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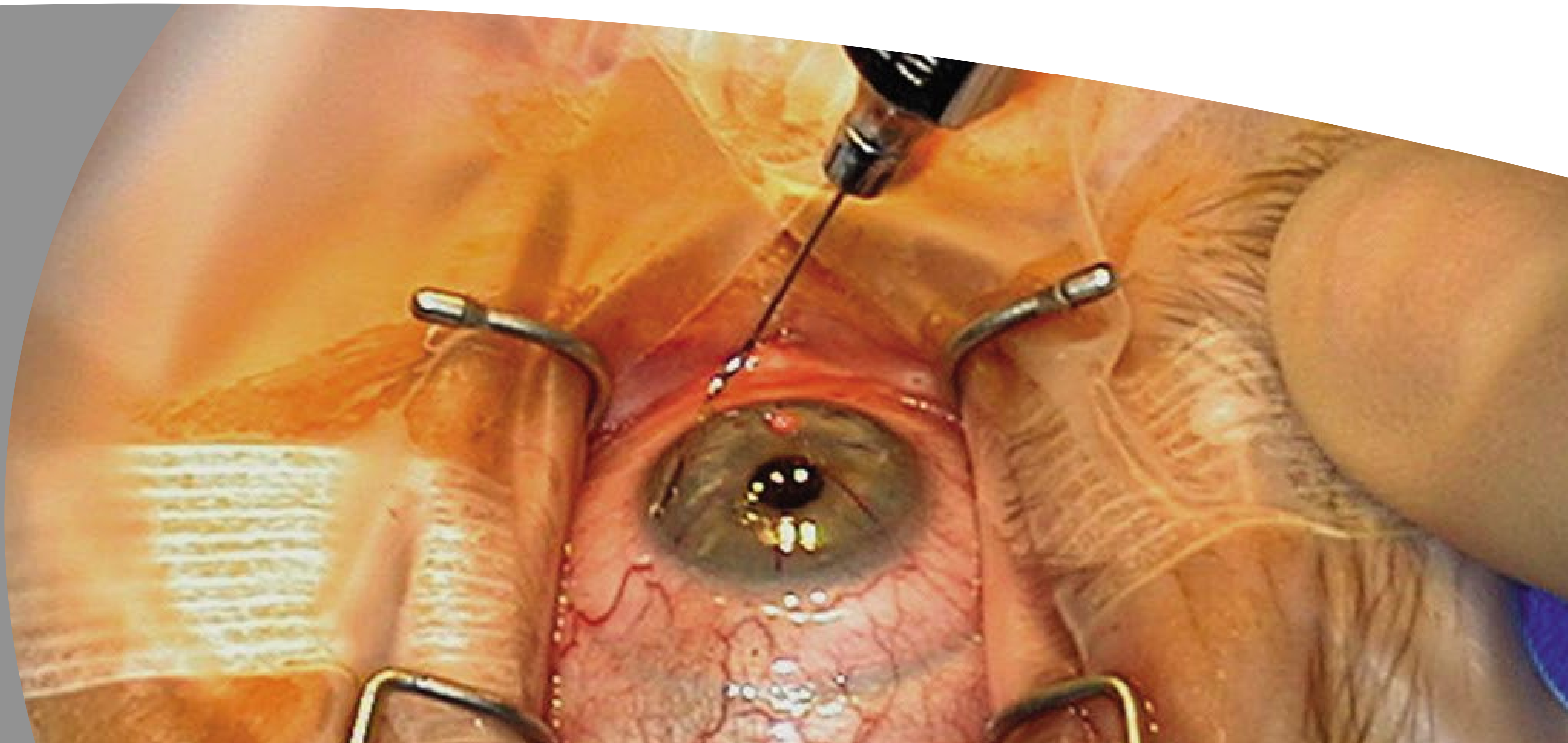

Refractive Surgery 2022

Refractive Surgery in the New Age

Subspecialty Day | AAO 2022

Chicago | Sept 30

Protecting Sight. Empowering Lives.®

Refractive Surgery Subspecialty Day 2022

Refractive Surgery in the New Age

Program Directors

Deepinder K Dhaliwal MD LAc and Jodhbir S Mehta MBBS PhD

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

Sponsored by the ISRS

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

Presented by:
The American Academy of Ophthalmology

Refractive Surgery 2022 Planning Group

Deepinder K Dhaliwal MD LAc
Program Director

Jodhbir S Mehta MBBS PhD
Program Director

Renato Ambrósio Jr MD
Burkhard Dick MD
Nicole Fram MD
Bonnie An Henderson MD
J Bradley Randleman MD

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1995–1997	Peter J McDonnell MD

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Refractive Surgery Subspecialty Day 2022 Planning Group

On behalf of the American Academy of Ophthalmology and the International Society of Refractive Surgery, it is our pleasure to welcome you to Chicago and **Refractive Surgery 2022: Refractive Surgery in the New Age.**

Deepinder K Dhaliwal MD LAc
Program Director

Allergan, Inc.: C
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Program Director

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Avellino Labs: C
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CorneaGen: C,L,SO
Glaukos Corp.: L
Johnson & Johnson Vision: L,C
Lensar: C
Ocular Science: SO,C
Ocular Therapeutix: S
Orasis Pharmaceuticals: C,SO
OysterPoint: C | RxSight: L,C
Vital Tears: L | Zeiss: C,L,S

Bonnie An Henderson MD
Alcon Laboratories, Inc.: C
Allergan, Inc.: C
Horizon: C

J Bradley Randleman MD
None

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Horizon: C

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

Shahzad I Mian MD (Cornea)
Kowa American Corporation: S
Novartis: S
Vison Care: S

Jody R Piltz MD (Glaucoma)
Aerie Pharmaceuticals: C,L

AAO Staff

Ann L'Estrange
None

Melanie Rafaty
None

Debra Rosencrance
None

Beth Wilson
None

Disclosure list contains individual's relevant disclosures with ineligible companies. All relevant financial relationships have been mitigated.

Refractive Surgery 2022 Contents

CME Credit

The Academy's CME Mission Statement

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

Refractive Surgery Subspecialty Day Meeting 2022 Learning Objectives

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

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

Refractive Surgery Subspecialty Day Meeting 2022 Target Audience

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

Teaching at a Live Activity

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

Scientific Integrity and Disclosure of Conflicts of Interest

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

Control of Content

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

Subspecialty Day 2022 CME Credit

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

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

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

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

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

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

Attendance Verification for CME Reporting

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

How to Claim CME

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

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

Academy Members

CME transcripts that include AAOE Half-Day Coding Sessions, Subspecialty Day and/or AAO 2022 credits will be available to Academy members through the Academy's CME Central web page. The Academy transcript cannot list individual course attendance. It will list only the overall credits claimed for educational activities at AAOE Half-Day Coding Sessions, Subspecialty Day and/or AAO 2022.

Nonmembers

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

Proof of Attendance

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

Academy Members

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

Nonmembers

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

CME Questions

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

2022 Award Winners

Jose I Barraquer Lecture and Award

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

Jose I Barraquer Lecture and Award—Graham D Barrett MBBCh

Graham D Barrett MBBCh

Graham David Barrett is a consultant ophthalmologist at the Lions Eye Institute and at Sir Charles Gairdner Hospital in Perth, Western Australia, and a clinical professor in the Department of Ophthalmology at the University of Western Australia. His special areas of interest include cataract and implant surgery, as well as corneal and keratorefractive surgery.

Professor Barrett has been especially active in the field of small-incision cataract surgery and phacoemulsification, and he has published many papers and is the author of several textbook chapters on related topics. He has produced several videos on cataract and refractive surgery, which have won awards at annual film festivals of the American Society of Cataract and Refractive Surgery and the European Society of Cataract and Refractive Surgeons. He is the recipient of the Harold Ridley Medal and the Binkhorst Medal.

His special areas of interests include lens prediction formulae, new techniques in cataract surgery and IOL implant surgery, IOL implant design, and refractive surgical techniques, including epikeratoplasty, synthetic refractive on-lays and in-lays, and keratoscopic devices. He has developed innovative instruments for all cataract surgery as well as phacoemulsification equipment and intraocular implants, which are widely used by surgeons.

Professor Barrett has been on the editorial boards of the *Journal of Cataract and Refractive Surgery* and the *European Journal of Implant and Refractive Surgery*. He is past president of the International Intraocular Implant Club and the Asia Pacific Association of Cataract and Refractive Surgeons, editor of *EyeWorld Asia-Pacific*, and the current and founding president of the Australasian Society of Cataract and Refractive Surgeons.

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—Deepinder K Dhaliwal MD LAc

Deepinder K Dhaliwal MD LAc

Deepinder K Dhaliwal MD LAc is a professor of ophthalmology at the University of Pittsburgh School of Medicine and chief of Refractive Surgery and the director of the Cornea Service at the Eye Center at the University of Pittsburgh Medical Center (UPMC). She is vice chair for Wellness and Communication in the Department of Ophthalmology. Dr. Dhaliwal also serves as the director of the UPMC Laser Vision Center and as the associate medical director of the Campbell Ophthalmic Microbiology Laboratory, and she has recently been appointed as codirector of the Corneal Stem Cell Task Force at the University of Pittsburgh.

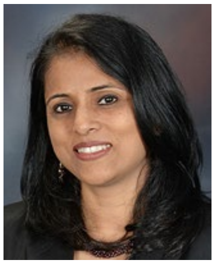
Dr. Dhaliwal earned her medical degree from Northwestern University in the Honors Program in Medical Education, where she was selected to be a member of the prestigious Alpha Omega Alpha Honor Society. She completed her residency in ophthalmology at the UPMC, where she was selected as chief resident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

Dr. Dhaliwal holds leadership positions in the Cornea Society, the International Society of Refractive Surgery of the American Academy of Ophthalmology, and the Eye and Contact Lens Association/CLAO. Dr. Dhaliwal is a recognized expert in her field and teaches corneal and refractive surgical techniques to other ophthalmologists globally. In addition to teaching and research activities, she has authored several book chapters and numerous journal articles, and she serves on the editorial board of several ophthalmology journals. In recognition of her clinical and surgical skills, she has been selected as a "Top Doctor" by her peers every year since 2006.

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— Soosan Jacob MBBS FRCS



Soosan Jacob MBBS FRCS

Dr. Soosan Jacob, director and chief of Dr. Agarwal's Refractive and Cornea Foundation and senior consultant in Cataract and Glaucoma Services at Dr. Agarwal's Eye Hospital, Chennai, India, is a noted surgeon and academician and a well-respected innovator. She is chair of the multimedia editorial board of the International Society of Refractive Surgery (ISRS), member of the ISRS executive committee, chair of the Cornea Committee of the Global Education & Research Society of Ophthalmology, associate editor at the *Journal of Refractive Surgery* (JRS), section editor at *EyeNet* (AAO), and editorial board member for many peer-reviewed journals. She has been featured at a virtual roundtable as one among five of the most influential female figures in ophthalmology and listed multiple times among the Top 100 most influential people in ophthalmology and as a key opinion leader. She is a two-time winner of the American Society of Cataract and Refractive Surgery (ASCRS) Golden Apple award and has also received the ASCRS Top-Gun Instructor award, the John Henahan Prize, the JRS Waring Medal, the Innovator's Award from the Connecticut Society of Eye Physicians, and numerous other international awards and named orations.

Dr. Jacob's innovations include corneal allogenic intrastromal ring segments for keratoconus; contact lens–assisted corneal crosslinking for thin corneas; presbyopic allogenic refractive lenticule inlays for presbyopia; glued capsular hook for subluxated cataracts; stab incision glaucoma surgery; air pump–assisted pre-Descemet endothelial keratoplasty and endoilluminator-assisted Descemet membrane endothelial keratoplasty; host Descemetic scaffolding; classification of Descemet detachments into rhegmatogenous, tractional, bullous, and complex, with treatment algorithm; relaxing Descemetotomy; turnaround technique for Intacs; glued endocapsular ring; anterior segment transplantation; suprabrow single-stab-incision ptosis surgery; sequential segmental terminal lenticular side-cut dissection and white ring sign for SMILE; SMILE lenticule–assisted dermoid excision; and others. Her educational YouTube channel is among the top-most heavily subscribed ophthalmic YouTube channels.

Dr. Jacobs has authored more than 110 peer-reviewed publications and more than 200 chapters in 40 textbooks and is editor for 17 ophthalmology textbooks.

Kritzinger Memorial Award

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

Kritzinger Memorial Award—Sri Ganesh MBBS DNB DSC(Hon.) FRCS (Glasgow) FAICO

Sri Ganesh MBBS DNB DSC(Hon.) FRCS (Glasgow) FAICO

Founder of Nethradhama Hospitals Pvt Ltd and Shraddha Eye Care Trust, **Dr. Sri Ganesh** started his practice in 1994 and now runs eight eye hospitals. He started his refractive surgery practice with radial keratotomy in 1994 and LASIK in 1997 and has been at the forefront of refractive surgery technologies ever since. He has performed over 120,000 cataract surgeries and 75,000 refractive surgeries. He has over 60 peer-reviewed publications and has done some pioneering work on lenticule extraction techniques and using SMILE lenticules in tissue addition techniques for correction of hyperopia and keratoconus.

Dr. Ganesh has contributed to six book chapters. He has trained over 200 national and international fellows in phaco and refractive surgeries. He was awarded an honorary doctorate from the Rajiv Gandhi University of Health Sciences in 2014 for his contributions to the field of ophthalmology. He was awarded the honorary FRCS (Glasgow) in 2018. He was awarded the Gold Medal Oration by the Australasian Society of Cataract and Refractive Surgeons in 2017, the Intraocular Implant & Refractive Society, India Gold Medal in 2007, and the Bombay Ophthalmologists' Association Gold Medal in 2011.

Dr. Ganesh has delivered numerous orations and lectures at various national and international conferences and conducted instruction courses and symposia. He has performed over 80 live surgical demonstrations during national and international meetings. He is a member of several national and international ophthalmic societies, including the International Intra-Ocular Implant Club.

Lans Distinguished Lecturer Award

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

Lans Distinguished Lecturer Award—Edward E Manche MD

Edward E Manche MD

Dr. Edward Manche is professor of ophthalmology and division chief of the Cornea and Refractive Surgery Service at the Byers Eye Institute at Stanford University School of Medicine. He received his medical degree from Albert Einstein College of Medicine and completed residency training at Rutgers, New Jersey Medical School, where he served as chief resident. He completed a two-year fellowship in Cornea and Refractive Surgery at the Jules Stein Eye Institute at UCLA.

