Abstract #: RP30053477**

**Senior Author: Rajesh Sinha MBBS**

**Coauthors: Mohamed Ibrahim Asif MBBS, Tusar Agarwal MD, Namrata Sharma MD MBBS, Jeewan S Titiyal MD**

**Purpose:** To compare the outcome of femtosecond laser–assisted cataract surgery (FLACS) and conventional phacoemulsification (CP) in post-vitrectomized eyes. **Methods:** Patients with cataract following vitreoretinal surgery were enrolled. FLACS was performed in Group 1 (n = 15) and CP in Group 2 (n = 15). Intraoperative phaco energy (cumulative dissipated energy, or CDE) was noted. **Results:** The mean CDE was 8.11 ± 6.42 percent seconds in Group 1 and 15.83 ± 13.17 percent seconds in Group 2. The mean endothelial cell loss was 4.46 ± 2.6% and 5.35 ± 3.19% at 1 week and 3 months, respectively, in Group 1 and 9.08 ± 3.5% and 11.94 ± 8.7% at 1 week and 3 months, respectively, in Group 2. The mean increase in central corneal thickness was 0.78% at 1 day and 0.65% at 1 week in Group 1, and 1.89% at 1 day and 1.42% at 1 week in Group 2. **Conclusion:** FLACS had significantly less intraoperative energy use, leading to less endothelial damage and less postoperative corneal edema than in conventional phacoemulsification.

**Evolving Indications for Implantable Collamer Lens ICL Explant**

**Abstract #: RP30053480**

**Senior Author: Manpreet Kaur MD**

**Coauthors: Jeewan S Titiyal MD, Rajesh Sinha MBBS, Namrata Sharma MD MBBS**

**Purpose:** To evaluate reasons for explantation of implantable collamer lens (ICL) and to report visual and anatomical outcomes. **Methods:** Eleven cases that underwent ICL explantation in the last 3 years were retrospectively analyzed for indications of ICL explant and outcomes. **Results:** Reasons for ICL explantation were chiped haptic during insertion (1/11), preparatory phacoemulsification before vitreoretinal surgery (2/11), post-traumatic ICL dislocation (1/11), nuclear sclerosis (1/11), silicone oil–induced cataract (1/11), anterior subcapsular cataract (1/11), high vault with raised IOP (1/11), shallow vault with recurrent uveitis (1/11), and acute postoperative endophthalmitis (1/11). Corrected distance visual acuity was ≥ 20/25 in 63.6% of cases. Concomitant phacoemulsification with IOL implantation was performed in 7 cases. **Conclusion:** Vault-related complications have decreased with newer-generation ICLs, and 81.8% of cases (9/11) required ICL explantation for other indications.

**Extended Depth of Focus IOL in Post–Myopic Refractive Surgery Patients**

**Abstract #: RP30053482**

**Senior Author: Kevin Lee Waltz MD**

**Coauthors: Kerry Assil MD, Stephen G Slade MD FACS**

**Purpose:** To compare the extended depth of focus IOL (EDOF-IOL) results in post–refractive surgery eyes to those with no prior refractive surgery (RS). **Methods:** Three surgeons submitted all cases in their practice implanted with an EDOF-IOL with prior myopic RS. These cases were compared with the FDA trial patients for the EDOF-IOL. **Results:** Fifty-five eyes were indentified: 34 right eyes, 29 females, mean age: 62.6 years. All had prior myopic RS for spherical equivalent −0.25 to −8.00. Mean uncorrected distance visual acuity (UCDVA) was 20/24.3 vs. 20/25 in FDA trial patients. Mean best corrected distance visual acuity (BCDVA) was 20/21.7 vs. 20/20 in FDA trial patients. **Conclusion:** No statistically significant differences were noted between the post-myopic RS patients and the FDA trial patients.
Review of Objective and Subjective Outcomes of 3 Different Presbyopic IOLs
Abstract #: RP30053494
Senior Author: Kevin Tomasko Jr MD
Coauthors: Allison Kade Fox BA MS, Kevin J Everett MD
Purpose: To compare subjective and objective outcomes of patients who underwent implantation of either Symfony, ReSTOR AF, or ReSTOR 3.0 IOL. Methods: 173 eyes from 121 patients were implanted with Symfony, ReSTOR AF, or ReSTOR 3.0. Vision was measured at near, intermediate, and distance, and patients were asked to fill out a survey detailing their subjective visual outcomes. Results: (1) Symfony patients performed best at intermediate and appeared to be most satisfied; however, they had the most glare. (2) ReSTOR AF patients did best at distance vision and were most likely to be glasses free. (3) ReSTOR 3.0 delivered the best near vision. Conclusion: Symfony and Restor AF patients were most satisfied overall. ReSTOR 3.0 appears best for near.

Visual Results and Defocus Curve with 3 Different IOLs
Abstract #: RP30053501
Senior Author: Luis Izquierdo Jr MD
Coauthors: Maria A Henriquez MD, Rocio Araujo, Josefin Mejias MD, Carlos Enrique Atayala Marin MD
Purpose: To evaluate visual acuity (VA) and defocus curve after cataract surgery with bilateral extended range of vision IOL, mix and match (1 eye with ZXR00 IOL and the other with Tecnis ZMB00 IOL), and bilateral trifocal IOL. Methods: Prospective cohort study that included 90 patients having cataract surgery: 30 patients with mix and match (Group 1), 30 with bilateral Tecnis Symfony ZXR00 IOL (Group 2), and 30 with bilateral AcrySof IQ PanOptix (Group 3). At 3 months postoperatively, VA, refraction, and defocus curve were measured. Results: Mean uncorrected VAs for distance were 0.06, 0.18, and 0.06 logMAR in Groups 1, 2, and 3, respectively (P = .20). Mean near uncorrected VAs were 0.18, 0.21, and 0.19 logMAR in Groups 1, 2, and 3, respectively, and there were statistically significant differences between groups (P = .03). Conclusion: The 3 IOLs showed excellent uncorrected distance and near visual acuity; however, the trifocal IOL and mix and match had better near VA.

Clinical Outcomes and Patient Satisfaction after Implantation of bifocal and trifocal IOLs: Twenty-Four-Month Follow-up
Abstract #: RP30053513
Senior Author: Jorge L Alió MD PhD
Coauthors: Antonio Renna PhD, Ana Belen Plaza, Renan Ferreira Oliveira
Purpose: To assess clinical outcomes and patient satisfaction after bilateral implantation of bifocal or trifocal IOLs. Methods: Prospective controlled observational study including 2 cohorts: (1) 16 patients with bifocal AcrySof ReSTOR +3.0D and (2) 12 patients with trifocal AT LISA 839MP. Assessment at 24 months postoperatively included uncorrected distance, intermediate, and near visual acuities (UDVA, UIVA, UNVA), contrast sensitivity (CSF), and a self-administered questionnaire (VFQ-25). Results: Group 1 (bifocal) showed better binocular UNVA (P = .04) and mesopic CSF at 3 cpd (P = .03), whereas Group 2 (trifocal) showed higher overall patient satisfaction (P = .03). Conclusion: Both IOLs showed very good outcomes, with trifocal IOLs providing higher patient satisfaction.

The Journal of Refractive Surgery’s Hot, Hotter, and Hottest—Late Breaking News
Evaluation of a New Mix and Match Approach with an Extended Depth of Field Trifocal and a Trifocal IOL
Abstract #: RP30053353
Senior Author: Florian T A Kretz MD
Coauthors: Matthias Gerl, Detlev R H Breyer MD, Hakan Kaymak MD, Karsten Klabe MD, Matthias Mueller PhD
Purpose: To evaluate a novel enhanced depth of focus (EDOF) IOL in the distance-dominant eye and a trifocal IOL in the near-dominant eye. Methods: In a prospective study, patients received an EDOF-IOL (AT Lara 809MP, Carl Zeiss) in their distance-dominant eye and a trifocal IOL (AT LISA 839MP, Carl Zeiss) in their near-dominant eye. Pre- and postoperative, monocular, and binocular functional results (UDVA, UIVA, CDVA, DCNVA, UNVA, and defocus curve) were evaluated. Results: Postoperative visual acuity for all distances has significantly increased compared to preoperatively. Binocular defocus curve analysis shows less drawdown in the intermediate range compared to binocular trifocal IOL implantation. Conclusion: The mix and match approach with an EDOF IOL in the distance-dominant and a trifocal IOL in the near-dominant eye seems to get better results for intermediate visual acuity while offering patients a higher degree of spectacle independency.
Small-Incision Lenticule Extraction Retreatments by Thin Flap LASIK

**Abstract #: RP30053357**

**Senior Author:** Dan Z Reinstein MD  
**Coauthors:** Glenn Ian Carp MBBC, Timothy J Archer MS

**Purpose:** To report outcomes of LASIK retreatments after small-incision lenticule extraction (SMILE)  
**Methods:** Review of LASIK retreatments after SMILE at London Vision Clinic (N = 100). Max epithelial and min cap thickness were used to confirm it was safe to create a flap. A nomogram for consecutive myopic LASIK was used. Follow-up was 1 year. **Results:** Mean attempted spherical equivalent refraction (SEQ) was −0.04 ± 0.99 D (−1.88 to +1.50 D). Mean cylinder was 0.70 ± 0.53 D (0.00 to 2.25 D). Postop uncorrected distance visual acuity was 20/20 or better in 83% of eyes. Mean postop SEQ was +0.19 ± 0.46 D (−0.88 to +2.13 D), with 81% within ±0.50 D. There was 1 line of corrected distance visual acuity loss in 15% of eyes, but no eyes lost ≥ 2 lines. Overcorrection was identified in myopic retreatments (n = 20) of −1.00 D or more; mean postop SEQ was +0.59 ± 0.64 D. **Conclusion:** Retreatment after SMILE by LASIK achieved excellent visual and refractive outcomes, although it appears that LASIK for consecutive myopia after SMILE requires a different nomogram than consecutive myopic LASIK.