Dr. Manche is a fellow of the American Academy of Ophthalmology and received its Achievement Award in 2003 and its Senior Achievement Award in 2014. He was elected to active membership in the American Ophthalmological Society in 2011 and is recognized in Best Doctors in America, Guide to America's Top Physicians, and Top Doctors in Silicon Valley. He serves on the editorial boards of the *American Journal of Ophthalmology*, *Journal of Ophthalmology*, and *Journal of Refractive Surgery.*

Dr. Manche has performed over 50,000 laser vision correction procedures. He lectures widely on topics in cornea and refractive surgery and has published over 135 peer-reviewed articles and 30 book chapters.

He has been a principal investigator for twenty-five FDA clinical trials, including wavefront-guided LASIK, phakic IOLs, and SMILE surgery.

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—Sheraz M Daya MD

Sheraz M Daya MD

Sheraz Daya is an ophthalmologist based in the United Kingdom. He qualified in 1984 with an honors degree in medicine at the Royal College of Surgeons in Ireland. He trained in New York and became board certified in internal medicine and later ophthalmology. In 1991 he trained under both Richard Lindstrom and Edward Holland at the University of Minnesota as a Fellow in cornea, anterior segment, and keratorefractive surgery. After a couple of years in practice in New York City, he was appointed director of the Corneoplastic Unit and Eye Bank, Queen Victoria Hospital, East Grinstead, UK (1994-2011). With his wife, Marcela, also an ophthalmologist, he established the Centre for Sight, which has three sites and recently celebrated its 25th year.

Mr. Daya introduced LASIK to the UK in 1994 and has remained a pioneer in modern refractive surgery, introducing the femtosecond laser for LASIK surgery to the UK in 2004 and developing its use in corneal transplantation and cataract surgery. He is the medical monitor for Technolas, Bausch + Lomb, manufacturers of the Victus and Teneo lasers, and he directed the development of their option for transepithelial PRK.

His areas of expertise include high-risk corneal transplantation, limbal stem cell transplantation, lamellar corneal transplantation, refractive surgery, and high-performance IOLs. He has over the last two years led a working group under the auspices of the American-European Congress of Ophthalmic Surgery (AECOS) Europe, devising new nomenclature for high-performance lenses.

Mr. Daya has published extensively on ocular surface reconstruction, limbal stem cell transplantation, and novel lamellar transplant techniques. He has over 100 publications and is the founding medical editor of *CRSTEurope*. He has served and continues to serve committees and boards of numerous organizations, including the European Society of Cataract and Refractive Surgeons, the United Kingdom & Ireland Society of Cataract & Refractive Surgeons, the American Society of Cataract and Refractive Surgery, the American Academy of Ophthalmology, the AECOS, the Royal College of Ophthalmologists, and the Corneal Society. He is president-elect of AECOS Europe, 2024 to 2026.

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—Michael W Belin MD

Michael W Belin MD

Michael W Belin attended Northwestern University (Evanston, Illinois), where he majored in bio-medical engineering, and received his medical degree from Rutgers Medical School (New Jersey). He completed his internship and residency at the Albany Medical College and his fellowship in cornea and external diseases at the University of Iowa. He subsequently completed a traveling fellowship by invitation from the Royal College of Surgeons of England Foundation.

Dr. Belin is Professor of Ophthalmology & Vision Science at the University of Arizona, Department of Ophthalmology, and Southern Arizona Veterans Administration Health Care System (Tucson, Arizona). He also holds an honorary professorship at the Military Hospital #1, Shenyang, China.

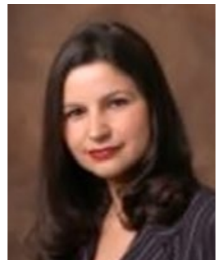
Dr. Belin is a past-president of the Cornea Society (2006-2008) and past[en]vice president for International Development (2008-2015). He is a Fellow of the Royal Australian & New Zealand College of Ophthalmology. He served on the Board of Directors, the Medical Advisory Board, and the Executive Committee of the Eye Bank Association of America. He is past chair of the American University Professors of Ophthalmology's Fellowship Compliance Committee (AUPO-FCC).

Dr. Belin is a past recipient of the Academy's Honor Award, Senior Honor Award, Academy Service Award, Achievement Award (x2), and Lifetime Achievement Award. Dr. Belin codeveloped with Dr. Ambrosio the Belin/Ambrosio display (BAD), the most commonly used refractive screening software, and he developed the ABCD Keratoconus Classification and Progression Display. He has published over 180 peer-reviewed articles and has presented over 250 papers at major national and international meetings.

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—Liliana Werner MD PhD



Liliana Werner MD PhD

Liliana Werner MD PhD is a professor of ophthalmology and vision sciences and codirector of the Intermountain Ocular Research Center at the John A Moran Eye Center, University of Utah. She has a MD from Brazil and a PhD in biomaterials from France. Dr. Werner's research is centered on the interaction between ocular tissues and different IOL designs, materials, and surface modifications. These include IOLs implanted after cataract surgery, phakic lenses for refractive surgery, and ophthalmic implantable devices in general. Another focus of her research is the performance of preclinical studies evaluating new IOL-related technology.

Dr. Werner has authored more than 360 peer-reviewed publications and book chapters on her research, coedited 3 books, and received numerous awards in international meetings for scientific presentations, videos, and posters. She has also been a guest speaker at various international meetings in at least 25 countries, and she is a consultant for companies manufacturing IOLs and other ocular biodevices. Since June 1, 2020, Dr. Werner has been the U.S. associate editor of the *Journal of Cataract & Refractive Surgery*. This year she will deliver the Charles D Kelman Lecture during the Spotlight on Cataract at the American Academy of Ophthalmology annual meeting.

31st 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—FangJun Bao MD

FangJun Bao MD

Dr. FangJun Bao received his Bachelor of Clinical Medicine degree from Zhejiang University in 2004 and graduated with a PhD in Ophthalmology and Visual Sciences at Wenzhou Medical University in 2015. Dr. Bao has been engaged in ophthalmology and optometry for a long time, especially in correcting refractive error through SMILE, femtosecond LASIK, transepithelial PRK, implantable collamer lenses, and other areas. He is an expert in keratoconus diagnosis and treatment (including corneal crosslinking). Dr. Bao was employed as an Honorary Visiting Professor at the University of Liverpool from 2015 to 2018. He was selected for the 551 Talents Project of Wenzhou in 2016, received an ARVO Travel Grant Award in 2017, and was selected as a High-Level Professional in Health Care of Zhejiang in 2020. He was supported from the Rising Stars Talent Cultivation Program for Future Vision Care Leadership and the Yucai Project of Zhejiang Association for Science and Technology. Dr. Bao's research interests include the investigation of keratoconus in terms of imaging and corneal biomechanical properties, the accurate measurement of IOP through correcting corneal stiffness, assessment of the effects of regional variation of corneal constitutive parameters in keratoconus before and after corneal collagen crosslinking therapy, the establishment and verification of predicting tools for corneal refractive surgery considering ocular biomechanical properties, and quantification of deterioration in corneal biomechanics with the use of prostaglandin F2α analogues. He has accomplished more than 10 projects, including 2 projects from the National Natural Science Foundation of China. He has published more than 40 papers in SCI journals as the main author.

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—Riccardo Vinciguerra MD

Riccardo Vinciguerra MD

Dr. Riccardo Vinciguerra is currently working as an ophthalmologist and scientific director at the Humanitas San Pio X Hospital, Milan, as well as a research collaborator at Biomechanical Engineering Group, University of Liverpool, UK. Despite his young age (36 years old), he is a well-known international researcher with multiple peer-reviewed publications, mainly in the field of corneal biomechanics, refractive surgery, corneal collagen crosslinking, and corneal transplants.

Dr. Vinciguerra completed medical school at the Università degli Studi di 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 and a cornea clinical fellowship at the Royal Liverpool University Hospital, Liverpool, UK. He then worked as a cornea consultant at the Birmingham and Midland Eye Center, Birmingham, UK. The article "Detection of keratoconus with a new biomechanical index," published in the *Journal of Refractive Surgery*, earned him the prestigious Troutman Prize in 2017 and was also previously awarded with the Trimarchi Prize by the University of Pavia, Italy.

Dr. Vinciguerra is the author of 95 original scientific articles in peer-reviewed journals and has received 5 prizes and awards. His work has been cited more than 2,200 times, with an h-index of 22.

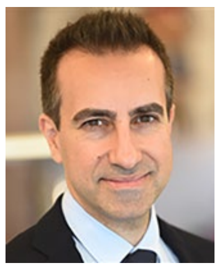
Faculty

Amar Agarwal MD
Chennai, India

Marcus Ang MBBS PhD
Singapore, Singapore

Irina S Barequet MD MHA
Herzliyya, Israel

Ashvin Agarwal MD
Chennai, India



Shady T Awwad MD
Beirut, Lebanon

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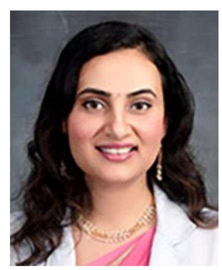

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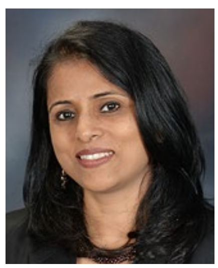

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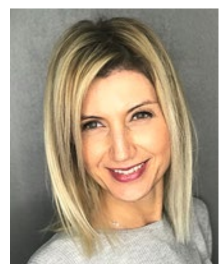

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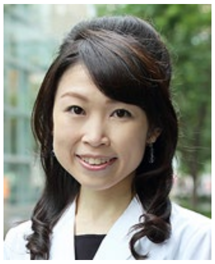

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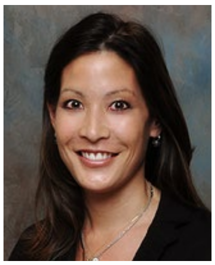

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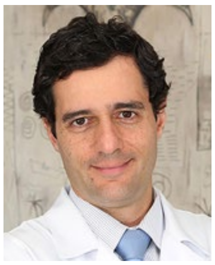

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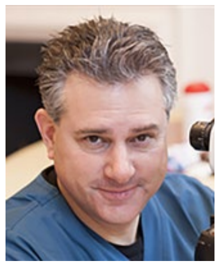

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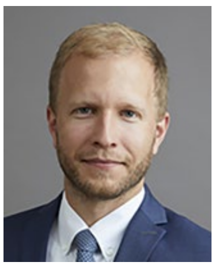

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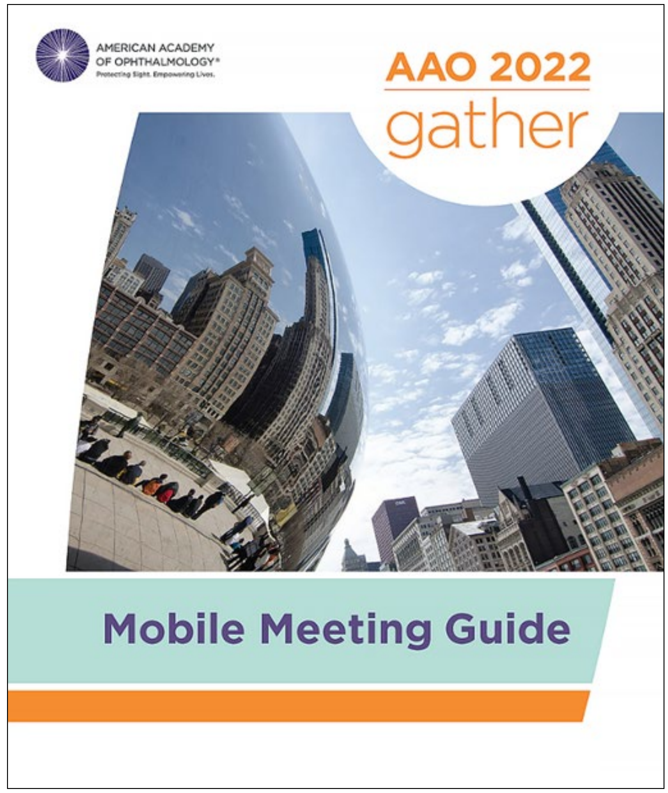

Refractive Surgery Subspecialty Day 2022

Refractive Surgery in the New Age

FRIDAY, SEPT. 30, 2022

8:00 AM	Welcome and Introductions	Deepinder K Dhaliwal MD LAc Jodhbir S Mehta MBBS PhD	

Section I: Refractive Surgery in the New Era

Moderators: Nicole R Fram MD and William B Trattler MD

Virtual Moderator Morning Sessions: Sabrina Mukhtar MD

Panelists: Damien Gatinel MD, Vanessa Pongo Valderas MD, and Helen K Wu MD

8:05 AM	Virtual Consults and Same-Day Surgery	Neda Shamie MD	1
8:12 AM	Optics 101: Matching Optics to Available Technology	Julie M Schallhorn MD	2
8:19 AM	Custom Treatments: Simple Solutions for a Complex Cornea	Kashif Baig MD MBA	3
8:26 AM	What If I Have an Aberrated Cornea? Small-Aperture Options	Roger Zaldivar MD	4
8:33 AM	I Can't Have LASIK . . . Now What? Transitioning to ICL	Gregory D Parkhurst MD	5
8:40 AM	SMILE . . . I'm Ready Now!	Saama Sabeti MD	6
8:47 AM	Discussion		

Section II: What's New for Me in 2022

Moderators: Jodhbir S Mehta MBBS PhD and Bonnie An Henderson MD

Panelists: Arthur B Cummings MD and Angela M Gutierrez MD

9:02 AM	Expanding Indications for Presbyopia-Correcting IOLs	Gregory Moloney MD	8
9:09 AM	Lenticule Extraction 2.0	Jodhbir S Mehta MBBS PhD	10
9:16 AM	Corneal Allogenic Intrastromal Ring Segments: Where Are We Now?	Soosan Jacob MBBS FRCS	11
9:23 AM	Phakic IOLs: New Indications, New Sizing Techniques	Dan Z Reinstein MD	12
9:30 AM	New Technologies Here and Coming Soon	Burkhard Dick MD	15
9:37 AM	Discussion		
9:52 AM	In These Unprecedented Times . . .	Sanjay D Goel MD	16

ISRS Awards

9:57 AM	ISRS Awards	Renato Ambrósio Jr MD	
10:07 AM	REFRESHMENT BREAK		

Section III: Pearls From Around the World in Refractive Surgery

Moderators: Renato Ambrosio Jr MD and Aylin Kilic MD

Panelists: Tae-im Kim MD PhD, Marguerite B McDonald MD, and Namrata Sharma MD MBBS

10:37 AM	Optimizing the Ocular Surface in Refractive Surgery	José Gomes MD	18
10:42 AM	Top Tips in Refractive Surgery Screening	Shizuka Koh MD	20
10:47 AM	My Top 5 LASIK Pearls	Ashiyana Nariani MD MPH	21

2:50 PM	Determinants of Subjective Quality of Vision After Phakic Intraocular Lens Implantation	Niklas Mohr MD	42
2:55 PM	Epithelial Basement Membrane Regeneration After PRK-Induced Epithelial-Stromal Injury in Rabbits: Fibrotic Versus Non-fibrotic Corneal Healing	Lycia Pedral Sampaio MD	43
3:00 PM	Discussion		

Section VII: ESCRS Symposium—Refractive Surgery in the New Age

Moderator: Oliver Findl MD

3:15 PM	Biosynthetic Collagen Presbyopic Corneal Inlay	Pavel Stodulka MD PhD	44
3:20 PM	Hyperopia Correction Using Allografts (LIKE)	Theo Guenter Seiler MD	45
3:25 PM	Adjustable Solution for the Enhancement of Pseudophakic Eyes With Additive IOLs	Michael Amon MD	46
3:30 PM	Presbyopic Phakic IOLs	José L Güell MD PhD	48
3:35 PM	IOL Calculations, the Internet Way	Oliver Findl MD	49
3:40 PM	Discussion		
3:45 PM	Refreshment Break		

Keynote Lecture II (Not eligible for CME credit)

4:15 PM	Introduction	Deepinder K Dhaliwal MD LAc	
4:16 PM	My Journey in Refractive Surgery and Lessons Learned	Sheraz M Daya MD	50

Section VIII: Innovation (Not eligible for CME credit)

Moderators: Burkhard Dick MD and Deepinder K Dhaliwal MD LAc

Panelists: Ranya G Habash MD, Dirk Muehlhoff MSC, and George O Waring IV MD

4:26 PM	Can We Restore Accommodation Today?	Luca Gualdi MD	51
4:33 PM	New Concept of Light Distribution for Bilateral Trifocal IOL Implantation	Francesco Carones MD	53
4:40 PM	Epi-On Crosslinking at Slit Lamp: Latest Advances	Farhad Hafezi FARVO MD PhD	54
4:47 PM	Refractive Correction With Tissue Addition	Michael Mrochen PhD	56
4:54 PM	Using AI to Optimize Excimer Ablations	A John Kanellopoulos MD	57
5:01 PM	Discussion		
5:28 PM	Closing Remarks	Deepinder K Dhaliwal MD LAc Jodhbir S Mehta MBBS PhD	
5:29 PM	ADJOURN		

Virtual Consults and Same-Day Surgery

Neda Shamie MD

NOTES

Optics 101: Matching Optics to Available Technology

Julie M Schallhorn MD

NOTES

Custom Treatments: Simple Solutions for a Complex Cornea

Kashif Baig MD

I. Options for Complex Cornea

  A. Corneal treatments (corneal allogenic intrastromal ring segments, topography-guided PRK)

  B. Scleral contact lenses

  C. IOLs (pinhole IOLs, supplementary IOLs)

Selected Readings

1. Parker JS, Dockery PW, Jacob S, Parker JS. Preimplantation dehydration for corneal allogenic intrastromal ring segment implantation. *J Cataract Refract Surg.* 2021; 47(11):e37-e39.
2. Ling JJ, Mian SI, Stein JD, Rahman M, Poliskey J, Woodward MA. Impact of scleral contact lens use on the rate of corneal transplantation for keratoconus. *Cornea* 2021; 40(1):39-42.
3. Shajari M, Mackert MJ, Langer J, et al. Safety and efficacy of a small-aperture capsular bag-fixated intraocular lens in eyes with severe corneal irregularities. *J Cataract Refract Surg.* 2020; 46(2):188-192.

What If I Have an Aberrated Cornea? Small-Aperture Options

Roger Zaldivar MD

Purpose

To evaluate visual performance and ease of use of a small-aperture IOL in cataract patients with aberrated corneas

Setting

Single site: Instituto Zaldivar, Mendoza, Argentina

Methods

Retrospective analysis of 80 patients presenting for cataract surgery with highly aberrated corneas. IC-8 IOL eyes were targeted for −0.75 D, and their fellow monofocal IOL eyes were targeted for plano. Uncorrected visual acuity, total corneal higher-order aberrations, and manifest refractive surgical equivalent (MRSE) were evaluated.

Results

Preoperative total higher-order aberrations were 0.5 µm ± 1.5 µm. Mean achieved MRSE in the IC-8 IOL eyes was −1 D ± 1.5 D and 0.5 D ± 1.0 in the fellow monofocal IOL eyes. For uncorrected near, intermediate, and far visual acuities, patients achieved 0.2 logMAR ± 0.2, 0.1 logMAR ± 0.2, and 0.2 logMAR ± 0.3, respectively.

Conclusions

The combination of a small-aperture IOL and a monofocal IOL provides prior corneal refractive patients with reliable extended depth of focus and effectively compensates for presence of corneal higher-order aberrations.

I Can't Have LASIK . . . Now What? Transitioning to ICL

Gregory D Parkhurst MD

NOTES

SMILE . . . I'm Ready Now!

Saama Sabeti MD

Introduction

The principle of keratomileusis, first described by Professor José Ignacio Barraquer in 1964, has evolved significantly from the original procedure, which involved the removal, shape modification, and reinsertion of a lamellar disc into the cornea.[1] This evolutionary process has included, most notably, the flapless and flap-based excimer laser ablation techniques of photorefractive keratectomy (PRK) and laser-assisted in situ keratomileusis (LASIK), respectively; femtosecond lenticule extraction (FLEx), in which a refractive stromal lenticule is manually removed from beneath a flap[2]; and finally, small-incision lenticule extraction (SMILE), a flapless, femtosecond laser procedure that involves refractive lenticule extraction from the stroma via a small incision.[3,4] SMILE was FDA approved for the correction of myopia and myopic astigmatism in 2016.

SMILE: Technique

SMILE surgery involves patient positioning under a single machine. The only device currently FDA-approved for SMILE surgery is the VisuMax femtosecond laser (Carl Zeiss Meditec). Docking of the contact glass onto the cornea is performed, and suction is applied while the patient fixates ahead on a green, blinking light. There is minimal corneal distortion with the curved contact glass, and low suction force is applied,[5] averting complete loss of vision during coupling. The femtosecond laser creation of the refractive lenticule and opening incision take approximately 30 seconds to complete, after which suction is released. The lenticule is then surgically dissected away from surrounding stroma and removed through a small incision in the superior cornea.

SMILE: A Revolutionary Option for Laser Refractive Correction

SMILE has been shown in numerous studies to have safety, efficacy, and predictability similar to those of femtosecond LASIK, the current standard for laser refractive surgery.[5-7] Its main potential advantages have been described to be in relation to reduced risk of postoperative dry eye disease and better preservation of corneal biomechanics.[5] Dry eye disease is a known complication of any laser refractive procedure. In LASIK, the sub-basal nerve plexus and superficial stromal nerve bundles within the flap interface are cut 300 degrees around the flap edge, and excimer laser ablation further severs stromal nerves; in contrast, during the SMILE procedure, the nerve fibers that originate outside of the cap diameter or anterior to the cap interface are spared.[5] Mean central corneal sensitivity has been shown to increase significantly faster in SMILE than in LASIK at up to 6 months postoperatively.[5,8] With respect to corneal biomechanics, ex vivo studies have demonstrated that the anterior 40% of the stroma is significantly stronger than the posterior 60% of the stroma in terms of tensile strength, and that vertical cuts weaken the cornea more than horizontal cuts.[5,9] Given that more of the anterior stroma remains to contribute to postoperative corneal tensile strength in SMILE as a flap cut is avoided, it has been proposed that SMILE should offer improved biomechanics.[9] Meta-analyses have suggested that SMILE may provide better preservation of corneal biomechanical strength compared to LASIK, looking at measures provided by the Corvis ST (Oculus) and/or Ocular Response Analyzer (Reichert Technologies).[7,10] These studies are limited, however, by nonstandardization of measurements of in vivo biomechanical strength, and further investigation of this subject will be relevant in the future as both our understanding and methods of measuring corneal biomechanical strength continue to evolve.

SMILE: Current Limitations

SMILE is currently FDA-approved for correction of up to –10 D of myopia and up to 3.0 D of astigmatism. Hyperopic treatments and cyclotorsion correction are not currently available in the United States but are in the pipeline.

Which Procedure Is Best for My Patient?

Of course, no single laser refractive procedure is the best option for all patients. As with all surgical management plans, the choice of procedure should cater to the patient's individual needs. It should be noted that, currently, patients requiring hyperopic correction, correction of myopia greater than –10.0 D, correction of cylinder greater than 3.0 D, or topography- or wavefront-guided treatments would not be candidates for SMILE. Appropriate patient selection with respect to degree of refractive error, residual stromal bed thickness, safety of having a flap, history of dry eye disease, and tolerance of procedure type should be taken into consideration when deciding which procedure is best for the patient.

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Expanding Indications for Presbyopia-Correcting IOLs

Gregory Moloney MD, Luke C Northey FRANZCO, Simon P Holland FRCSC, and David TC Lin FRCSC

Introduction

There is a range of available presbyopia-correcting IOLs, categorized into subtypes—such as accommodating; extended depth-of-focus (EDOF); multifocal, including trifocal and bifocal; and small-aperture—based upon the implant's optical design.[1] Traditionally, implantation of these IOLs was limited to patients with no existing ophthalmic pathology or history of refractive surgery. As outcome data has expanded for presbyopia-correcting IOLs, so too have indications for their use.[2] In addition to advances in presbyopia-correcting IOLs, we have access to refined refractive laser platforms to optimize vision before and after cataract or clear lens extraction.

There is a need to further assess the interaction of these technologies in order to optimize vision outcomes and spectacle independence for our patients. In this presentation I will discuss the expanding indications for presbyopia-correcting IOLs, particularly focusing on the role laser vision correction (LVC) may have in patients receiving these implants.

Background Observations and Existing Literature

Trifocal and multifocal IOLs promise spectacle independence across a range of distances, with reported adverse events including haloes, glare, starbursts, and altered contrast sensitivity.[3] Initial clinical trials were limited to patients with no history of corneal surgery or significant astigmatism.[3] Their use after LVC, including LASIK and PRK, offers challenges with accurate IOL power selection and postoperative optical aberrations.[4]

With our improving understanding of trifocal IOL suitability and biometry accuracy in post-LVC patients, there are now case series describing satisfactory vision and patient-reported outcomes for post-LVC patients receiving trifocal IOLs.[5,6] Similarly, LVC has been used postoperatively to correct residual refractive error in multifocal IOL patients whilst preserving near and intermediate visual acuity.[7]

EDOF IOLs aim to achieve uncorrected distance visual acuity and offer some capacity for uncorrected intermediate and near vision by elongating the focal point without diffractive rings.[1] With appropriate IOL power calculations, post-LVC patients receiving an EDOF IOL may achieve good uncorrected distance and near visual acuity.[8]

Small-aperture IOLs rely upon pinhole optics to provide extended depth of focus and are effective at improving vision across a range of working distances.[9] As further discussed below, we have used this technology in combination with topography-guided PRK to correct corneal irregularity and improve visual acuity in patients with keratoconus and cataract.[10]

My Experience and Proposed Future Directions

Patients with existing corneal pathology, particularly those with irregular astigmatism associated with corneal ectasias, are often considered unsuitable for the above presbyopia-correcting IOLs. In our practice we work to first optimize corneal regularity, in suitable patients, through application of topography-guided PRK. This initial treatment step expands the group of patients who may benefit from a presbyopia-correcting IOL.

Little is currently published about the ability of topography-guided refractive treatments to expand indications for advanced technology IOLs. We will present cases that address the following scenarios:

1. Topography-guided laser as pretreatment of the irregular cornea prior to cataract surgery
2. Topography-guided laser as postcataract intervention
3. Topography-guided laser as an adjuvant to newer IOL designs

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Lenticule Extraction 2.0

Jodhbir S Mehta MBBS PhD

NOTES

Corneal Allogenic Intrastromal Ring Segments: Where Are We Now?

Soosan Jacob MBBS FRCS

The term "corneal allogenic intrastromal ring segments" (CAIRS) was coined to refer to the use of allogenic segments of tissue that are placed within intrastromal ring channels to achieve flattening of the ectatic cornea. The speaker first described this technique and started it in 2015, and since then it has been constantly gaining greater and greater acceptance around the world. It is now being practiced in more than 12 countries around the world, among them the United States, Germany, Ireland, Turkey, Lebanon, Israel, Australia, Canada, South Africa, and the Dominican Republic.

CAIRS are created by using a special double-bladed trephine designed by the speaker (patent pending). The segments may be created from any source of allogenic tissue and may be prepared as fresh cut segments; unprocessed segments; and processed, preserved, or packaged segments. They may be prepared by the surgeon or supplied precut by the eye bank. They may also be prepared using the femtosecond laser for cutting the segments.

CAIRS is performed on the patient's eye after creating circular intrastromal channels. These channels are created using the "Ring" setting of the femtosecond lasers. They may also be created using manual dissection techniques, such as the prolate system or tunnel dissectors. Smaller optic zone, wide channels, and more superficial placement than synthetic segments is possible while retaining efficacy. One or 2 entry incisions are programmed to guide the CAIRS into the channels.

The CAIRS may be designed to be of uniform thickness or to be customized. Customization can include specifically shaped CAIRS, symmetric or asymmetric CAIRS, progressive or variable thickness CAIRS, progressive and/or variable width CAIRS, combinations, sudden or gradually tapered shape transitions, and variations in extent and location of shape change along the arc length, among others. Various instruments designed by the speaker (Epsilon Instruments, no financial interests) are available for achieving this as well as for easy insertion into the channels. Customization can help tailor CAIRS to the individual patient's topographical and refractive requirements.