Repeatability and Reproducibility of VHF Digital Ultrasound for Posterior Segment Dimensions

**Abstract #: RP30053358**  
**Senior Author:** Dan Z Reinstein MD  
**Coauthors:** Amy T Kelmenson MD, Jason M Jacobs MD, Timothy J Archer MS, Tariq Lewis, Glenn Ian Carp MBBC

**Purpose:** To assess repeatability and reproducibility of VHF digital ultrasound (VHF-DU) for sulcus and lens equatorial diameter. **Methods:** Five consecutive scans were obtained for 10 eyes using the Insight 100 VHF-DU by 2 operators. Sulcus and lens equatorial diameter were measured. Repeatability and reproducibility analysis was performed by ANOVA. Standard deviation, coefficient of repeatability (COR, 2.77 x SD), and coefficient of variation (COV, SD/mean) were calculated. **Results:** Sulcus diameter repeatability was 0.12 mm (COR 0.34 μm, COV 1.13%), and reproducibility was 0.019 mm (COR 0.052 μm, COV 0.17%). Lens equatorial diameter repeatability was 0.13 mm (COR 0.36 μm, COV 1.30%), and reproducibility was 0.024 mm (COR 0.065 μm, COV 0.24%). **Conclusion:** Measurement of sulcus and lens equatorial diameter showed high repeatability and reproducibility for the Insight 100 VHF-DU.

Microscope-Integrated Intraoperative OCT-Guided SMILE: Novel Surgical Technique

**Abstract #: RP30053368**  
**Senior Author:** Jayanand Urkude MD  
**Coauthors:** Namrata Sharma MD DNB MNAMS, Jeewan S Titiyal MD, Manthan Hasmukhbhai Chaniyara MD DNB FICO

**Purpose:** To study efficacy and outcomes of microscope-integrated intraoperative OCT (MI OCT)-guided small-incision lenticule extraction (SMILE). **Methods:** MI OCT-guided SMILE was done in 6 eyes. **Results:** After an intrastromal lenticule was created using a femtosecond laser, patients were shifted under MI OCT. The desired plane of dissection was achieved by tracking the tip of dissector under direct visualization of MI OCT scans. The dissector was passed anterior to the lenticule and advanced only when its tip was visualized under MI OCT. If the tip of the dissector was posterior to the lenticule, a corrective step was performed. Complete separation of the lenticule was confirmed by the presence of 2 hyper-reflective planes of the lenticule. After lenticule extraction, the empty interface was screened for the presence of any residual lenticule. Successful lenticule extraction was possible in all eyes. One month postoperatively all eyes had uncorrected distance visual acuity of 20/20. **Conclusion:** MI OCT-guided SMILE gives real-time feedback, which can influence surgical decision making, thus increasing precision, safety, and reproducibility.

Cosmetic Artificial Iris Implantation Following Small Incision Lenticule Extraction (SMILE)

**Abstract #: RP30053362**  
**Senior Author:** Georges D Baikoff MD  
**Coauthors:** Jigisha S Joshi MD, Zulfiqar Ali MD, Manthan Hasmukhbhai Chaniyara MD DNB FICO, Namrata Sharma MD, Alan Tumay MD, S Sarah Chaniyara MD DNB FICO

**Purpose:** To alert cornea surgeons that corneal collagen cross-linking (CXL) for patients with keratoglobus, either epi-off or epi-on, can result in serious complications. **Methods:** A 60-year-old female presented with declining vision and was diagnosed with progressive keratoconus (KC). Her treatment, subsequent complications, and eventual correct diagnosis will be presented. She was seen in our office 2 years after the procedures were performed and the complications had resolved. **Results:** Epi-off CXL was performed O.D., resulting in “spontaneous” perforation that was successfully treated. Several months later, the O.S. was noted to progress. A different surgeon performed epi-on CXL O.S., and a “spontaneous” perforation occurred and was successfully treated. **Conclusion:** The patient was found to have uniformly thin corneas O.U. out to the periphery, which was diagnosed as keratoglobus. CXL for keratoglobus may be associated with serious complications.
Transepithelial Topography and OCT-Guided Custom Ablation for Enhancement of Myopic Regression after Myopic Laser Surgery
Abstract #: RP30053377
Senior Author: Wen Zhou MD MS
Coauthor: Aleksandr Stojanovic MD

Purpose: To evaluate the outcomes of transepithelial topography and OCT-guided ablation in corneas with regression after previous myopic refractive surgery. Methods: A retrospective case series of 50 eyes with regression after myopic laser surgery underwent enhancements. Ablation was based upon data from corneal topography, while the epithelial ablation depth was guided by OCT. Results: Safety and efficacy indexes of the retreatment were 1.07 and 0.89, respectively. At their last follow-up 96% and 63% had an uncorrected distance visual acuity of 20/40 and 20/20 or better. Higher-order aberrations decreased significantly (P < .001). Epithelial thickness showed significant smoothening (P < .001). Conclusion: Custom retreatment guided by transepithelial topography and OCT is safe and highly effective for myopic regression in patients who have previously undergone myopic laser surgery.

PRK for Extreme Myopia with Upgraded Schwind Amaris (SmartSurfACE) Laser Beam Profile
Abstract #: RP30053379
Senior Author: David T C Lin MD
Coauthors: Simon P Holland MD, John Hogden, Murad M Al Obthani MBBS

Purpose: Photorefractive keratectomy (PRK) for extreme myopia with upgraded Schwind Amaris (SmartSurfACE) laser beam profile. Methods: Seventy-six eyes with a mean preoperative spherical equivalent refraction of −11.8 D ± 1.5 D underwent transepithelial (TE) SmartSurfACE PRK. Results: Achieved treatment: −10.1 D to −16.9 D (mean: −12.2 D). Postoperative uncorrected distance visual acuity (UCDVA) ranged from 20/15 to 20/60 (mean: 20/22 ± 4 letters). Postoperative UCDVA and CDVA correlated with preoperative CDVA with a statistically significant minimal improvement in both acuities. Mild postoperative corneal haze: 0 to 1.5 (average: 0.3 ± 0.4). Conclusion: Satisfactory results were obtained from TE PRK SmartSurfACE in extreme myopia, with good efficacy and safety.

Clinical Outcomes after Bilateral Implantation of a New Extended Depth of Focus IOL
Abstract #: RP30053384
Senior Author: Seyed Javad Hashemian MD

Purpose: To assess the visual outcomes obtained with a new diffractive extended depth of focus IOL (EDOF-IOL), the Tecnis Symfony. Methods: This study enrolled 70 eyes of 35 patients who had bilateral implantation of the EDOF-IOL, after lensectomy. Monocular and binocular uncorrected (UDVA) and corrected (CDVA) distance visual acuity, monocular and binocular UNVA and DCNVA at 40 cm, and binocular uncorrected and distance corrected intermediate visual acuity (DCIVA) at 60 cm were evaluated over 6 months. Results: Six months postoperatively, monocular UDVA and UNVA had significantly improved from preoperative measurements. The binocular UDVA and near (UNVA) and intermediate (UIVA) visual acuities were 20/30 or better in 100%, 94.2%, and 94.2% of patients, respectively. The DCVA, DCIVA, and DCNVA were 20/30 or better in 100%, 82.9%, and 82.9% of patients, respectively. More than 89.4% of patients reported no or mild halos and glare. Conclusion: Bilateral implantation of the EDOF-IOL provided good refractive and visual outcomes across all distances.