CAIRS provide desirable refractive and topographic effects without disadvantages that Intacs and other synthetic segments have, such as overlying melts, necrosis, intrusion, extrusion, and migration. It can be done for a large range of keratoconus, from mild to advanced. The procedure has shown significant improvement in all parameters, such as uncorrected and spectacle-corrected visual acuity, spherical equivalent, maximum, mean, and SimK keratometric values, astigmatism, anterior elevation, and so on.

CAIRS is combined simultaneously or sequentially with corneal crosslinking when used for progressive keratoconus or other progressive ectasias. It can be used in advanced cases if thickness is sufficient to also perform crosslinking to aid stabilization. It has numerous advantages over deep anterior lamellar keratoplasty (DALK), being an easier and safer procedure with less risk of intra- and postoperative complications and with surgical interventions that lie outside the visual axis. The procedure is reversible and adjustable and does not take away the ability to do DALK or any other treatment option that may become necessary or available in the future. It may also be used synergistically with treatment modalities such as topography-guided ablation or phakic IOL implantation. Though the possibility of rejection exists, it is in practicality very low for numerous reasons, such as low amount of tissue transfer, absence of endothelial and epithelial transfer, the intrastromal location, distance from the limbus, lack of sutures, and the rapid repopulation by host keratocytes.

To conclude, CAIRS is a safe and effective treatment modality for corneal ectasia and is gaining more and more popularity around the world. Further multicentric studies will help throw more light on this treatment modality.

Phakic IOLs: New Indications, New Sizing Techniques

New Sizing Parameters and Model for Predicting Vault for the Implantable Collamer Lens

Dan Z Reinstein MD

The implantable collamer lens (ICL) (Staar Surgical; Monrovia, CA) is well recognized as a safe, effective, and stable method of correction in a wide range of ametropia.[1-5] The key safety parameter for implantation depends on the ICL sizing and, notably, the separation between the ICL and the natural crystalline lens, commonly referred to as the vault. Precise sizing of the ICL and an accurate estimation of the vault are crucial to the success of ICL surgery. A high vault has been linked to early cataract formation,[3-5] and a low vault associated with glaucoma as a result of raised IOP.[6,7]

Improvements to sizing techniques have developed over time with the advent of new diagnostic technology and formula. Until recently, recommended sizing algorithms for ICL sizing used mainly external landmarks to define the horizontal white-to-white (WTW) diameter in predicting the position of the ICL behind the iris. However, this method has been documented to have a poor correlation with the internal posterior chamber anatomy.[2-6] As a result, sizing formulae using internal measurements obtained from ultrasound biomicroscopy (UBM) or OCT can be used to improve accuracy and therefore safety in ICL implantation.

A number of devices can be used to record the various measurements required in determining the size of the ICL. UBM devices can provide detailed imaging of iris structures, such as the posterior pigmented epithelium, in addition to structures located behind the iris, such as the ciliary body, sulcus, lens zonules, and peripheral crystalline lens surface, which are not visible by optical diagnostic devices. Anterior segment OCT can image the anterior chamber and internal landmarks, such as the scleral spur and anterior chamber angle. The Artemis Insight 100 very-high frequency (VHF) digital ultrasound scanner (ArcScan; Golden, CO) includes infrared imaging of the eye and results in the output of higher-resolution B-scan images of the anterior segment and posterior chamber to improve ICL sizing.

The manufacturer-based nomogram determines the size of the ICL based solely on measurements of the WTW and ACD. However, since the ICL is fixated within the sulcus, direct sulcus-to-sulcus (STS) measurements are therefore optimal to predict vault. In order to overcome any potential errors, many ICL sizing nomograms have been developed in order to achieve a more accurate and therefore acceptable vault: Dougherty et al[8] published sizing formulae based on handheld UBM measurement and found lens power and STS horizontal diameter were well correlated with ICL sizing. Kojima et al[9] also employed handheld UBM-based measurement of the posterior chamber STS and introduced the concept of adding crystalline lens rise from the STS plane (STSL) along with anterior chamber depth (ACD) in a multivariate sizing formula.

Nakamura et al have published an OCT-based NK formula[10] and updated NK-2 formula[11] using a multivariate model for ICL sizing including ACD, anterior chamber width, and crystalline lens rise from the angle-to-angle plane.

The Reinstein ICL sizing formula was derived by multiple linear regression analysis using stepwise forward elimination to assess the correlation of the central vault with anterior segment and posterior chamber parameters. The following variables were measured in the development of the model for predicting the central vault: ICL size, ICL power, STS, ciliary body inner diameter (CBID), zonule-to-zonule, STS lens rise (STSL), ACD, anterior chamber angle, scotopic pupil diameter (SPD), angle-to-angle, and WTW. Statistically significant parameters were retained for inclusion in the final model. A series of eyes were treated using the Reinstein formula v1.0 before the process was repeated to derive an updated Reinstein formula, v2.0. The vault outcomes were compared to the training group and also to the predicted vault based on the recommended lens size calculated by sulcus-based sizing methods (Dougherty,[8] Kojima[9]), OCT-based methods (NK2[11] and Igarashi[12]), and the Staar OCOS website.

Results

The statistically significant variables included in the Reinstein sizing formula were ICL size, ICL power, CBID, STSL, and SPD. The analysis concluded that the central vault would be higher for a larger lens size, higher for a higher lens power, higher for a smaller CBID, higher for a lower STSL, and higher for a larger SPD.

The interquartile range for the central vault improved from 391 µm for the Training Group to 169 µm for Reinstein formula v1.0 and 131 µm for Reinstein formula v2.0 (Figure 1). Using the Reinstein formula, the central vault was within ±100 µm of the predicted vault for 61% of eyes, within ±200 µm for 86%, and within ±300 µm for 96% of eyes (Figure 2). When comparing the Reinstein formula with those previously published, the most similarity was found with the Dougherty and Igarashi formulae. The NK2 and Kojima tended to recommend slightly larger lenses. The Staar OCOS calculator recommended the largest lenses, indicating a 13.7-mm lens in 37% of eyes and a 12.6-mm lens for only 4%. This led to the lowest accuracy of the predicted vault, with only 18% predicted within ±100 µm. Overall, the Staar formula recommended the same lens size only 40% of the time, and a lens size 2 sizes larger in 17% of eyes.

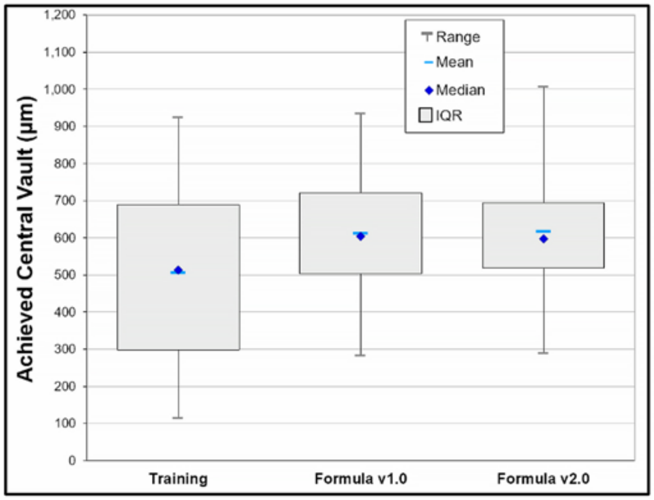

Figure 1. Box plot of the central vault 1 month after surgery.

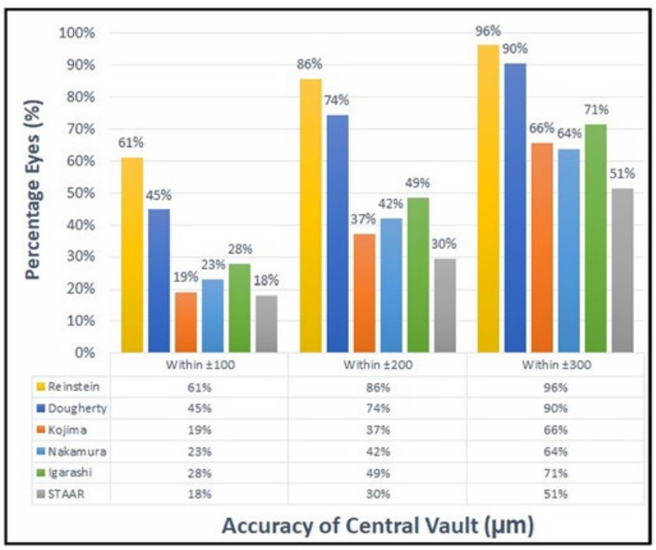

Figure 2. Histogram of the central vault accuracy relative to the target vault 1 month after surgery.

Previously published ICL sizing formulae did not include the SPD, which was found to be a significant predictive variable, where a larger pupil diameter indicated a higher lens vault. It is important to emphasize that postoperative vault should be measured with the physiological pupil in standard lighting conditions. Of all the variables in the Reinstein formula, STSL had the highest correlation with the postoperative vault. As this is a vertical measurement, it has a direct impact on the vault regardless of the lens position inside the eye.

The final resting position of the lens is a variable to consider when comparing the estimated vault to the vault achieved postoperatively. A subanalysis of the training group found the lens footplates rested in the ciliary body in 94% of eyes compared to directly at the sulcus in only 6%. These findings were similar to those published by Zhang et al,[13] concluding that the haptics in most cases were not in the ciliary sulcus—in the ciliary process in 12.7%, under the ciliary sulcus in 10.4%, and inserted in the ciliary body in 32.1% of eyes. Improvements to ICL positioning can be achieved with the use of intraoperative OCT to review the angle anatomy and vault live during the procedure; further research is required to evaluate this as a variable, which could lead to more accurate ICL positioning and therefore vault prediction.

Conclusion

The present study demonstrated that the measurement of ciliary body inner diameter by VHF digital ultrasound and scotopic pupil size combined with the STS lens rise, lens size, and lens power provide a powerful tool to accurately calculate the postoperative lens vault. Combined with intraoperative OCT for accurate lens positioning, overall safety and long-term outcomes of ICL implantation can be improved. The Reinstein formula v2.0 can be used to determine optimal ICL size and effectively predict the postoperative vault to target.

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New Technologies Here and Coming Soon

H Burkhard Dick MD

The immediate future of refractive surgery has to be evaluated against the background of demographics. And as challenging as our times certainly are—with pandemic, war, and the threat of recession—in this field developments could not be more to our advantage. A new generation, the so-called millenials, is coming of age, many of them with well-paying jobs, an openness toward new technologies, and an attitude toward refractive surgery as the appropriate, the cool, the chill thing to do.

A number of new options are already here, while others are close to being introduced into the market. LASIK might still be the biggest kid on the block and encorporate elements like topography guidance; with wavefront aberrometry systems like iDesign, the term "customization" will be given a new meaning. Eyetracking will become indispensable for many patients who tend to movement or heavy breathing while being treated. Blended vision, on which Dan Reinstein certainly has something to say during the meeting, is a valid option for many patients who demand spectacle independence despite their presbyopia.

SMILE will expand its indications and in due time also benefit some (though probably not all) hyperopes. What is probably gonna change is its name—as an eminent procedure in refractive surgery it requires one that sends a clear message to patients and not a number of designations depending on the manufacturer.

In general, however, one might predict that nonablative surgery will rise to new heights. With already existing IOL designs, it will be imperative to provide patients age 50plus with excellent vision on (almost) all distances and to reduce the disadvantage of most lenses that are introduced to treat presbyopia: the optic side effects like halo and glare that so significantly hamper night vision and particularly the ability to drive a car in darkness for many patients with multifocal IOLs. Intraoperative aberrometry can help us find errors in preoperative IOL calculation and thus a better chance to reach target refraction.

Of all technologies that have a great potential for the future, none has been around, as an idea, for so long as the small-aperture concept. Developed in the early 1600s, it's now available as the IC-8, which has shown promising results. As will be demonstrated, the principle can also be applied by an implant that is not an IOL but seems to be able to enhance the visual comfort of an existing IOL.

The light-adjustable lens (LAL) has given us a tool to deal with residual refractive error after cataract and/or lens-based refractive surgery. A new generation will help us to transform the type of IOL we just have implanted in cases of patient complaints and second thoughts about the nature of the IOL that they truly wanted. Going from monofocal to multifocal and vice versa in a noninvasive way—it's not a dream anymore.

To an even greater degree, index shaping will open new ways to recreate an IOL that is already implanted; we will thus be able to offer truly individual care and individual solutions by performing surgery and during postoperative monitoring.

A promising future indeed for our patients. Yet, with all those fascinating technologies currently rising, one challenge will be to make them available to all patients interested in modern refractive surgery and the visual comfort and thus superior quality of life it can provide. Progress comes with a price tag—and usually an exorbitant one, in our age of inflation even more so. Therefore, refractive surgeons will have to play their part as an important segment of the health-care community and make their voices heard to ensure that state-of-the-art eye surgery will benefit not only the affluent but all our patients.

In These Unprecedented Times . . .

Refractive Surgery Subspecialty Day 2022

Sanjay "Sonny" D Goel MD MD

Action Requested: Support Ophthalmology's Advocacy Efforts

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

Where and How to Invest

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

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

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

Why Invest?

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

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

OPHTHPAC for Federal Advocacy

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

- Improving the Medicare payment system, so ophthalmologists are fairly compensated for their services
- Securing payment equity for postoperative visits, which will increase global surgical payments
- Stopping optometry from obtaining surgical laser privileges in the veterans' health-care system
- Reducing prior authorization and step therapy burdens

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

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

Surgical Scope Fund for State Advocacy

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

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

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

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

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

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

State Eye PAC

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

Support Your Colleagues Who Are Working on Your Behalf

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

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Optimizing the Ocular Surface in Refractive Surgery

José AP Gomes MD

Introduction

Refractive surgical procedures have experienced significant advances over the past decades. Surgical techniques and visual outcomes have continued to improve, while vision-jeopardizing complications have continued to decrease. In contrast with this favorable scenario, ocular surface disease (OSD) signs and symptoms remain common in the early postoperative period and persist in a few cases. Hovanesian et al reported that 43% of patients after PRK and 48% of LASIK patients referred dry eye (DED) symptoms.[1] This can affect visual function and quality of life, creating a conflict between patient's and refractive surgeon's expectations.

To prevent or decrease this outcome, ophthalmologists must identify DED and other OSD before any refractive procedure. Patients who have DED and are considering keratorefractive surgery, particularly LASIK, should be cautioned that these surgeries might worsen their condition.[2] Not to mention the impact of OSD on preoperative topography, tomography, biometry, and keratometry, which can affect surgical planning and, consequently, optical results.[2] Optimizing the ocular surface is paramount, and all OSD should be accessed effectively before and after keratorefractive or phacorefractive surgery.[2]

Mechanisms of Damage on the Ocular Surface

Corneal and refractive surgery are associated with DED through various mechanisms. Surgical transection of the corneal nerves—by the corneal flap, ablation, incisions, or trephination—is a common mechanism of corneal surgical techniques and a causative factor of postoperative DED.[3] This is related to the reduction in corneal sensitivity and corneal trophic function. Studies have shown that corneal sensitivity is reduced after corneal incisions years after surgery.[4,5]

In LASIK, reduction of corneal sensitivity is caused by the amputation of the corneal nerves. A similar effect occurs after PRK due to the ablation of the subepithelial innervation.[4] Reduced corneal nerve sensory function would reduce feedback to the lacrimal gland and basic tear secretion and inhibit blinking reflex. The tear film stability is also reduced due to the altered corneal shape and to the impaired mucin secretion by the damaged epithelial and goblet cells of the ocular surface.[6]

Predisposing factors include preoperative dry eye and meibomian gland dysfunction (MGD). Accordingly, treatment of MGD may improve postoperative outcomes.[7] The pre- and postoperative use of preserved steroids and antibiotics may exacerbate the OSD due to corneal nerve injury and goblet cell and meibomian gland toxicity. The negative impact on goblet cells and meibomian glands reduces postoperative tear film stability and worsens DED.

Optimizing the Ocular Surface in Refractive Surgery

In 2017, the Tear Film and Ocular Surface Society Dry Eye Workshop II (TFOS DEWS II) proposed a stepwise guideline to manage DED (see Figure 1).[8] In 2019, the American Society of Cataract and Refractive Surgery Cornea Clinical Committee reviewed this guideline and proposed a refinement focused on the presurgical patient for refractive and cataract surgery.[2] For these patients, if any DED is diagnosed, treatment should be initiated at a more advanced level to achieve a faster restoration of the ocular surface homeostasis to optimize preoperative measurements and maximize postoperative outcomes.[2] Tear-film inflammation, lid margin disease, and ocular surface staining should be addressed simultaneously.[2] A combination of topical and systemic agents with interventional procedures based on disease subtype and severity will define the best-customized approach for the preoperative of each patient.[2]

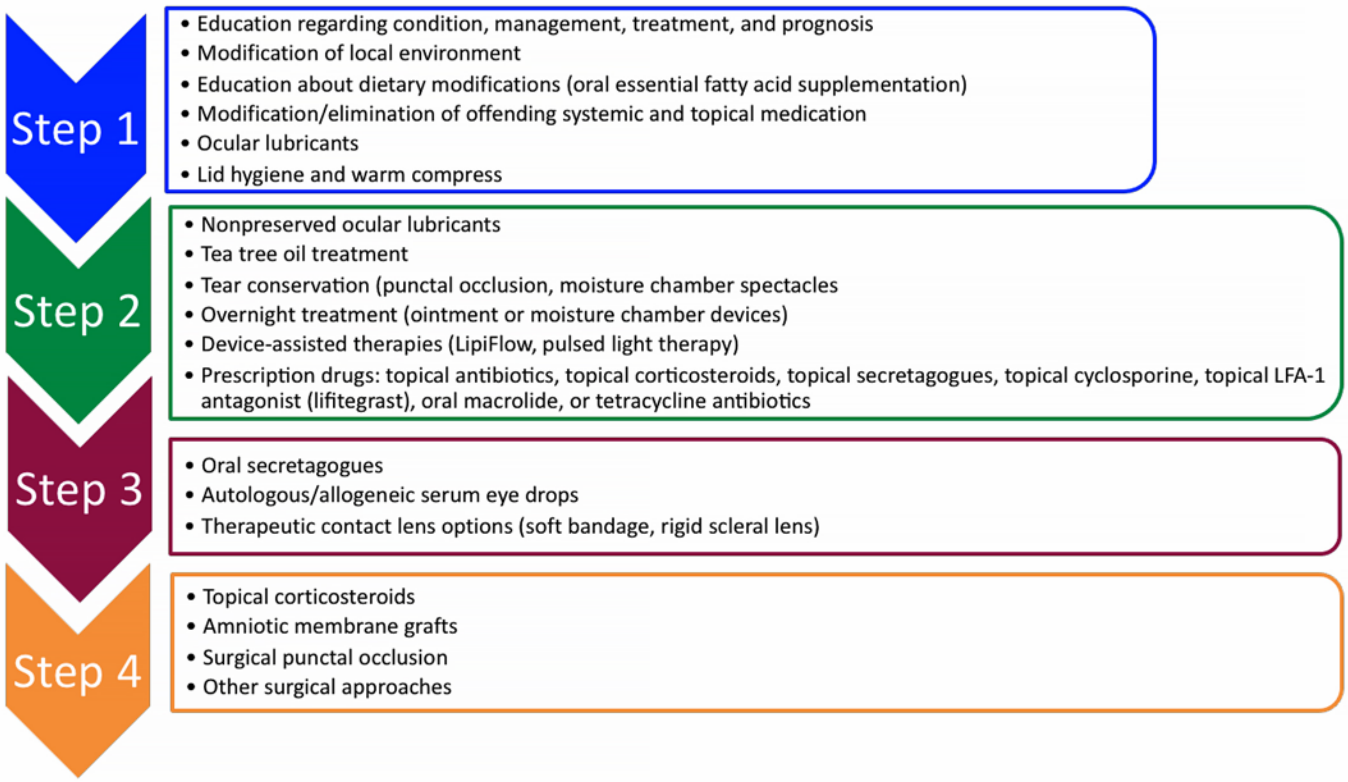

Figure 1. Staged management and treatment recommendations for DED. Adapted from Jones L, Downie LE, Korb D, et al. TFOS DEWS II Management and therapy report. *Ocul Surf.* 2017; 15:614-615.

In this presentation, we will summarize the most important OSD that needs to be addressed before any refractive procedure and present the major mechanisms behind the different refractive procedures that damage the ocular surface and break the homeostasis of the tear film functional unit, causing postoperative signs and symptoms. In the second part, we will present an updated comprehensive review of the strategies and propose stepwise guidelines to optimize the ocular surface before, during, and after refractive surgery.

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Top Tips in Refractive Surgery Screening

Shizuka Koh MD

Pathogenesis of keratoconus and corneal ectasia include genetic, biochemical, biomechanical, and environmental factors. Although it generally presents bilaterally, it is often asymmetrical. In some very asymmetric cases, one eye manifests with clinical keratoconus or ectasia and the contralateral eye does not present with clinical or topographical signs of ectasia. Such corneas have been defined as having very asymmetric ectasia (VAE) with normal topography, termed "forme fruste keratoconus (FFKC)."

However, what diagnosis do you give if both eyes have normal front surface, based on Placido-disk corneal topography, without clinical signs and show borderline or abnormal values in corneal tomography or biomechanical assessments? Such cases pose a genuine nomenclature paradox, and terms such as "borderline susceptible corneal ectasia" or "bilateral FFKC" could be proposed. Particularly if the patient has familial background or a habit of eye rubbing, high susceptibility for ectasia might be considered. Especially during preoperative screening for laser refractive surgery to prevent postoperative ectasia, the comprehensive examination is essential for such borderline cases ("bilateral FFKC").

Better safe than sorry. When the patient is referred for refractive screening, in addition to standard ophthalmic examinations, we do a variety of assessments: topography, tomography (both Scheimpflug-based and OCT), biomechanics assessment, and wavefront measurement. Multimodal imaging is helpful in diagnosis of borderline cases. Also, we administer the questionnaire for keratoconus-related risk factors. In this presentation, important tips in refractive surgery screening will be described, with case examples.

Selected Readings

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My Top 5 LASIK Pearls

Ashiyana Nariani MD MPH

1. Use LASIK as a tool to address uncorrected refractive error.

Refractive error is the third leading cause of blindness and the leading cause of moderate-severe visual impairment. There is a worldwide necessity to use refractive surgery to address the global burden of disease and the United Nations Sustainable Development Goals.[1,2] Global refractive surgery is the concept whereby refractive surgery, including LASIK, is used to address refractive error.

2. Modernize and improve diagnostics in your practice via artificial intelligence (AI).

Use of AI in preoperative evaluation of refractive surgery candidates can potentially provide a patient selection modality that can help minimize the risk of postoperative ectasia.[3-5]

3. Topography-guided LASIK can improve outcomes.

Sophisticated features, including computerized eye movement tracking, cyclorotation compensation, active centration, and smoothing of the cornea, are potential advantages of traditional LASIK and/or small-incision lenticule extraction (SMILE).[6,7]

4. Dry eye prevention is critical.

Given the risk of LASIK-induced dry eye disease, corneal denervation, and neurotrophic epitheliopathy, prophylactic management optimizes postoperative outcomes. Treating patients with LASIK-induced neurotrophic epitheliopathy with topical cyclosporine A, for example, treats the underlying inflammation and may benefit nerve regeneration.[8,9]

5. Sometimes LASIK is a better solution than SMILE!

SMILE is not FDA approved for the treatment of hyperopia or mixed astigmatism. Additionally, there are complex nuances involved in prior SMILE vs. LASIK eyes for enhancement procedures.[10]

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My Top 5 Pearls for Advanced Surface Ablation

Marcelo V Netto MD

I. Preoperative Evaluation
  A. Corneal irregularity
  B. Refraction and contact lens use
  C. Ocular surface and dry eye tests
    1. Meniscus
    2. Tear breakup time
    3. Vital dye staining
    4. Meibomian gland analysis
    5. Placido disc images

II. Intraoperative Management
  A. Haze prevention
    1. Mitomycin C (MMC) 0.02% in every single case
    2. Follow-up: 20 years
    3. Side effects and complications
      a. No endothelial cell loss
      b. No corneal applanation
      c. No corneal flattening
      d. No refractive regression
      e. No corneal melting
      f. No relationship with corneal ectasia
  B. Concentration and exposure time
    1. Fixed concentration: 0.02%
      a. Virgin corneas: 30 to 60 seconds (see Tables 1-3)

Table 1

Myopic Correction	Exposure Time
Up to 5 dp	30 seconds
5 to 7 dp	40 seconds
7 to 10 dp	50 seconds

Table 2

Astigmatic Correction	Exposure Time
Up to 2 dp	40 seconds
2 to 4 dp	50 seconds
>4 dp	60 seconds

Table 3

Hyperopic Correction	Exposure Time
Up to 2 dp	40 seconds
2 to 4 dp	50 seconds
>4 dp	60 seconds

      b. High-risk cases: MMC 0.02% for 1 minute
        i. post-LASIK
        ii. post-penetrating keratoplasty
        iii. post-radial keratotomy
        iv. previous haze
        v. haze in the contralateral eye
      c. MMC reapplication
        i. enhancements
        ii. 30 seconds
        iii. no side effects reported
  C. MMC storage
    1. Freezer temperature
      a. –20° C
      b. –4° F
    2. Storage time: 2 weeks (after opened)
  D. Corneal haze treatment
    1. OCT-guided PTK
    2. MMC 0.02% for 2 minutes

III. Postoperative Care
  A. Nonsteroidal anti-infammatory drops (NSAID)
    1. Not recommended
    2. Delayed healing after 3 days of NSAID
  B. Preservative-free lubricant eye drops
  C. Contact lenses, 5 to 7 days
  D. Pain control
    1. Lubricant (0.4 mL) with anesthetic drops (0.2 mL)
    2. Oral analgesic (codeine)
    3. Cold compress

My Personal Tips for Refractive Cataract Surgery

Ashvin Agarwal MD

Introduction

This talk will cover the specific but rather important area of complex, challenging cataract cases. Cataract surgery in cases with irregular astigmatism at both the lenticular and corneal plane—especially in cases of subluxated IOL or when it is with cataract associated with keratoconus, post-PK, pellucid marginal degeneration, etc.—poses a huge threat to postoperative visual outcomes, especially owing to the fact that these are extremely highly unpredictable due to the amount of aberrations entering the eye.

The first concept that will be shown is one of placing a multifocal IOL in cases where bag integrity has been lost using the glued IOL technique, and the other concept is creating a pin-hole sized pupil, as it controls the amount of aberrated light entering the eye, especially in eyes with irregular astigmatism.

Presentation

Case 1

A case of subluxated multifocal IOL bag complex, where the same IOL is taken and refixed using the glued IOL technique

Case 2

A case where pin-hole pupilloplasty (PPP) is created to ensure the aberrations on most irregular corneas are prevented from creating distortion to the patient's vision

Pinhole visual acuity is the best possible vision that can be attained in a patient. PPP works on the principle that a pinhole helps to focus the central and paracentral rays in cases with higher-order corneal aberrations. PPP wards off the peripheral unfocused rays, thereby enhancing the visual quality and image (see Figure 1). It also works on the principle of the Stiles-Crawford effect, where the light entering the eye from the center of pupil creates a greater photoreceptor response compared to light entering from the peripheral edge of the pupil.[1,2] As a pinhole is created, only central rays are focused that create a greater cone photoreceptor response.

Intraoperatively, the surgical microscope projects the light reflex on the eye, translating into the formation of Purkinje images. The Lumera microscope (Zeiss) projects 3 reflexes; hence each Purkinje image is a collection of 3 light reflexes. The main illumination light is in the top of the triad, whereas the light from the 2 coaxial tubes forms the 2 side reflexes.[3] The iris tissue is aimed to surround the P1 reflex with the help of PPP, thereby achieving a customized small pinhole pupil (see Figure 2).