Enhancement after Myopic Small-Incision Lenticule Extraction Using Surface Ablation
Abstract #: RP30053388
Senior Author: Martin Dirisamer MD
Coauthors: Nikolaus Luft MD, Daniel Kook MD, Walter Sekundo MD, Siegfried Priglinger MD, Jakob Siedlecki MD

Purpose: This study was conducted to report the feasibility and outcomes of secondary surface ablation after small-incision lenticule extraction (SMILE). Methods: The databases of 4 independent laser centers in Germany, Austria, and Luxembourg were screened for patients who had undergone surface ablation after myopic SMILE. 1963 eyes were treated with myopic SMILE; in 43 eyes of 31 patients (2.2%), PRK retreatment was performed, with a minimum follow-up of 3 months. Results: Surface ablation resulted in a spherical equivalent of 0.03 ± 0.57 D at 3 months (P < .0001). Mean uncorrected visual acuity improved from 0.23 ± 0.20 logMAR to 0.08 ± 0.15 logMAR (P < .0001). Conclusion: Combined with the intraoperative application of mitomycin C, surface ablation seems to be a safe and effective method of secondary enhancement after SMILE.

LASIK Using Topography-Modified Refraction vs. Standard: Prospective Contralateral Eye Study
Abstract #: RP30053391
Senior Author: A John Kanellopoulos MD

Purpose: Safety and efficacy comparison of topography-modified treatment refraction (TMR) with standard. Methods: Group A was treated with TMR, and Group B, contralateral eye, was treated with SR. Fifty cases (100 eyes) were evaluated for perioperative acuity, refraction (RE), topography, tomography, wavefront analysis, pupilometry, and contrast sensitivity for at least 12 months. Results: Mean values: RE −5.5 D and −1.75 D astigmatism. Group A vs. Group B, respectively: uncorrected distance visual acuity improved from 20/200 to 20/16 vs. 20/20. Postop corrected distance visual acuity: 20/13.5 and 20/20. One line in vision gained: 55.6% vs. 27.8%; 2 lines of vision gained: 11.1% vs. 5.6%. Refractive astigmatism up to 0.5 D: 88.3% vs. 44.4%. Contrast sensitivity was superior to preop in Group A only. All differences were statistically significant. Conclusion: TMR LASIK may offer superior outcomes in topography-guided myopic LASIK. These findings may change the current clinical paradigm of the optimal subjective refraction utilized in laser vision correction.
Pediatric Corneal Crosslinking Combined with Partial Topo-Guided Excimer Normalization (Athens Protocol) for Keratoconus
Abstract #: RP30053392
Senior Author: A John Kanellopoulos MD

Purpose: To evaluate refractive, pachymetric, topometric, and visual rehabilitation changes in Athens protocol (AP) applied in pediatric keratoconus (KC). Methods: Fifty-two consecutive eyes of 34 KC patients underwent AP. We evaluated uncorrected (UDVA) and corrected (CDVA) distance visual acuity, refraction, and Scheimpflug and OCT tomography parameters for a mean of 4.5 years (3 to 11). Results: Mean changes: UDVA: 0.2 to 0.5; CDVA: 0.38 to 0.81; steepest keratometry in dipters: 49.5 ± 3.71 to 44.5 ± 1.81; index of height decentration: 0.105 to 0.054; thinnest cornea: 458 ± 27 to 395 ± 33 μm. There was no further KC progression; 1 case of late haze developed. Fifteen patients functioned without and 19 functioned with spectacles and/or soft contact lenses. Conclusion: AP appears to be a safe, effective, and predictable alternative in the management of progressive pediatric KC.

Combined Ex Vivo Femto Laser-Assisted Intracorneal Ring Segment Xenografts and Corneal Crosslinking: A Novel Technique
Abstract #: RP30053393
Senior Author: Vasilis Skouteris MD
Coauthor: A John Kanellopoulos MD

Purpose: To evaluate ex vivo the efficacy and feasibility of a new technique. Methods: Eight human donor corneas were subjected to femto-assisted intracorneal ring segment xenografts (ICRSX)—350-μm thick, 100-μm wide, 7-mm arc diameter, and 1350 arc at 90% depth, prepared from gamma-radiated porcine corneas—combined with transepithelial corneal crosslinking (CXL). Placido-based topographic, Scheimpflug-tomographic, and OCT evaluations were performed. Results: In mean values: 7.5 D flattening in topography and 6.5 in tomography mapping. OCT evaluation of ICRSX placement depth and centration. Conclusion: Porcine corneas have long been used as xenografts in cardiac surgery. ICRSX may become an alternative for myopia and/or keratoconus management.

Topography-Guided LASIK vs. Small-Incision Lenticule Extraction Change Anterior and Posterior Curvature in a Similar Fashion? A Long-term ContraLateral Eye Study
Abstract #: RP30053394
Senior Author: Vasilis Skouteris MD
Coauthor: A John Kanellopoulos MD

Purpose: To compare planned and achieved corneal stromal thickness reduction in topography-guided LASIK and small-incision lenticule extraction (SMILE) surgery in a contralateral eye study. Methods: Stromal thickness reduction was retrospectively investigated in 22 myopic patients: one eye was treated with topo-guided LASIK, and the contralateral eye, with SMILE. OCT was employed to provide pre- and post-operative pachymetry maps. Corneal thickness change was evaluated as the difference in minimum thickness between pre- and post-pachymetry. Results: Postop stromal reduction was on average 87.59 ± 29.45 μm, compared to the average programmed maximum ablation depth of 89.09 ± 25.41 μm for topo-guided LASIK and 84.91 ± 20.7 μm; 108.5 ± 22.98 μm for the SMILE cases, respectively. Conclusion: Actual objective corneal thickness reduction following topography-guided LASIK is more accurate than in SMILE, as it correlates better with the attempted vs. achieved refractive change.

Do LASIK and Small-Incision Lenticule Extraction Change Anterior and Posterior Curvature in a Similar Fashion? A Long-term ContraLateral Eye Study
Abstract #: RP30053395
Senior Author: Ioanna Kontari MD
Coauthor: A John Kanellopoulos MD

Purpose: To correlate the long-term changes in anterior corneal power (ACP) and posterior corneal power (PCP) before to those after topo-guided (TG) LASIK vs. small-incision lenticule extraction (SMILE) in a contralateral eye study. Methods: In 22 consecutive myopic patients, 1 eye was randomized to have TG LASIK, and the contralateral had SMILE. Preoperatively we evaluated refraction, corrected (CDVA) and uncorrected (UDVA) distance visual acuity, keratometry, ACP and PCP (Scheimpflug tomography), and anterior segment OCT. Results: In myopia −5 to −10 D, the periperaoperative ACP was 50.20 ± 1.58 D and 42.57 ± 1.84 D for the LASIK group vs. 49.96 ± 167 D and 43.23 ± 1.99 D for the SMILE group. In myopia 0 to −5 D, the periperaoperative CP was 49.35 ± 2.43 D and 46.50 ± 2.68 D vs. 50.47 ± 1.77 D and 46.54 ± 1.71 D. PCP in cases of myopia −5 to −10 D changed from 6.21 ± 0.22 D to 6.24 ± 0.22 D vs. −6.16 ± 0.23 D to 6.18 ± 0.28 D. PCP in myopia 0 to −5 D zone increased from −6.15 ± 0.37 D to 6.16 ± 0.38 D vs. −6.23 ± 167 D to −6.26 ± 0.26 D. Conclusion: LASIK appears to effect ACP more than SMILE when adjusted for myopic power corrected. PCP changes appear similar in the 2 procedures.

Topography-Planned vs. Achieved Corneal Thickness Reduction in Femtosecond Laser-Assisted Myopic LASIK and Small-Incision Lenticule Extraction
Abstract #: RP30053396
Senior Author: Ioanna Kontari MD
Coauthor: A John Kanellopoulos MD

Purpose: To compare planned and achieved corneal stromal thickness reduction in topography-guided LASIK and small-incision lenticule extraction (SMILE) surgery in a contralateral eye study. Methods: Stromal thickness reduction was retrospectively investigated in 22 myopic patients: one eye was treated with topo-guided LASIK, and the contralateral eye, with SMILE. OCT was employed to provide pre- and post-operative pachymetry maps. Corneal thickness change was evaluated as the difference in minimum thickness between pre- and post-pachymetry. Results: Postop stromal reduction was on average 87.59 ± 29.45 μm, compared to the average programmed maximum ablation depth of 89.09 ± 25.41 μm for topo-guided LASIK and 84.91 ± 20.7 μm; 108.5 ± 22.98 μm for the SMILE cases, respectively. Conclusion: Actual objective corneal thickness reduction following topography-guided LASIK is more accurate than in SMILE, as it correlates better with the attempted vs. achieved refractive change.
Topography-Guided LASIK vs. Small-Incision Lenticule Extraction: One-Year Refractive and Quality-of-Vision Outcomes in Contralateral Eyes

Abstract #: RP30053397

Senior Author: Iro Pentari MS
Coauthor: A John Kanellopoulos MD

Purpose: To compare refractive and vision outcomes of topography-guided (TG) LASIK with those of small-incision lenticule extraction (SMILE). Methods: In 22 consecutive patients (44 eyes), one eye was prospectively randomized to have TG LASIK, and the contralateral to have SMILE. We evaluated perioperative acuity, refraction (SE), keratometry, contrast sensitivity, wavefront (RMS of higher-order aberrations [RMSh] and coma), and objective scatter index (OSI). Results: Mean values of TG LASIK vs. SMILE, respectively, were as follows: uncorrected distance visual acuity (UDVA) 20/20: 83.3% vs. 61.1%; UDVA 20/16: 50% vs. 22.2%; BCVA 20/20: 94.4% vs. 88.9%; SE in diopters: +0.14 ± 0.12 vs. −0.24 ± 0.32; contrast sensitivity at 6 cycles per degree: 7.2 ± 1.01 vs. 6.20 ± 1.52; RMSh: 0.28 vs. 0.55 μm; coma: 0.15 vs. 0.35 μm; OSI: 0.9 vs. 1.35. Conclusion: TG LASIK was superior to SMILE in all metrics studied. The difference between the 2 techniques currently may derive from eye-tracking and/or active centration control in TG LASIK.