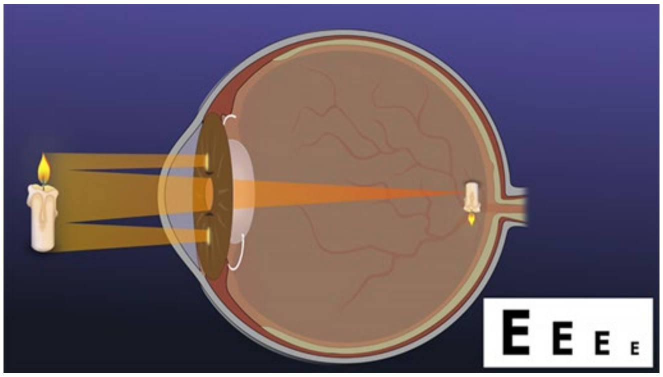

Figure 1. Animated image depicting the principle of pinhole pupilloplasty (PPP). A clear focused image is obtained when the rays from the central cornea are focused on the retina.

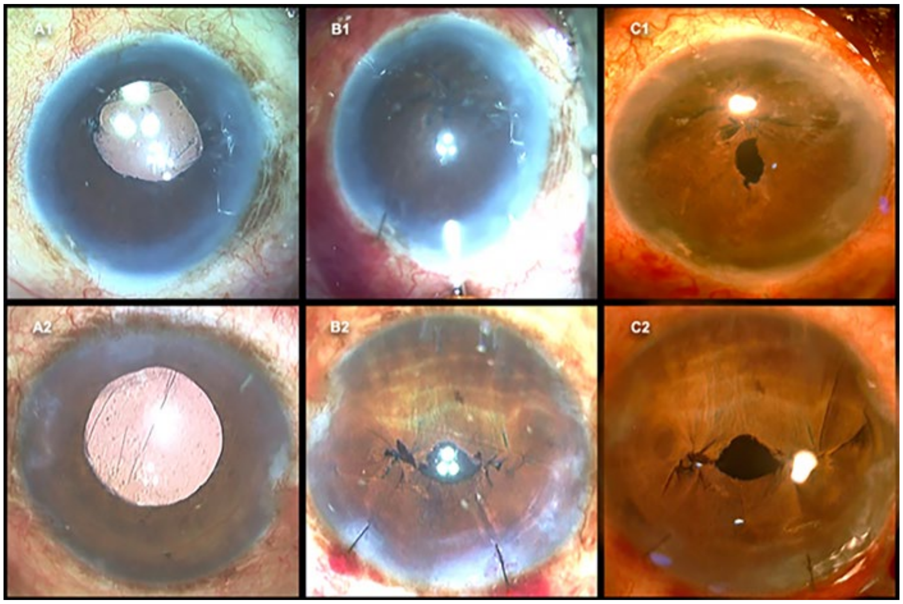

Figure 2. Clinical images of PPP in 2 cases. A1, A2; Preoperative image before PPP in a pseudophakic eye that denotes Purkinje images. B1, B2: Intraoperative image depicting a well-centered PPP with the P1 reflex engulfed by pupillary margin. C1, C2: Postoperative image as visualized on a slit-lamp examination.

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Corneal Ring Segments for Corneal Ectasia

Shady Awwad MD

I. Mechanism of Action of Corneal Ring Segments in Ectasia
   A. Topography
      1. Stromal remodeling
      2. Epithelial remodeling
   B. Segment specific
      1. One segment
      2. Two segments
      3. Short arc segments
      4. Asymmetric segments

II. Clinical Impact
   A. Sphere and cylinder
   B. Kmax and SimK
   C. Higher-order aberrations
   D. Corrected and uncorrected distance visual acuity

III. Incorporation Into Other Treatment Modalities
   A. Corneal crosslinking
   B. Topography-guided or wavefront-guided PRK with or without crosslinking
   C. Phakic IOLs

IV. Epilogue

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Cataract Planning After Keratorefractive Surgery

Marcus Ang MBBS PhD

Background

In eyes that have undergone keratorefractive surgery, accurate selection of desired IOL power for cataract surgery remains a challenge.[1]

- An increasing number of patients who have undergone LASIK, excimer laser photorefractive keratectomy (PRK), small-incision lenticule extraction (SMILE), or radial keratotomy (RK) require cataract surgery.
- Traditionally, methods required pre–refractive surgery keratometry with manifest refraction to estimate IOL power in such eyes.
- However, such information may no longer be needed, as formulae for IOL prediction have bypassed this need with more accurate measurements of total corneal power.[1]

Challenges

The key challenges in determining IOL power in eyes with previous keratorefractive surgery are to accurately measure its corneal refractive power and predict the effective lens position.[2]

- Corneal curvature: Large variations within the central optical zone may be detected using keratometry and corneal topography. Asymmetrical changes to posterior corneal curvature can occur, especially after RK.
- Total corneal refractive power: Inaccurate calculations due to the change in relationship between anterior and posterior corneal curvatures after keratorefractive surgery
- Effective lens position: Usually estimated based on the corneal refractive power, although some newer formulae have negated this.

Summary of Outcomes

Several reviews and meta-analyses have summarized the current evidence for various formulae and calculation methods in post-keratorefractive eyes.[1,2] In general:

- Current outcomes of formulae in post-myopic LASIK or PRK eyes did not exceed 75% accuracy within 0.5 D of target spherical equivalent (SE).
- Formulae for post-hyperopic LASIK or PRK fared poorer compared to myopic eyes that underwent LASIK or PRK, with prediction errors within 0.5 D ranging from 47.6% to 71.9%.
- Eyes that have undergone RK generally have the lowest accuracy for prediction compared with eyes that have undergone myopic or hyperopic LASIK or PRK.
- More studies are required to examine specific issues for cataract surgery and IOL selection post-SMILE, but early studies suggest similar outcomes to LASIK correction.[3]

IOL Choices

Patients who have undergone previous keratorefractive surgery usually want to remain spectacle free after cataract surgery. Thus, refractive targets and implant choice remain key decisions.[4]

- Aspheric IOL: Implants with negative spherical aberration (SA) may be useful in eyes after myopic LASIK or PRK, but not in hyperopic corrections.
- Toric IOL: May be suitable in carefully selected eyes, such as those with regular corneal astigmatism (central 3-mm optical zone) and eyes with difference of <0.75 D in corneal astigmatism magnitude and <15 degree meridians between 2 ocular biometers
- Multifocal and extended depth of focus IOL: Remains controversial. Although some studies have reported good outcomes, predictability and quality of vision remain key concerns. Small-aperture IOL may reduce irregular astigmatism while increasing depth of focus in the nondominant eye.[5]

Conclusions

Cataract planning and surgery in eyes with previous keratorefractive surgery still remains a challenge, and addressing patients' expectations with adequate preoperative counselling is required.[1]

- Despite recent improvements in accuracy of IOL prediction in post–keratorefractive surgery eyes, refractive outcomes of cataract surgery in eyes are still less accurate than in eyes that have no prior surgery.
- Current literature is still limited by retrospective studies with small sample sizes.
- However, improvements in corneal topography and tomography systems that integrate formulae which incorporate measurements of total corneal power and posterior corneal curvature may lead to further improvements in IOL prediction accuracy in such eyes.

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Refractive Surgery as a Turning Point in the Human Experience

Guy M Kezirian MD

Refractive surgery is one of the most important achievements of our time.

- This is the first time in the history of humankind that we have been able to correct a congenital defect of such critical importance as vision, and to do so on such a large scale, and so safely.
- It has always been individuals who made that possible.
- My purpose today is to recognize some of those individuals and to highlight the importance of you here today, as a critical link in the chain of progress.

Refractive surgery stands at a precipice.

We will either leap from that precipice and soar to the heavens with innovation, safety, and access, or fall to the rocks with lack of standards, complications, and controversy.

- The global population is exploding.
- The prevalence of myopia is outstripping the growth of the overall population.
- There are not enough refractive surgeons to meet the challenge.
- 2021 marked the year that refractive surgery was recognized as a separate specialty. This in turn will foster a completely new industry.
- It will be up to many of the people in this room to oversee that development so that refractive surgery can achieve its potential to be the default approach to vision correction.

How far we have come with approaches to vision correction!

We can view refractive surgery innovators and pioneers from the modern era in co-equal camps: innovators, clinicians, organizers, validators, teachers. Let me honor a few of the many here.

- In the Innovator class we have:
  - Sir Harold Ridley
  - José Ignacio Barraquer Moner MD
  - Steve Trokel MD with Francis L'Esperance, Charles Munnerlyn, and many others
  - Charlie Kelman MD
- In the Clinicians class we have:
  - Marguerite McDonald MD
  - Luis Ruiz MD of Bogotá, Colombia; Lucio Buratto MD of Milan, Italy, and Ioannis Pallikaris of Greece
  - Richard Troutman MD and Casimir Swinger MD
  - Svyatoslav Fyodorov MD of Russia and his student Leo Bores of the U.S.
  - And of course, many of the people in this audience have also made tremendous contributions!
- Some have stepped up to assume leadership roles, making it possible for us to come together in societies and organizations.
  - International Society of Refractive Keratoplasty/International Society of Refractive Surgery
  - American Intra-Ocular Implant Society/American Society of Cataract and Refractive Surgery
  - European Society of Cataract and Refractive Surgeons
  - It wasn't until the late 1990s that the implant societies incorporated the "R" for "refractive" into their names and their mission.
- Validation of refractive surgery is critical:
  - Prospective Evaluation of Radial Keratotomy (PERK) study
  - U.S. Food and Drug Administration
  - CRS LASIK Study
  - Our journals and their editors and editorial boards
- Educators
  - Charles Casebeer MD

Contemporary refractive surgeons are part of a long and remarkable chain of innovators and pioneers who made it possible to do what we do.

- As our technologies improve, we will multiply the impact of our small army of refractive surgeons to reach the world. Digital medicine, automation, artificial intelligence, improved delivery models, and economic innovations will make that possible.
- Whatever your skillset, wherever your talents lie, it is imperative that all of us do our part to further the legacy of those whose shoulders we stand on.

If we succeed, history will look back at our time and recognize refractive surgery for what it is: a turning point in the human experience.

Let us honor those who made it possible and bring refractive surgery to its potential as the default method for vision correction.

There is no one else. We are those guys. This is our time.

LASIK Flap Issues

J Bradley Randleman MD

NOTES

Management Pearls for LASER/SMILE Refractive Nightmares

Sheetal Brar MBBS

I. Introduction

II. Common Intraoperative Surgical Complications of SMILE

  A. Black spots

    1. Prevention of black spots

      a. Prevent corneal drying

      b. Minimal use of topical anesthesia

      c. Energy optimization

    2. Management strategies, depending upon location and size

  B. Suction loss

    1. Prevention of suction loss

      a. Prior instructions

      b. Proper cone selection

      c. Drying conjunctival sac to remove excess fluid

    2. Management strategies: Depending upon stage of suction loss, when to convert to LASIK, and when to continue with SMILE

  C. Cap/incision tear

    1. Prevention of cap/incision tear

      a. 4-mm incision for beginners

      b. Proper technique of dissection

    2. Management strategies: depending upon the extent and location

  D. Lenticule tears and retained lenticules

    1. Prevention of lenticule tears and retained lenticules

      a. Preventing opaque bubble layer

      b. Preventing black spots

      c. Laser optimization

      d. Increasing minimal thickness for low myopia

    2. Management strategies

      a. Based on anterior segment OCT and topography findings

      b. When to use CIRCLE software to convert the cap into a flap

      c. When to explore the pocket

      d. When to perform topography-guided treatments

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Phototherapeutic Keratectomy: Therapeutic Refractive Surgery

Renato Ambrósio Jr MD PhD, Joana Mello MD, Alexandre Batista da Costa Neto MD, and Louise Pellegrino Gomes Esporcatte M MsC

I. Phototherapeutic Keratectomy (PTK): Fundamental Considerations

  A. Excimer laser flat ablation, which causes a biomechanical flattening effect, as described in the classic editorial "The cornea is not a piece of plastic."[1]

  B. The optimized PTK profile, as in the WaveLight excimer platform,[2] with more energy delivered to the periphery, does steepen the cornea in the PTK mode, leading to a myopic result.[3]

  C. The PTK mode has been classically used to remove corneal opacity[4,5] and different complications of refractive corneal surgery.[6,7]

  D. Many refractive surgeons have popularized the PTK mode to remove the epithelium for advanced surface ablation procedures, with some advantages in the wound healing response.[5]

  E. The PTK mode has been to remove the epithelium (Cretan or Athens modified Protocol) in crosslinking (CXL) procedures.[8,9]

  F. Smoothing PTK can be used for treating irregularities.[10]

II. Therapeutic refractive surgery goes beyond (but not over) the ablation profile of PTK.

  A. Distinguishing elective refractive surgery from therapeutic refractive surgery is critical.[11]

  B. Therapeutic surgeries share refractive technology but have a fundamentally different goal.

    1. Femtosecond laser (FS) for the pocket in CXL, ring assessments, corneal transplantation (FALK, DALK, DSAEK), and other procedures can also be considered therapeutic refractive procedures.

    2. Customized ablation profiles (topo/tomo/wavefront) may have a therapeutic goal of rehabilitating vision.

  C. The goal defines the success of the surgery. Some of the excellent results in the therapeutic arena would be a disaster for an elective refractive surgery patient.

III. The term "custom therapeutic ablation" should be considered; it can be combined with crosslinking in cases of corneal ectasia, as with the Athens Protocol and its modifications (ie, Tel Aviv Protocol).[12-14]

IV. Conclusion

  A. Therapeutic surgery includes but goes beyond the PTK ablations.

  B. Correct understanding of the indications

  C. The role of patient education as in the Violet June Keratoconus Awareness campaign

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Cliffhanger

Amar Agarwal MD

Introduction

Cliffhanger will showcase worst-case scenarios and how one can manage them.

The term "pseudophacocele"[1] refers to subconjunctival extrusion of an IOL. It is mostly traumatic in nature and most commonly results from opening or gaping of the surgical wound many years after the cataract surgery is performed. The surgical wound represents an inherent weakness in the contour of the globe, which upon forceful trauma leads to IOL extrusion. Due to an intact conjunctiva, the extruded IOL almost always gets contained into the subconjunctival space. This prevents the globe from being directly exposed to the environment. The term "phacocele" means the crystalline lens is in the subconjunctival space.

Management

The initial management involves exploration of the wound. Fluid infusion is introduced inside the eye with either an anterior chamber maintainer (ACM) or a Trocar ACM. Conjunctival peritomy is done, and the extruded IOL is located and removed. If the IOL is found to be broken, the remaining part of the IOL should also be located. The ruptured wound in the scleral wall is then assessed. In our experience with pseudophacocele, the surgical wound for cataract surgery gaped in all cases.

The scleral wound is then sutured with 10-0 nylon to restore the integrity of the globe. A vitrectomy probe is introduced inside the anterior chamber, and vitreous, along with hyphema, is cleared from the anterior chamber. Once the anterior chamber is cleared, pars plana vitrectomy is performed; the vitreous cavity is explored, and a thorough vitrectomy is performed.

Glued intrascleral fixation of IOL is then performed, and if iris is absent then you can use an aniridic IOL.

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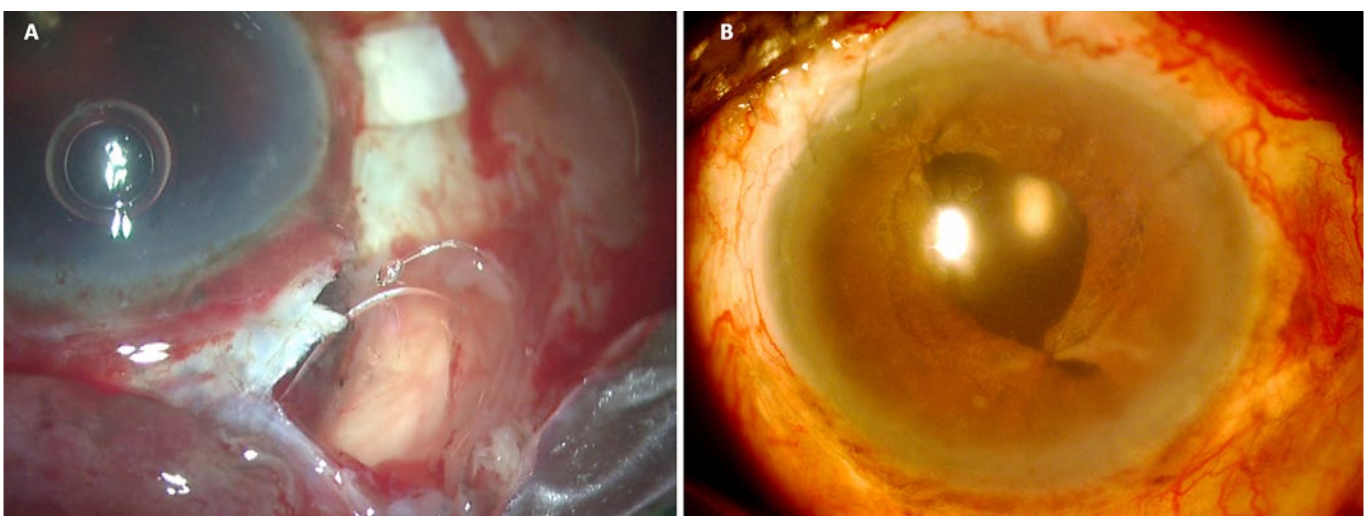

Figure 1. (A) Ruptured globe with pseudophacocele. (B) One-month postop image with 20/20 vision.

Premium IOLs in Posterior Capsule Rupture

David F Chang MD

NOTES

Novel Solutions to Iris Repair

Priya Narang MS

Introduction

Iris repair forms an important aspect of anterior segment reconstruction, as apart from filtering light that enters inside the eye it is also associated with refractive concerns. The iris repair is essentially comprised of an iris base repair and pupil-centric repair.

Various techniques have been described for pupil-centric iris repair, like Siepser's and modified Siepser's, McCannel and modified McCannell. The most common techniques for iris base repair are the nonappositional (hangback) method and the sewing machine and modified sewing machine techniques. In cases with traumatic iris tissue loss, surgeons often perform artificial iris implantation or use an aniridia IOL to optimize visual acuity.

Video Description

My video showcases the newer technique to perform single-pass, four-throw (SFT) pupilloplasty[1] to achieve appropriate pupil-centric iris repair. The video then transitions to showcase how to perform a two-fold technique for iris base repair.[2] In the two-fold technique, a nonappositional repair for iris base is combined with SFT technique. Two-fold method can be employed for massive, moderate, and minimal iridodialysis.

The video then focusses on the refractive aspect of iris repair, wherein application of SFT technique to perform pinhole pupilloplasty (PPP)[3-7] is demonstrated. PPP is performed in cases with higher-order aberrations (HOAs) where other corrective measures to treat HOAs do not suffice. PPP is centered around the Purkinje-1 reflex that emanates from the coaxial light of the microscope. The pinhole size can be customized by incorporating the calibrated reticle into the eyepiece of the surgical microscope. The appropriate pinhole size that provides the best visual acuity to the patient can be assessed during preoperative evaluation with a specially designed pinhole device that has pinholes ranging from 0.5 mm to 4.0 mm in diameter. The extended depth of focus, photopic and mesopic visual acuity along with contrast sensitivity achieved in studies with PPP will be highlighted, along with advantages and disadvantages of the procedure.

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Refractive IOL Exchange Challenge

Elizabeth Yeu MD

NOTES

Surgical Posture and Ergonomics to Save Your Neck and Back

Deepinder K Dhaliwal MD LAc

NOTES

Nutrition for the Surgeon

Maria A Henriquez MD

Surgery is accepted as one of the most demanding professions that create physical and mental strain on the performers. Participating in surgery creates mental stress that leads to cardiovascular changes as sympathetic hyperactivity during operations and a higher heart rate variability during surgical days that can lead to alterations in autonomic cardiac control and may contribute to the development of cardiac disease.

Over 50% of physicians are experiencing burnout, a syndrome characterized by a high degree of emotional exhaustion and depersonalization and a low sense of personal accomplishment at work. Although physicians do their best to provide outstanding care to their patients, they often do not prioritize their own self-care. As a result, participation in healthy lifestyle behaviors is often given a low priority.

Poor eating behaviors due to an unhealthy diet (high fat, high sugar, highly processed foods), disorganized eating schedule, jet lag, and shift work are detrimental to health, with an increased risk of diabetes and cancer. Surgeons should focus on physical health, mental health, mindfulness, and stress reduction. But how can we balance all these components if 24 hours a day are not enough for us? Through this talk, I will give you some tips based on my personal experience and scientific literature that will help you to improve your quality of life for the benefit of you and your patients.

Eat Well

Thirty-nine percent of the world's adult population is overweight. Optimal eating is associated with increased life expectancy and a reduced risk of all types of chronic disease. Many claims have been made about the competitive merits of different diets relative to one another, but we can say that diets that favor longevity and health are generally characterized by minimally processed foods, predominantly plant-based foods, and low alcohol consumption, as well as avoidance of overeating, including calorie restriction. Inhabitants from the blue zones and Ikaria (who have a longer lifespan) have in common a heart-healthy eating plan that emphasizes fruits, vegetables, whole grains, beans, nuts, seeds, healthy fats, and red wine, rich in antioxidants.

Avoid Refined Sugars

Before your surgical day, don't consume carbs with a high glycemic index (GI). High GI foods (over 70) cause a sudden spike in the blood sugar level, causing a spike in insulin secretion and consequently hypoglycemia. You experience fatigue, hunger, mental confusion, and cravings. In consequence, you eat sugar, and the cycle begins again. In the long term this results in fat accumulation, decreased lipolysis, insulin resistance, hyperinsulinism, and even depression and anxiety. When low GI foods (<55) are consumed, the sugar is absorbed into the body gradually. Lower sugar diets are associated with better mental clarity, cognitive ability, memory recall, and positive mood and behavior, all necessary for our clinical and surgical performance. Include high-quality carbohydrates such as whole grains, pulses, or fruit with a low glycemic index and higher fiber components.

Weigh Yourself

Weigh yourself, either with a simple scale or, more recommended, by calculating your body mass index (BMI). Pretesting guidelines for BMI include no food within 8 hours of testing, no water within 2 hours of testing, no exercise within 24 hours of testing, no alcohol consumption within 48 hours of testing, and empty the bladder/bowels within 30 min before testing. Additionally, adequate (but not excessive) hydration is essential for accurate assessment.

Take Your Daily Dose of Vitamins

If the free radical theory of aging is true, antioxidants should slow aging and prolong lifespan. The optimal source of antioxidants seems to come from our diet, not from antioxidant supplements in pills or tablets. Try to include antioxidant vitamins, such as vitamin C, omega 3, lipoic acid, coenzyme Q, resveratrol, and curcumin. Ten percent to 50% of all elderly have a functional deficiency of vitamin B12 or D. Caution must be taken with vitamin A and E, since more studies are needed to reach conclusions about their long-lasting effect on longevity versus their increased mortality relationship.

Exercise

Skeletal muscles decrease by 3%-10% per decade, starting at 25 years of age. Exercise is currently the only intervention that has shown remarkable efficacy for reducing the incidence of age-related disease, improving quality of life, and even increasing lifespan in humans. Its benefits can be seen even with modest implementation: 6 weeks of a resistance training program (2-3 sessions per week) may result in a 50% strength gain in sedentary healthy elderly individuals. Try to implement resistance and endurance training. Muscle stimulation is essential.

Sleep

Glucose, fatty acid, cholesterol metabolic pathways, and the endocrine system are all under circadian control. The disruption of our circadian rhythm alters metabolism and worsens our health status. The National Sleep Foundation's updated sleep duration recommendations include 7-9 hours for young adults and adults and 7-8 hours for older adults.

Study

Try to familiarize yourself with and understand the following terms: circadian rhythm, insulin, glycogen, hyperglycemia, insulin resistance, low and high glycemic index, cortisol, cardiorespiratory fitness, maximal oxygen uptake, dyslipidemia, polyunsaturated fat source, saturated fat, monounsaturated fat, high-quality food, antiaging foods, the blue zones, Ikaria inhabitants.

Get Inspired

Surround yourself (whether physically or through networks) with people who motivate you and have the same goals as you.

Extending life is not as important as giving more life to the years you have. Interventions at the individual level should focus on physical health, mental health, mindfulness, stress reduction, and resilience. Medical iatrogenic death is third cause of death in the United States, so it is our duty as doctors to stay healthy, have a good attitude, and keep our mental and motor skills at our most optimal level.

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Prolonging Your Surgical Life

Rosa Braga-Mele MD

NOTES

Changes in Corneal Biomechanical Properties in PRK Followed by Two Accelerated CXL Energy Doses in Rabbit Eyes

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Abstract

Purpose

To evaluate whether photorefractive keratectomy (PRK) combined with the two commonly delivered energy doses in accelerated corneal cross-linking (A-CXL) could help the cornea maintain its preoperative stiffness level.

Methods

A total of 72 corneas of 36 healthy white Japanese rabbits were randomly divided into four equal groups. The groups included an untreated control group and three that had undergone PRK. After tissue ablation, one of the latter three groups (PRK group) was left untreated, whereas the other two were exposed to riboflavin (0.22% concentration by volume) and ultraviolet-A (370 nm) with the same irradiation (30 mW/cm^2) but different CXL energy doses of 1.8 J/cm^2 (PXL group) and 2.7 J/cm^2 (PXH group). Dynamic Scheimpflug analyzer (Corvis ST; Oculus Optikgeräte GmbH) measurements of stiffness parameter at first applanation (SP-A1), Stress-Strain Index (SSI), and other dynamic corneal response parameters were taken 3 days preoperatively and 1 month postoperatively. Subsequently, ex vivo inflation testing was performed and the tangent modulus of each specimen was estimated using an inverse analysis process.

Results

In comparison to the control group, the tangent modulus at a stress of 10 kPa decreased by 8.9% in the PRK group and increased by 10.6% and 22.4% in the PXL and PXH groups, respectively. SP-A1 decreased postoperatively in the PRK group ($P < .05$), indicating an overall stiffness reduction of –7.4, –3.5, and –5.3 mm Hg/mm in PRK, PXL, and PXH groups, respectively. The material stiffness parameter SSI remained almost unchanged in the PRK group ($P = .989$), increased slightly in the PXL group (8.3%, $P = .077$), and increased significantly in the PXH group (11.1%) ($P < .05$).

Conclusions

Biomechanical deterioration following PRK was significant and could not be fully compensated for by ACXL with either 1.8 or 2.7 J/cm^2 doses. The increased value of corneal overall stiffness was higher in A-CXL with 2.7 J/cm^2 energy than with 1.8 J/cm^2 energy.

[*J Refract Surg*. 2021; 37(12):853-860.]

Reprinted with permission from SLACK Incorporated Bao F, Chen W, Zheng X, et al. Changes in corneal biomechanical properties in PRK followed by two accelerated CXL energy doses in rabbit eyes. *J Refract Surg.* 2021;37(12):853-860. https://doi.org/10.3928/1081597X-20210830-03

Incidence of Ectasia After SMILE From a High-Volume Refractive Surgery Center in India

Sheetal Brar MS, C R Roopashree MS, and Sri Ganesh MS DNB

Abstract

Purpose

To report the incidence of ectasia after small incision lenticule extraction (SMILE) in a high-volume refractive surgery center in India.

Methods

To derive the incidence of ectasia after SMILE, all eyes that underwent SMILE or SMILE Xtra (SMILE combined with prophylactic accelerated corneal cross-linking) from November 2012 to August 2019 were retrospectively analyzed. Furthermore, these cases were classified as being "normal" or "borderline" based on certain predefined criteria. Only eyes with a minimum follow-up of 12 months were included.

Results

Of the total 7,024 eyes analyzed, 6,619 eyes underwent SMILE, of which 10 eyes developed ectasia at a mean interval of 21.3 months, making the incidence of ectasia after SMILE 0.15%. Of these 10 eyes with ectasia, 2 eyes had normal preoperative topography, whereas the remaining 8 eyes were borderline as per the predefined criteria. Retrospective data analysis revealed that 6,025 of 7,024 eyes were normal and thus suitable for a standard SMILE procedure, whereas 999 eyes were borderline, of which 594 eyes underwent SMILE and 405 eyes underwent SMILE Xtra. The incidence of ectasia in borderline eyes undergoing SMILE was 0.80% (8 of 999) versus 0% (none) for borderline eyes undergoing SMILE Xtra (chi square, $P < .05$).