Optical Quality of 3 Different Trifocal IOLs: A Laboratory Study Using an Optical Bench

Abstract #: RP30053400

Senior Author: Ramin Khoramnia MD
Coauthors: Tamer Tandogan MD, Stephanie Liebing, Chul Young Choi, Timur Yildirim, Gerd U Auffarth MD

Purpose: To analyze the optical quality of 3 different trifocal IOLs (FineVision, PanOptix, and AcrySof IQ PanOptix). Methods: We analyzed the FineVision (Physiol; Belgium), the AT LISA tri 839MP (Zeiss; Germany), and the AcrySof IQ PanOptix (Alcon; USA) at the OptiSpheric optical bench (Trioptics). We evaluated the modulation transfer function (MTF) at a spatial frequency of 50 lp/mm, the trough focus scan, and the Strehl ratio for FineVision (Physiol), AT Lisa, and PanOptix, respectively, were 0.335, 0.298, and 0.370 for the 3-mm aperture, and 0.243, 0.180, and 0.270 for the 4.5-mm aperture. Results: At the far focus, the Strehl ratios for FineVision, AT Lisa, and PanOptix, respectively, were 0.335, 0.298, and 0.370 for the 3-mm aperture, and 0.243, 0.180, and 0.270 for the 4.5-mm aperture. At the intermediate focus, the Strehl ratios were 0.189, 0.185, and 0.162 for the 3-mm aperture, and 0.099, 0.097, and 0.114 for the 4.5-mm aperture. At the near focus, the Strehl ratios were 0.305, 0.283, and 0.464 for the 3-mm aperture, and 0.177, 0.181, and 0.155 for the 4.5-mm aperture. Conclusion: Assessment of the 3 trifocal IOL models at the optical bench could show distinct peaks at the far, intermediate, and near focus. The performance was comparable.

IJOL Opacification after Posterior Lamellar Keratoplasty: A Material Analysis with Special Reference to Optical Quality Assessment

Abstract #: RP30053401

Senior Author: Ramin Khoramnia MD
Coauthors: Tamer Tandogan MD, Bert Constantin Giers MD, Chul Young Choi, Saadettin Sel MD, Gerd U Auffarth MD

Purpose: Laboratory analysis and optical quality assessment of explanted hydrophilic IOLs with clinically significant opacification after posterior lamellar keratoplasty (PLK). Methods: Thirteen opacified IOLs (8 different IOL models, 4 different manufacturers) after PLK were analyzed. Analyses included optical bench assessment for optical quality, light microscopy, scanning electron microscopy, and energy dispersive X-ray spectroscopy. Results: In all IOLs the opacification was caused by a thin layer of calciumphosphate that had accumulated underneath the anterior optical surface of the IOLs in the area spared by the pupil anterior capsulorhexis. The calcifications led to a significant deterioration of the modulation transfer function across all spatial frequencies. Conclusion: The instillation of exogenous material such as air or gas into the anterior chamber seems to increase the risk for hydrophilic IOL opacification irrespective of the manufacturer or the lens material.
Functional Optical Zone and Centration after Small- Incision Lenticule Extraction and Femtosecond Laser-Assisted LASIK: A Randomized Controlled Trial

Abstract #: RP30053422

Senior Authors: Hon Shing Ong MBBS
Coauthors: Iben B Pedersen, Han Nian Marcus Ang MBBS, Ashraf M Mahmoud, Cynthia Roberts PhD, Jodhbir S Mehta MBBS PhD

Purpose: To compare functional optical zone (FOZ) and centration after small-incision lenticule extraction (SMILE) and LASIK. Methods: Seventy masked patients were randomized to receive SMILE in one eye and LASIK in the other for myopia and myopic astigmatism. FOZ was calculated using the Ohio State University Corneal Topography Tool on 3-month postoperative images (Pentacam, Oculus). Treatment area (TA) was defined as total area of optical zone and transition zone. Decentration was the linear distance between FOZ center and pupil center. Results: Mean preoperative spherical equivalent was \( -5.4 \pm 1.6 \) D in both SMILE and LASIK eyes (\( P = .89 \)). The FOZ was larger in SMILE than in LASIK (30.3 ± 3.6 mm² vs. 29.2 ± 3.7 mm², \( P = .04 \)), although SMILE had a smaller optical zone (6.48 ± 0.1 mm vs. 6.52 ± 0.1 mm, \( P = .02 \)) and TA (33.9 ± 0.9 mm² vs. 46.3 ± 2.6 mm², \( P < .001 \)). No difference in decentration was seen in SMILE compared to LASIK eyes (\( P = .69 \)). Conclusion: Despite smaller optical zones, SMILE created larger FOZs than LASIK. This may be due to different corneal biomechanical changes in the 2 procedures.

Comparison of Visual Outcomes and Complications of Posterior Chamber Phakic IOL Implantation with and without a Central Hole for Correction of High Myopia and Myopic Astigmatism

Abstract #: RP30053426

Senior Author: Seyed Javad Hashemian MD

Purpose: To evaluate the visual outcomes and complications after implantation of V4c ICL (with CentraFLOW) and V4 ICL. Methods: V4c and V4 ICL implantation was done for correction of high myopic astigmatism with at least 1 year of follow-up. The outcome measures that were evaluated included pre- and postoperative uncorrected (UDVA) and corrected (CDVA) distance visual acuity, endothelial cell count (ECC), lens opacification, IOP, and lens rotation. Results: Forty-six eyes underwent V4c ICL implantation, and 40 eyes had implantation of V4 ICL with PI. Mean preoperative MSEs were −8.65 and −8.51 D in the V4c and V4 groups, respectively, reduced to −0.16 and −0.33 D, respectively. Mean preoperative cylinders were −1.38 and −1.65 D, respectively, which were reduced to −0.51 and −0.46 D. At 1 year, mean ECC losses were 2.4% and 3.1%. One eye of the V4c group and 3 eyes of the V4 group required rerotation surgery. Safety and efficacy indices were the same, and lens was clear in both groups. Conclusion: The V4c and V4 ICL implantations are comparable in terms of visual outcome and safety profile for correction of high myopic astigmatism.

Retrospective Evidence on Topography-Modified Refraction and Topo-Guided Treatment Improving LASIK Outcomes

Abstract #: RP30053427

Senior Author: Iro Pentari MS
Coauthor: A John Kanellopoulos MD

Purpose: Long-term outcome analysis of wavefront-optimized (WFO) treated eyes. Methods: 200 myopic WFO cases were retrospectively evaluated for uncorrected (UDVA) and corrected (CDVA) distance visual acuity, refractive error (RE), corneal coma (C7, C8), and trefoil (C9, C10). Preoperative topography data were available and used to generate hypothetical C7-C10 treatment data—assuming topography-guided (TG) with topography-modified refraction (TMR) cylinder amount and axis adjustment had been used instead of WFO—which was compared to the current C7-C10 data. Results: After a year, the WFO results were as follows: UDVA, 20/22; CDVA, 20/20; RE (in diopters), −0.25 sphere and −0.45 cylinder; C7 and C8, 0.3 μm; C9 and C10, 0.4 μm. Conclusion: TMR in TG LASIK may offer improved outcomes through reduction of C7-C10 and accurate cylinder correction. Angle kappa and/or accommodation cylinder may bias standard clinical refractions.

Tolerance to Induced Astigmatism: Comparison of a Small- Aperture IOL with a Trifocal IOL

Abstract #: RP30053428

Senior Author: Robert Edward T Ang MD

Purpose: To evaluate the tolerance to astigmatism with a small-aperture IOL (IC-8, AcuFocus) and a trifocal IOL (Finevision) by measuring visual acuity with various levels of astigmatic defocus induced at 90, 180, and oblique axes. Methods: Twenty IC-8 IOL eyes and 16 FineVision IOL eyes were evaluated. Tolerance to induced astigmatism was studied by measuring distance visual acuity at various levels of astigmatic defocus at 90, 180, and oblique axes. Visual acuity was measured using a Landolt C Snellen chart and converted to logMAR at each dioptric step. Results: Visual acuity in the IC-8 eyes was significantly better than in the FineVision eyes at all dioptric steps. Significant differences in mean acuities varied from 0.50 lines at 0.00 D of defocus to 2.1 lines at 2.50 D of defocus. Overall, visual acuity of 0.1 logMAR was maintained for up to 1.5 D of astigmatic defocus with the IC-8 IOL. Conclusion: The small-aperture IOL is tolerant to residual postoperative astigmatism of up to 1.5 D when compared to the trifocal IOL.
Effect of Preoperative Meibomian Gland Dysfunction Treatment with a Thermal Pulsation System on Patient Outcomes after Refractive Laser Surgery

Abstract #: RP30053431

Senior Author: Beatrice Cochener MD

Purpose: To evaluate effect of preoperative thermal pulsation treatment on post–corneal refractive laser outcomes in patients with meibomian gland dysfunction (MGD) with or mild dry eye symptoms prior to surgery. Methods: This 12-month, prospective, controlled, randomized, single-center clinical trial included patients who received LipiFlow treatment 30 days before laser (Group 1) and controls (Group 2). Primary endpoint was the Standard Patient Evaluation of Eye Dryness (SPEED) score and MG function using the Meibomian Gland Evaluator. Results: Twenty-one eyes (13 patients) were included in Group 1, and 30 eyes (16 patients) in Group 2. In Group 1 there were significant reductions in mean SPEED score and increases in MGE at all time points vs. baseline. Differences between the 2 groups were statistically significant at all follow-up times (P < .05). Conclusion: LipiFlow treatment in patients with MGD before LASIK had a beneficial effect on MG and dry eye symptoms through 12 months postoperatively.

Improving the Efficacy of Biomechanical Stiffening in Iontophoresis-Assisted Transepithelial Corneal Crosslinking

Abstract #: RP30053432

Senior Author: Emilio A Torres Netto MD

Coauthors: Sabine Kling PhD, Nikki Hafezi, Farhad Hafezi MD PhD

Purpose: To optimize the biomechanical effect of iontophoresis-assisted transepithelial corneal crosslinking (I-CXL) using different UV-irradiation settings. Methods: 112 porcine corneas were divided into 7 groups. Different intensity/time settings were used: 3 groups received epi-off CXL, and 4 groups received I-CXL. Young’s modulus and stress after relaxation were analyzed. Results: Among all I-CXL groups, only the 1.5 mW/cm²/60 min group showed a significant stiffening effect. All epi-off groups provided a stiffening effect significantly stronger than in I-CXL. Conclusion: The biomechanical effect of I-CXL was only significant when using a low irradiance/long irradiation setting, doubling the time of the Dresden protocol. Although still less effective than epi-off CXL, this modification may establish epi-on as a treatment option in low-compliance patients.

Prospective Multicenter Trial of a Small-Aperture IOL

Abstract #: RP30053437

Senior Author: Tim Schultz MD

Coauthor: Burkhard Dick MD

Purpose: To evaluate the clinical acceptability of monocular implantation of the small-aperture IC-8 IOL in one eye and an aspheric monofocal IOL in the fellow eye. Methods: Visual acuity, depth of focus, contrast sensitivity, patient satisfaction, visual symptoms, and adverse events are reported on 105 subjects. Results: At 6 months, uncorrected distance (UCDVA), intermediate (UCIVA), and near (UCNVA) visual acuities in the IC-8 eyes were 20/23, 20/24, and 20/30, respectively. 99%, 95%, and 79% of subjects achieved 20/32 or better binocular UCDVA, UCIVA, and UCNVA, respectively. 95.9% of subjects reported they would have the procedure again, while 4.1% of subjects reported they would not have the procedure again. Conclusions: The small-aperture IC-8 IOL showed excellent outcomes in visual performance, safety, patient satisfaction, and tolerance to residual astigmatism.

Primary Posterior Laser Capsulotomy: A Prospective Randomized Intraindividual Comparative Trial

Abstract #: RP30053438

Senior Author: Burkhard Dick MD

Coauthor: Tim Schultz MD

Purpose: To investigate safety and feasibility of a new femtosecond laser-assisted method for posterior capsule opacification (PCO) prevention. Methods: As the last step of the procedure, a primary posterior laser capsulotomy (PPLC) was conducted. The posterior capsule was identified between the anterior hyaloid surface and the posterior optic surface of the IOL. In the other eye, routine manual cataract surgery without posterior capsulotomy was performed. Results: In all cases (26 patients) it was possible to identify and aim the posterior capsule. No significant difference in visual acuity, macular thickness, laser flare, or IOP was seen between the PPLC group and the control group. Conclusion: The described off-label PPLC is a safe, feasible, and promising technique in prevention of PCO over 6 months follow-up.

Snake-Like Chromatin Cell Protein Related to Eye Rubbing in Patients with Keratoconus and Allergic Conjunctivitis

Abstract #: RP30053439

Senior Author: Maria A Henriquez MD

Coauthors: Luis Izquierdo Jr MD, Nadia Canorio MSc PhD

Purpose: To evaluate the presence of snake-like chromatin cell protein related to eye rubbing in patients with keratoconus (KC), allergic conjunctivitis, and controls. Methods: Prospective cohort study included 193 eyes (86 with KC diagnosis, 88 controls, and 19 with allergy conjunctivitis) that underwent impression cytology of conjunctiva to detect snake-like chromatin cell protein (SLCP) and morphological characterization of dry eye and allergy conjunctivitis. Results: SLCP was observed in 26.74% of the KC eyes, 74.68% of the allergic conjunctivitis eyes, and 4.54% of controls. There was a statistically significant difference in the frequency of eye rubbing between KC with and those without presence of SLCP (4.47 and 2.86 times/week, respectively; P = .02). Morphological characterization of dry eye was present in 79.06% of KC eyes. Conclusion: KC can be present in eyes that did not have expression of SLCP with or without eye rubbing. The presence of the SLCP is greater in eyes with frequent and intense eye rubbing.
The Effect of LASIK on Corneal Stiffness Measured by Brillouin Microscopy
Abstract #: RP30053444

Senior Author: Theo Guenter Seiler MD
Coauthors: Amira Eltony PhD, Peng Shao PhD, Seok-Hyun Yun PhD, Theo Seiler MD PhD

Purpose: To evaluate in vivo the biomechanical effect of LASIK by means of Brillouin microscopy. Methods: Brillouin shifts were acquired centrally in 29 healthy eyes of 29 patients receiving femto-LASIK. The measurements were performed preoperatively and on 1 day and 1 and 3 months postoperatively using a Brillouin microscope (BOSS, Inteleon Optics). Results: Preoperatively, the eyes showed an average Brillouin shift of 5.718 ± 0.017 GHz, which decreased significantly to 5.684 ± 0.020 GHz at 1 day after surgery (P < .0001). At 1 month after surgery, the central Brillouin shift was 5.718 ± 0.020 GHz, similar to preoperative values (P = .89), and remained stable until 3 months after surgery. Conclusion: This first report on Brillouin microscopy in LASIK patients shows a transient drop in local stiffness immediately after surgery, which returned to preoperative values at 1 month after surgery. In addition, Brillouin microscopy facilitates preoperative filtering of weak corneas in order to avoid keratectasia after LASIK.

Comparative Analysis of Corneal OCT Parameters in Patients with Highly Asymmetric Keratoconus and Normal Corneas
Abstract #: RP30053445

Senior Author: J Bradley Randleman MD
Coauthor: Claudia E Perez-Straziota MD

Purpose: To evaluate corneal OCT in distinguishing highly asymmetric keratoconus from normal corneas. Methods: OCT measurements were obtained with the RTVue (Optovue) in 20 highly asymmetric eyes and 20 normal controls. Parameters compared included central, regional, and relational total thickness and epithelial thickness. Area under the curve (AUC) was calculated for all candidate metrics. Results: Total central (522 vs. 539 μm, P = .04) and minimum (513 vs. 531 μm, P = .02) corneal thicknesses were significantly lower in asymmetric KC eyes than normal corneas. No other values were significantly different. No metric could distinguish between groups (AUC < 0.7 for all comparisons). Conclusion: Highly asymmetric (forme fruste) keratoconus eyes were thinner than normal corneas but otherwise difficult to distinguish using corneal OCT imaging. Epithelial thickness measurements were not useful in distinguishing between groups.

Analysis of Pseudoaccommodation in Aspheric and Extended Depth of Focus IOLs Using Ray Tracing Aberrometry
Abstract #: RP30053446

Senior Author: Karolinne M Rocha MD
Coauthors: Jorge Haddad MD, Eliza Barnwell MD, George O Waring IV MD

Purpose: To evaluate depth of focus curves using ray tracing aberrometry in aspheric and extended depth of focus (EDOF) IOLs. Methods: Ray tracing aberrometry (iTrace) was used to objectively measure depth of focus in pseudophakic eyes implanted with an aspheric neutral IOL (EnVista, B+L), an aspheric IOL with negative spherical aberration (ZCB00, J&J), and an EDOF IOL (Symfony, J&J) at 1-3 months postoperatively, and in presbyopic and young subjects (control group). Delocus, higher-order aberrations (HOA), visual Strehl ratio based on optical transfer function (VSOTF), and accommodation range index were recorded. Results: 107 eyes were included in this prospective study. The EDOF group had statistically significantly higher accommodation range index, followed by the aspheric neutral IOL group in highly aberrated corneas (P = .0005). The negative spherical aberration IOL group had the highest VSOTF and MTF (P < .05). Conclusion: Pseudoaccommodation from changes in spherical aberration, pupil size, and residual HOA may contribute to near vision functionality observed in pseudophakic eyes.

Detecting the Progression of Keratoconus More Quickly Using Scheimpflug Analysis to Treat It Earlier
Abstract #: RP30053447

Senior Author: Maria A Henriquez MD
Coauthors: Luis Izquierdo Jr MD, Josefina Mejias MD, Mirel Rincon MD

Purpose: To evaluate visual and tomographic changes in progressive and nonprogressive keratoconus (KC) at 3 months follow-up and to determine risk factors associated with progression. Methods: This prospective cohort study included 106 eyes with newly diagnosed KC. Scheimpflug imaging analysis and visual acuity were performed at the time of diagnosis and 3 months later. Results: 13.20% of eyes experienced progression at 3 months of follow-up. The mean changes of Kmax in the progressive and nonprogressive groups were +2.34 D and −0.32 D, respectively (P < .001). An increase of 7 mm in the ISV at 3 months showed an AUROC of 0.92 (RR = 16.42, P < .001); high decentration index greater than 0.15 at baseline had an AUROC of 0.82 (RR = 1.42, P = .02). Conclusion: Progression can be assessed at short-term follow-up. Specific parameters from the initial assessment and 3-month follow-up, mainly related to corneal irregularity indices, are risk factors for progression.
Ablation-Free Corneal Refractive Correction via Femtosecond Laser-Induced Refractive Index Modification
Abstract #: RP30053448

Senior Author: Scott M MacRae MD
Coauthors: Daniel Brooks, Kaitlin Wozniak, Sara Gearhart, Dan Savage, Jonathan D Ellis, Wayne Knox PhD, Krystel Huxlin PhD

Purpose: To assess feasibility of inscribing a 1.5 D cylinder correction over a 5.8-mm diameter optical zone in 3 cat eyes via femtosecond laser modification of corneal refractive index (RI) in vivo. Methods: Ocular wavefronts were measured before and at different time-points after the treatment. The intended pattern was a 3-layered, phase-wrapped Fresnel lens written 150-µm deep, using a high-repetition ultrafast laser (405-nm wavelength, 165-fs pulsewidth). In preparation for first-in-human studies, we then compared RI change of ex vivo feline and human corneas by measuring diffraction efficiency of gratings written into stroma. Results: No ablation was observed in the treated eyes, but cylinder measured 8, 12, and 13 days postop averaged −1.39 ± 0.11 D, close to the target of −1.5 D. RI change attained in ex vivo feline and human corneas was also comparable. Conclusion: Laser-induced RI change is a predictable tool for noninvasive, ablation-free refractive error correction in the cornea.

Integrated Corneal Tomography and Biomechanical Assessments for Enhancing Ectasia Detection
Abstract #: RP30053450

Senior Author: Renato Ambrósio Jr MD

Purpose: To present 2 external validation studies for the tomographic / biomechanical index (TBI). Methods: One eye each from 100 patients with mild keratoconus (central K < 48 D) and from 100 normal patients from India. From Iran, 1 eye each from 34 normal patients and both eyes from 24 patients with very asymmetric ectasia (VAE). Results: Same cutoff value of 0.79 (100% sensitivity for frank ectasia with 100% specificity in the original study) had 99% sensitivity and 100% specificity in the India study and 100% sensitivity for the ectatic eyes with 100% specificity in the cases from Iran. Considering the eyes with normal tomography from the 24 VAE cases from Iran, same optimized TBI cutoff of 0.27 (90.4% sensitivity and 96% specificity in the original study) provided 91.6% sensitivity with 97% specificity. Conclusion: TBI is validated as an enhanced tool for detecting ectasia.

Cyclosporine A for Improvement of Uncorrected Visual Acuity following LASIK
Abstract #: RP30053456

Senior Author: Sudarshan K Khokhar MD FRCSC
Coauthors: Esha Agarwal, Ganesh Pillay MD, Namrata Sharma

Purpose: To study the role of cyclosporine A 0.05% in improvement of uncorrected visual acuity (UCVA) in post-LASIK patients. Methods: In this prospective randomized study, 40 eyes of 40 patients having UCVA < 6/6 at 1 week after LASIK were randomized into 2 postoperative regimens: Group A, standard postoperative regimen + cyclosporine A, and Group B, standard regimen only. Results: At 1 month and 3 months follow-up, 75% and 90% of eyes had UCVA of 6/6 in Group A, as compared to 55% and 65% of eyes in Group B, respectively. Conclusion: Cyclosporine A is effective in improving UCVA in post-LASIK patients.

Same-Day Vision after Transepithelial PRK with New Laser Beam Profile
Abstract #: RP30053462

Senior Author: David T C Lin MD
Coauthors: Simon P Holland MD, John Hogden MBBS BMedSc RANZCO, Samuel Arba Mosquera

Purpose: To evaluate same-day uncorrected distance vision (UDVA) after transepithelial photorefractive keratectomy (TE PRK) using 3 laser beam profiles. Methods: Retrospective study of UDVA after transepithelial PRK (N = 815) performed with Schwind Amaris 1050 (SA) SmartSurfACE, SA with initial beam profile (SAO), or Allegra WaveLight (AW). UCDA was checked 30 minutes after surgery. Patients in the SA SmartSurfACE group were asked if they could read their phone messages. Results: Half of the patients undergoing TE PRK with SA SmartSurfACE (n = 723) achieved ≥ 20/40, 97% ≥ 20/100. SAO patients (n = 48): 7% ≥ 20/40, 77% ≥ 20/100. AW patients (n = 44): none achieved ≥ 20/40, 42% ≥ 20/100. Of patients treated with SA SmartSurfACE TR PRK (n = 112), 92% were able to read phone and text messages at 30 minutes postoperatively. Conclusion: Rapid recovery of functional vision can be achieved with TE PRK using an upgraded laser beam profile, SA SmartSurfACE, compared with SA with original beam profile and Allegra WaveLight.

Topography-Guided PRK or Phototherapeutic Keratectomy in Keratoconus with Crosslinking?
Abstract #: RP30053464

Senior Author: Simon P Holland MD
Coauthors: David T C Lin MD, John Hogden MBBS BMedSc RANZCO, Samuel Arba Mosquera, Murad M Al Obthani MBBS

Purpose: To compare keratoconic eyes undergoing combined topographic-guided photorefractive keratectomy (TG-PRK) and corneal collagen crosslinking (CXL) with those undergoing phototherapeutic keratectomy (PTK) and CXL. Methods: Patients underwent either TG-PRK (10) or PTK with the Schwind Amaris 1050 laser / SmartSurfACE (8) followed by CXL. Data analyzed included spherical correction, cylinder correction, spherical equivalent, uncorrected (UDVA) and corrected (CDVA) distance visual acuity, average K, Kmax, and central corneal thickness. Follow-up range: 3 to 18 months. Results: In the TG-PRK cohort there was statistically significantly reduced residual cylinder (PTK, −.55 D, and TG-PRK, −.91 D; P = .1) and improvement in UDVA (7 vs. 2 lines; P = .005) and in CDVA (2 vs. 0; P = .01). Conclusion: TG-PRK CXL therapy was statistically superior to PTK CXL in cylinder correction, UDVA, and CDVA. Our study suggests that TG-PRK with CXL is preferred to PTK CXL in achieving better vision in keratoconus, but long-term follow-up is needed.
Wavefront-Guided, Topo-Guided, or Conventional Ablation Algorithm: Which Is Better for Primary Myopic LASIK?
Abstract #: RP30053466
Senior Author: Alexander Doga MD
Coauthors: Irina A Mushkova MD PhD, Adelya Karimova MD PhD
Purpose: To evaluate and compare visual and refractive outcomes after primary LASIK surgery for the correction of myopia using 3 different treatment protocols. Methods: We observed 748 eyes with low and moderate myopia, out of which 258 eyes were operated by the wavefront-guided (WFG), 243 eyes by the topo-guided (TG), and 247 eyes by the standard ablation’s algorithm (control). All flaps were formed with the femtosecond laser, and all eyes were treated by the MicroScan-Visum excimer laser (Russia). The customized ablations were planned with aberrometer and keratotopography data obtained using PlatoScan and KeraScan-M softwares. Results: The percentsages of eyes achieving uncorrected distance visual acuities of 20/20 and 20/16 in the WFG, TG, and control groups were 94.2% and 69%, 93% and 47%, and 88.3% and 34.8%, respectively. Postoperative spherical equivalent (SE) was within ±0.5 D in 95.7%, 94.2%, and 89.5%, respectively. Conclusions: All evaluated LASIK treatment protocols are predictable and effective for the correction of myopia. The treatment planned with aberrometer and keratotopography data obtained the best postoperative refractive outcomes.

Femtosecond Laser–Induced Refractive Index Change in IOL and Contact Lens
Abstract #: RP30053472
Senior Author: Jay Stuart Pepose MD PhD
Coauthors: Len Zheleznvak PhD, Gustavo Gandara-Montano, Sam Butler, Gennyoung Yoon PhD, Scott M MacRae MD, Krystel R Huxlin PhD, Jonathan D Ellis PhD, Wayne M Knox
Purpose: To change refractive correction and multifocality of IOL and contact lens materials using femtosecond laser--induced refractive index (RI) change. Methods: A high repetition rate femtosecond laser system was used to modify ophthalmic hydrogel materials (Contamac, 58% water). Various lenses were written into the hydrogel material over a 6-mm diameter optical zone (sphere: −3 to +1.5 D, cylinder: 1.5 D; diffractive multifocal with 1.5 D add power). Visual acuity (VA) was assessed in 5 subjects viewing through a modified (−1.5 D) and unmodified (plano) lens. Aberrometry was performed with a Shack-Hartmann wavefront sensor. Results: Best corrected VA was comparable between a modified (−1.5 D) and unmodified (plano) lens (VA: −0.16 + 0.06 and −0.22 + 0.06 logMAR, respectively). Aberrometry revealed a writing error of 0.06 ± 0.13 D of the desired target. Conclusions: Femtosecond laser RI change can customize the refractive correction and multifocality of IOL and contact lens hydrogel while providing high visual quality.

Comparison of Visual Outcomes between Multifocal and Trifocal IOLs
Abstract #: RP30053474
Senior Author: Yonca A Akova MD
Coauthor: Nilufer Yesilirmak MD
Purpose: To investigate the visual outcomes between mix-and-match bifocal IOLs (ReSTOR +2.50 and +3.0 D) and bilateral implantation of trifocal IOLs (PanOptix). Methods: Prospective, comparative study included 42 eyes of 21 patients scheduled to undergo phacoemulsification and IOL implantation. PanOptix IOLs were implanted in 20 eyes of 10 patients, while ReSTOR IOLs were implanted in 22 eyes of 11 patients. Manifest refraction, distance visual acuity (DVA), intermediate and near visual acuities, contrast sensitivity, and higher-order aberrations (HOAs) were measured. Results: There were no differences in DVA, manifest refraction, or HOAs between groups. The PanOptix group achieved better near and intermediate visual acuities and better contrast sensitivity, at 3 and 18 spatial frequencies, than the ReSTOR group. Conclusion: Both lenses provided good distance visual quality. Trifocal IOLs provided better visual acuities at near / intermediate distances and better contrast sensitivity than mix-and-match bifocal IOLs.

Correlation of Change in V4c Implantable Collamer Lens Vaulting and Pupil Diameter in Different Light Conditions
Abstract #: RP30053475
Senior Author: Rajesh Sinha MBBS
Coauthors: Malikireddy Sravanrhi Jr MD, Reena Singh, Jeewan S Titiyal MD
Purpose: To study change in vault of implantable collamer lens (ICL) in different light conditions and to define its relationship with change in pupil diameter. Methods: In 30 eyes of 15 myopes with the V4c ICL, the vault was measured with RTVue anterior segment OCT (AS-OCT) in room light and under scotopic and photopic conditions, along with pupil diameter using AS-OCT and ImageJ software. Results: Mean ICL vaults in room light and under scotopic and photopic conditions were 568.57 ± 215.83 µm, 567.47 ± 225.11 µm, and 418.4 ± 210.04 µm, respectively (significant decrease in photopic condition; insignificant change in scotopic). As compared to room light, there was a significant decrease in pupil diameter in photopic conditions and an increase in scotopic conditions. Every 1-mm decrease in pupil size caused a decrease in vault by 59.51 µm (ImageJ) and 56.19 µm (AS-OCT). Conclusion: ICL vault decreases significantly under photopic conditions, along with a decrease in pupil diameter; however, scotopic conditions have an inconsistent and lesser effect on vaulting.
Topography-Guided PRK with Crosslinking for Keratoconus with a New High-Speed Laser
Abstract #: RP30053486
Senior Author: Simon P Holland MD
Coauthors: David T C Lin MD, John Hogden MBBS BMedSc RANZCO, Murad M Al Obthani MBBS, Samuel Arba Mosquera
Purpose: To evaluate topography-guided PRK (TG-PRK) for keratoconus (KC) with crosslinking (CXL) with the Schwind Amaris 1050 (SA).
Methods: Retrospective case series of 137 KC eyes treated with SA laser and CXL. Data collected: pre- and postoperative uncorrected (UDVA) and corrected (CDVA) distance visual acuity, MR, and topographic cylinder. Results: 72/137 (53%) showed UDVA ≥ 20/40, 62 (45%) improved CDVA, and 29 eyes (21%) gained 2 or more lines (P = .0003). No patient showed progression. Mean astigmatism was reduced from 2.82 ± 1.93 D to 0.96 ± 1.07 D (P = .0008). Mean spherical equivalent was improved from −3.17 ± 3.88 D to −0.87 ± 1.23 D (P = .05). Conclusion: One year results of TG-PRK CXL with the Schwind Amaris 1050 showed efficacy and safety in the treatment of keratoconus. More than half had UDVA of 20/40 or better postoperatively with 21% improving CDVA 2 or more lines, providing an alternative for contact lens–intolerant keratoconus patients, although long-term results are needed to validate results.

Post-LASIK Ectasia Treated by Topography-Guided PRK and Crosslinking Using a New High-Speed Laser
Abstract #: RP30053487
Senior Author: John Hogden MBBS BMedSc RANZCO
Coauthors: Simon P Holland MD, David T C Lin MD, Samuel Arba Mosquera, Murad M Al Obthani MBBS
Purpose: To evaluate early results of topography-guided PRK (TG-PRK) for post-LASIK ectasia (EC) with crosslinking (CXL) with the Schwind Amaris 1050 (SA).
Methods: Retrospective case series of 24 EC eyes treated with SA laser and CXL. Data collected: pre- and postoperative uncorrected (UDVA) and corrected (CDVA) distance visual acuity, MR, and topographic cylinder. Results: Twelve had sufficient data for analysis. Seven of 12 (58%) showed UCVA ≥ 20/40 postoperatively; 4 (33%) had improved CDVA, and 3 (25%) gained ≥ 2 lines (P = .03). No patient showed progression. Mean astigmatism was reduced from 2.82 ± 1.93 D to 0.96 ± 1.07 D (P = .0008). Mean spherical equivalent was improved from −0.87 ± 1.23 D to −0.19 ± 1.34 D (P = .05). Conclusion: Early results of TG-PRK CXL with the Schwind Amaris 1050 show efficacy and safety in treating post-LASIK ectasia. More than half (58%) had UDVA ≥ 20/40 at 1 year, and 25% had CDVA improved ≥ 2 lines. The technique may be an alternative treatment for post-LASIK ectasia with contact lens intolerance.

Improve Visual Outcomes in Transepithelial PRK with Optimized Asphericity
Abstract #: RP30053490
Senior Author: John Hogden MBBS BMedSc RANZCO
Coauthors: Simon P Holland MD, David T C Lin MD, Samuel Arba Mosquera
Purpose: To evaluate postoperative asphericity after SmartSurface PRK, PRK. Methods: Pre- and postoperative asphericity after SmartSurface PRK, higher-order aberrations (HOA) at 3 months (N = 106 eyes) in low (≤ −4.125 D), moderate (−4.25 D to −6.25 D), and high myopia (≥ −6.25 D); and analysis of change in asphericity with HOA off (C4, 6, 8). Results: The low myopia group (n = 33) improved negative asphericity (Q = −0.04 ± 0.18 preop to −0.18 ± 0.21 postop; P < .05). The moderate myopia group (n = 35) maintained or slightly improved negative asphericity (Q = −0.07 ± 0.14 preop to −0.05 ± 0.25 postop; P = .35). For the high myopia group (n = 38), eyes became more oblate (Q = −0.09 ± 0.15 preop vs. 0.62 ± 0.72 postop; P < .05). Conclusion: SmartSurface PRK improves or maintains negative asphericity in low and moderate myopia. Further adjustment of spherical aberration (C4, 6, 8 HOA off) may improve distance acuity.

Corneal Remodeling after Implantation of a Corneal Shape–Changing Inlay Concurrently with LASIK
Abstract #: RP30053491
Senior Author: Beatrice Cochener MD
Purpose: To compare the corneal surface changes induced by the Raindrop Near Vision Inlay between ammetropic subjects receiving LASIK concurrently and emmetropic subjects implanted with the inlay alone. Methods: Clinical outcomes, wavefront, and OCT records of 34 hyperopic and 29 myopic patients implanted with the inlay. The mean change to the anterior corneal surface was calculated from 6-month postop minus preop wavefront differences. The epithelial thinning profiles were calculated from OCT measurements. Results: At the inlay center, the stroma anterior to the inlay was raised ~28 μm. In response, the epithelium thinned ~17 μm. The resulting change to the central anterior corneal surface was ~10 μm. The epithelial thinning was not significantly correlated with LASIK treatment between −4.6 and +2.6 D. Conclusions: The stromal and epithelial remodeling after inlay implantation appears independent of the level of LASIK treatment.
Corneal Crosslinking for Keratoconus Relapse after Penetrating Keratoplasty
Abstract #: RP30053499
Senior Author: Irina S Barequet MD
Coauthors: Amir Abd Elkader, Inbal Gazit, Noa Avni Zauberman MD, Yoav Y Berger MD
Purpose: To evaluate the safety and efficacy of corneal cross-linking (CXL) in eyes after keratoplasty that developed relapse of keratoconus. Methods: We reviewed the data of 5 eyes from 4 patients who underwent CXL after a late relapse of keratoconus after an uneventful penetrating keratoplasty. Results: Corrected distance visual acuity significantly improved 1 year after CXL. Preoperative Kmax and astigmatism were 52.06 ± 3.9 D and −8.24 ± 3.6 D, respectively; and postop were 48.27 ± 3.5 D and −7.4 ± 3.9 D, respectively. No intra- or postoperative complications were noted. Conclusion: CXL is a safe procedure in keratoplasty eyes with recurrence of keratoconus and effectively stabilizes the cornea and refraction parameters.

Effects of a New Matrix Therapy Agent, Cacicol, after Corneal Collagen Crosslinking
Abstract #: RP30053507
Senior Author: Michele Pacheco MD
Coauthors: Alejandro Navas MD, Juan Carlos Serna MD, Karla Zuñiga, Enrique O Graue Hernandez MD, Arturo J Ramirez-Miranda MD
Purpose: To evaluate the efficacy of a new matrix regenerating therapy agent (RGTA), Cacicol, in epithelial defects after collagen crosslinking. Methods: Prospective blind study. In subjects who underwent CXL (epithelium-off modality), RGTA was applied in 1 eye and sodium hyaluronate in the other eye to measure epithelial defect size. Results: Thirty-one eyes were included in each group; mean age, 22.13 ± 5.02 years. Twenty-four hours after CXL procedure, the Cacicol group had a mean area of epithelial defect of 43.71 mm² vs. 47.85 mm² in the sodium hyaluronate group (P = .318). At 72 hours, 1.35 mm² vs. 1.19 mm² (P = .819), respectively. At 120 hours, 96.8% of the Cacicol group eyes had no remaining epithelial defect, compared to 93.5% in the sodium hyaluronate group. Conclusion: Although epithelial defect size was smaller in the Cacicol group at 24 hours, final closure time had no statistically significant difference between groups.

Management and Prevention of Complications in Refractive Surgery

Causes and Management of Intrastromal Corneal Ring Segment Explantation at King Khaled Eye Specialist Hospital
Abstract #: RP30053442
Senior Author: Hernan Alfonso Martinez-Osorio MD
Coauthors: Hussain Al Habboubi MD, Awad Al Qarni MD, Azza M Maktabi MD, Samar Ayed Al-Swailem MD
Purpose: To evaluate the clinical outcomes, complications, and management of intrastromal corneal ring segment (ICRS) explantation in King Khaled Eye Specialist Hospital (KKESH). Methods: Retrospective study (2007-2017). Two groups were analyzed: Group 1, ICRS surgery done in KKESH (n =41), and Group 2, surgery done elsewhere (n = 29). Causes of removal, POP outcomes, and management were analyzed. Results: Causes of ICRS removal were visual disturbances (45%-27%), ICRS extrusion (38%-41%), corneal neovascularization (9%-14%), and infection (6%-16%). In Group 1 the elapsed time between implantation and explantation was 30 months. Refraction and keratometry were reversible when management was done with CL or glasses. Preimplantation sphere of −8 can predict keratoplasty (P 0.02). Management was done with contact lens (45%-45%), observation (15%-14%), glasses (15%-23%), and keratoplasty (27%-21%). Conclusion: After explantation, most patients (60%-68%) can be managed with glasses or CL. ICRS is a reversible surgery when patients do not need PKP.
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* Indicates that the presenter has financial interest. No asterisk indicates that the presenter has no financial interest.
U.S. Application
(You must be a current member of the AAO to join the ISRS.)

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Medical Degree (e.g. MD, MBBS, etc.) ....................................................................

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Office Phone ............................................................................................................
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AAO Member ID: (optional) .....................................................................................

MEMBERSHIP LEVELS

Applicants can pay their application fee to join this year, as well as their membership dues for the following year.

☐ 1 year $250 USD ☐ 2 years $485 USD

The different dues rates are based strictly on the completion dates of your training (residency or fellowship).

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A letter of verification from your Professor/Program Chair with your begin and end dates must be submitted with application.

☐ Journal of Refractive Surgery Subscription (One Year) $100 USD

Total Amount Due: $ USD

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☐ JCB ☐ Check or Money Order Enclosed
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Fax: 415.561.8575
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- Receive complimentary subscription to the *Journal of Refractive Surgery*, the highest-rated journal in the refractive surgery subspecialty, in print and online.
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- Obtain guaranteed entry to the exclusive *ISRS Member Lunch at Refractive Surgery Subspecialty Day*. Hear experts speak on cutting-edge subjects not listed in the official program while networking with refractive surgeons from around the world.
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**Gain Status and Recognition**
- Earn the coveted *ISRS Recognition Award* by contributing to ISRS programs and publications.
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ISRS’s impact factor was 3.709 in 2016, making it the highest ranking journal in the refractive surgery subspecialty.
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Family Name ........................................................................................................................................ Date of Birth
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City ............................................................................................................................................. State / Province ............................................................................................................. Postal Code
Country ........................................................................................................................................ Email
Office Phone ................................................................................................................................ Fax
Medical School Name (Required) Completion Date (MM/YYYY) (Required)
Ophthalmology Training School Name (Required)
City ............................................................................................................................................. Province/District & Country
Beginning Date (MM/YYYY) (Required) Completion Date (MM/YYYY) (Required)
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• If you are in your 1st, 2nd, or 3rd year out of training (based on the completion dates of residency or fellowship), email Member Services for reduced application fee rates.

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A letter of verification from your Professor/Program Chair with your begin and end dates must be submitted with application.

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☐ Practicing Members – Annual postage for the Journal of Refractive Surgery print subscription – $55 USD
☐ Members in Training – Annual postage for the Journal of Refractive Surgery print subscription – $100 USD
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ISRS membership is invaluable, giving you access to services and tools to achieve personal and professional success at every stage of your ophthalmic career.

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¹ISRS's impact factor was 3.709 in 2016, making it the highest ranking journal in the refractive surgery subspecialty.
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<tr>
<td>Saturday, Nov 11</td>
<td>SYM61</td>
<td>MOC Exam Review: Core Ophthalmic Knowledge</td>
<td>10:00 AM to 12:00 PM</td>
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<td>Diagnose This Live Saturday</td>
<td>2:00 PM to 4:00 PM</td>
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<td>Sunday, Nov 12</td>
<td>Course 203</td>
<td>Evidence-Based Guidelines in the Management of Glaucoma</td>
<td>10:15 AM to 12:30 PM</td>
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<td>Decoding the Uveitis Workup: Why, When, and What to Order</td>
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<td>Course 206</td>
<td>Update on Diagnosis and Management of ROP: Pearls for ROP</td>
<td>10:15 AM to 12:30 PM</td>
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<td>Examining the Optic Nerve and Evaluating the Visual Field:</td>
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<td>The Art and Science of Glaucoma Drainage Devices:</td>
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<td>Optical Coherence Tomography: Basics and Beyond</td>
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<td>Monday, Nov 13</td>
<td>SPO2</td>
<td>Spotlight on Cataract Complications</td>
<td>8:15 AM to 12:15 PM</td>
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<td>Herpes Simplex Keratitis: When Herpes Isn't a Dendrite, and Vice Versa</td>
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<td>Case Studies on the Use of OCT for Diagnosis of Unknown Causes of Visual Loss: Is it the Retina, Anterior Visual Pathway, or Misinterpretation of Normal?</td>
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<td>Current Topics in Cornea/External Disease: Highlights of the Basic and Clinical Science Course 8</td>
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<td>Principles of Pediatric Ocular Trauma Management</td>
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<td>State of the Art of Intracameral Antibiotics, NSAIDs, Corticosteroids, and Drop-Free Cataract Surgery</td>
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No time during the meeting? Log in to aao.org/cme-central and select your CME type from the filter for self-assessment and take SACME courses from home.