Conclusions

The incidence of ectasia after SMILE in the early postoperative period was 0.15%, with borderline eyes accounting for most cases. Borderline eyes treated with SMILE Xtra did not progress to ectasia, potentially suggesting a protective role of simultaneous CXL.

[*J Refract Surg*. 2021;37(12):800-808.]

Reprinted with permission from SLACK Incorporated Brar S, Roopashree CR, Ganesh S. Incidence of ectasia after SMILE from a highvolume refractive surgery center in India. *J Refract Surg.* 2021;37(12):800-808. https://doi.org/10.3928/1081597X-20210812-03

Visual and Refractive Outcomes Following Laser Blended Vision With Non-linear Aspheric Micro-anisometropia (PRESBYOND) in Myopic and Hyperopic Patients

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Abstract

Purpose

To report 6-month visual and refractive outcomes following PRESBYOND Laser Blended Vision (Carl Zeiss Meditec) treatment using non-linear aspheric micro-anisometropia laser in situ keratomileusis (LASIK) for the correction of myopic and hyperopic presbyopia.

Methods

A retrospective, non-comparative study of 139 consecutive patients with a mean age of 53.13 ± 5.84 years (range: 42 to 70 years) treated with LASIK-induced micro-anisometropia using the MEL 90 excimer laser and VisuMax femtosecond laser (both Carl Zeiss Meditec). The target refraction was plano for distance eyes (dominant eye) and between −0.50 and −1.50 diopters (D) for near eyes. Patients were observed for 6 months.

Results

A total of 278 eyes (78 myopic and 200 hyperopic) from 139 patients completed the study. Mean preoperative spherical equivalent (SE) was −3.40 ± 1.83 D (range: −0.50 to −8.25 D) for myopic eyes and +1.61 ± 0.98 D (range: −1.25 to +4.63 D) for hyperopic eyes. Mean postoperative SE refraction of distance eyes was +0.20 ± 0.35 D (range: −0.38 to +1.00 D) and −0.14 ± 0.42 D (range: −1.38 to +0.88 D) for myopic and hyperopic eyes, respectively. Mean postoperative SE refraction of near eyes was −0.90 ± 0.44 D (range: −0.13 to −2.25 D) and −1.21 ± 0.48 D (range: −0.13 to −2.25 D) for myopic and hyperopic eyes, respectively. Mean binocular uncorrected near visual acuity was 0.15 ± 0.16 logMAR (range: 0.00 to 0.50 logMAR) and 0.10 ± 0.15 logMAR (range: 0.00 to 0.60 logMAR) for myopic and hyperopic eyes, respectively. Mean binocular uncorrected distance visual acuity was -0.08 ± 0.09 logMAR (range: -0.10 to 0.20 logMAR) and -0.06 ± 0.12 logMAR (range: -0.10 to 0.40 logMAR) for myopic and hyperopic eyes, respectively. Stereoacuity was better than 100 seconds of arc in 79% of myopic eyes and 85% of hyperopic eyes, and all vision quality scores were greater than 90 of 100. No eyes lost two or more lines.

Conclusions

The non-linear aspheric micro-anisometropia protocol resulted in safe and effective visual outcomes in patients with both myopic and hyperopic presbyopia.

[*J Refract Surg*. 2022; 38(5):288-297.]

Determinants of Subjective Quality of Vision After Phakic Intraocular Lens Implantation

Niklas Mohr MD, Martin Dirisamer MD PhD, Jakob Siedlecki MD PhD, Wolfgang J Mayer MD PhD, Benedikt Schworm MD, Lisa Harrant, Siegfried G Priglinger MD PhD, and Nikolaus Luft MD PhD

Abstract

Purpose

To evaluate postoperative subjective quality of vision in patients who underwent Implantable Collamer Lens (ICL) (STAAR Surgical) implantation for correction of myopia and to identify potential predictive parameters.

Methods

In this single-center cross-sectional study, a total of 162 eyes of 81 patients (58 women, 23 men) who underwent ICL implantation were analyzed. The Quality of Vision (QOV) questionnaire was used to assess patient-reported outcomes. Baseline characteristics (eg, age), treatment parameters (eg, surgical corrected refraction), and refractive (eg, residual refraction) and visual (eg, uncorrected distance visual acuity) outcomes were analyzed regarding their effect on QOV.

Results

Mean age was 33.3 ± 7.0 years (range: 21 to 51 years) and mean preoperative spherical equivalent was −8.42 ± 2.49 diopters (D) (range: −3.25 to −14.38 D). After a mean postoperative follow-up period of 19 ± 14 months (range: 6 to 54 months), the safety index score was 1.23 ± 0.21 and the efficacy index score was 1.17 ± 0.22. The mean QOV scores were 35.5 ± 11.3, 32.2 ± 11.1, and 23.3 ± 16.1 for frequency, severity, and bothersomeness, respectively. The most frequently experienced symptoms were halos (90.1%) and glare (66.7%). Halos appeared in 66.7% of the patients "occasionally" and 5 of them (6.2%) experienced them "very often." Only 1 patient (1.2%) classified halos as "very bothersome." Patients older than 36 years reported visual symptoms more frequently ($P < .05$) and showed higher bothersomeness scores ($P = .01$).

Conclusions

Halos are the most commonly perceived long-term visual disturbance after myopic ICL implantation with a central hole. Visual symptoms can persist more than 6 months postoperatively, causing only minor disturbances in most cases. Older patients seem more prone to experiencing these symptoms.

[*J Refract Surg*. 2022;38(5):280-287.]

Reprinted with permission from SLACK Incorporated Mohr N, Dirisamer M, Siedlecki J, et al. Determinants of subjective quality of vision after phakic intraocular lens implantation. *J Refract Surg.* 2022;38(5):280-287. https://doi.org/10.3928/1081597X-20220405-01

Epithelial Basement Membrane Regeneration After PRK-Induced Epithelial-Stromal Injury in Rabbits: Fibrotic Versus Non-fibrotic Corneal Healing

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Abstract

Purpose

To study epithelial basement membrane (EBM) regeneration in non-fibrotic and fibrotic corneas after photorefractive keratectomy (PRK).

Methods

Rabbits (120 total) had either epithelial scrape alone, -4.50 diopters (D) PRK, -9.00 D PRK, or no surgery. Immunohistochemistry was performed on cryofixed corneas at time points from unwounded to 8 weeks (four corneas at each time point in each group). Multiplex immunohistochemistry was performed for EBM components, including collagen type IV, laminin beta-3, laminin alpha-5, perlecan, and nidogen-1. Stromal cellular composition was studied by triplex immunohistochemistry for keratocan, vimentin, and alpha-smooth muscle actin (SMA).

Results

PRK-injured EBM significantly regenerated by 4 days after surgery. However, early TGF-beta-regulating perlecan incorporation into the nascent EBM declined 4 to 7 days after surgery in fibrotic corneas. Non-fibrotic corneas that had fully regenerated EBM (with all five components incorporated into the EBM) were transparent and had few SMA-positive myofibroblasts in the stroma. Conversely, corneas with defective nascent EBM that lacked perlecan developed many anterior stromal myofibroblasts and fibrosis at 3 to 4 weeks after surgery and had large amounts of collagen type IV in the nascent EBM and anterior stroma. Myofibroblasts synthesized perlecan but were incompetent to incorporate the heparin sulfate proteoglycan into the nascent EBM. Corneal transparency was restored over several months even in fibrotic corneas, and this was associated with a return of EBM perlecan, myofibroblast disappearance, and reabsorption of disordered extracellular matrix.

Conclusions

Defective incorporation of perlecan into the regenerating EBM by subepithelial myofibroblasts, and likely their precursor cells, underlies the development and persistence of stromal fibrosis after PRK corneal injury.

[*J Refract Surg*. 2022;38(1):50-60.].

Reprinted with permission from SLACK Incorporated. de Oliveira RC, Sampaio LP, Shiju TM, Santhiago MR, Wilson SE. Epithelial basement membrane regeneration after PRK-induced epithelial-stromal injury in rabbits: fibrotic versus non-fibrotic corneal healing. *J Refract Surg.* 2022;38(1):50-60. doi:10.3928/1081597X-20211007-02

Biosynthetic Collagen Presbyopic Corneal Inlay

Safety and Efficacy Study

Pavel Stodulka MD PhD

Surgical correction of presbyopia, the most common visual impairment worldwide, remains an unmet clinical need that impacts patients' quality of life. One of the recently developing modalities for correction of presbyopia is cornea inlays. In principle, cornea inlays aim either to create bifocal optics by changing the refractive index, to increase depth of focus by creating small aperture, or to change the cornea shape. Corneal inlays are minimally invasive and do not require corneal tissue removal, and the procedure is reversible.[1] The devices already introduced to the market, however, were made of synthetic materials and were challenged by biocompatibility issues, and upon their clinical use were subsequently withdrawn from the market due to safety concerns.[2] The biocompatibility issues might be overcome if biological lenticules derived from refractive procedures, like laser stromal refractive lenticule extraction, commonly called SMILE, are used, as shown in first feasibility cases.[3,4] Indeed, the TransForm Corneal Allograft (Allotex, Boston) has been investigated in clinical trials and its benefits have been described, but complete clinical outcomes and subsequent steps to the market have not been not published.[5] Another innovative approach is in biocompatible liquid filler material injected into a stromal pocket, which was shown to steepen the anterior cornea surface and flatten the posterior surface in rabbit eyes.[6]

The biocompatibility is thus an important focus. From this view, a novel presbyopic corneal inlay (CorVision, LinkoCare; Sweden) was engineered from medical-grade type I biosynthetic collagen. The inlay, at 2-3 mm in diameter and a 20-30 µm thin, is implanted into a femtosecond laser–created corneal pocket so it steepens the central cornea in order to increase its refractive power by spherical aberration. It is typically implanted to the nondominant eye to achieve mini-monovision. A study is assessing the safety and effectiveness of this device over a period of 12 months of follow-up.

The study includes 110 patients aged 40-65 years with near addition +1.25 D to +3.50 D. Patients with spherical equivalent (SE) −0.75 D to +1.50 D and ≤ 1.5 D cyl in the nondominant eye were included, while patients with corneal thickness <470 µm and corneal curvature ≥50 D or significant eye pathology were excluded. The CorVison corneal microlens was implanted into a 6-mm pocket at depth of 140-220 µm created by a femtosecond laser in the nondominant eye only. Uncorrected and corrected visual acuities at 40 cm near (UNVA, DCNVA), 66 cm intermediate (UIVA, DCIVA), and 4 m distance (UDVA, CDVA), refraction, corneal topography, IOP, and slit-lamp examination were recorded up to 1 year.

Results at 12 months show that UNVA at 40 cm improved, from 0.59 ± 0.15 logMAR to 0.16 ± 0.15 logMAR. UDVA worsened, from 0.06 ± 0.13 logMAR to 0.34 ± 0.21 logMAR, while CDVA remained stable, from −0.04 ± 0.06 logMAR preop to 0.02 ± 0.12 logMAR postop. Manifest refraction SE changed from 0.33 ± 0.40 D preop to −1.28 ± 0.66 D postop. Binocular UNVA improved, from 0.46 ± 0.15 to 0.14 ± 0.14, and binocular UDVA remained unchanged, at −0.11 ± 0.09 logMAR preop and −0.09 ± 0.08 logMAR postop.

The adverse events recorded were related to temporary IOP increase (steroid respondents), complaints of dysphotopsia, dry eyes, and in 2 cases mild corneal pocket hazes. All adverse events were temporary, and mostly ceased. Two patients did not adapt to monovision and had the microlens explanted.

Overall, the presbyopic corneal biosynthetic collagen microlens appears safe and effective in correction of presbyopia. Binocular UNVA significantly improved, while binocular UDVA remained unchanged.

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Hyperopia Correction Using Allografts (LIKE)

Theo Guenter Seiler MD

NOTES

Adjustable Solutions for the Enhancement of Pseudophakic Eyes With Additive IOLs

Michael Amon MD

Introduction

In recent years, supplementary IOLs (add-on IOLs) have been used more frequently to correct pseudophakic ametropia. The implantation of a second IOL in the posterior chamber is usually less traumatic and associated with lower risk of complications compared to the IOL exchange. Hence the piggyback technique was developed further as a secondary procedure to correct postoperative refractive errors. The piggyback technique, in which at least 2 IOLs are implanted in the posterior chamber of the same eye, was first described by Gayton and Sanders[1] in 1993 for the treatment of high hyperopic errors.

A common and significant complication associated with primary piggyback IOLs was interlenticular opacification. This was a direct result of placing both biconvex IOLs into the capsular bag. Cell growth formed a membrane between the surfaces of piggyback acrylic IOLs, leading to decreased vision, secondary to postoperative hyperopic shift, as well as opacification.[2] All this can be avoided by implanting the first IOL into the capsular bag and the second IOL into the ciliary sulcus, because the lens epithelial cell migration is blocked by the anterior capsular adhesion.[3]

Currently 3 companies are producing supplementary IOLs: Rayner Sulcoflex, Cristalens Reverso, and 1stQ Supplementary IOL. Versions range from monofocal aspheric to trifocal and finally toric and multifocal toric.

Supplementary lenses are especially designed for pseudophakic eyes and should not be implanted into aphakic or phakic eyes.

Another advantage of this method is its predictability: Power calculation for the supplementary IOL depends only on the patient's current refraction. The exact calculation should be carried out according to the manufacturer's recommendation.

Implantation

After mydriasis a supplementary IOL is usually implanted under topical anesthesia. Then a clear corneal incision of appropriate size (1.9 to 2.7 mm) is made, and the ciliary sulcus is filled with an ophthalmic viscoelastic device (OVD). Finally the supplementary IOL is implanted and positioned in the ciliary sulcus using an injector or a forceps.

An upside-down implantation can result in an iris capture and has to be avoided.

We do not perform an iridectomy in standard cases.

For endophthalmitis prophylaxis, an intracameral antibiotic should be applied at the end. Postoperative therapy consists of the application of topical NSAID eyedrops for 2-4 weeks.

Supplementary lenses can be implanted primarily after implantation of the first lens (Duet implantation) or secondarily in the case of existing pseudophakia.

Indications

An important indication for supplementary lenses is the secondary implantation after a "biometric surprise." Especially in the field of refractive lens surgery, the postoperative expectations are extremely high, and thus the desired refraction can be guaranteed with a second surgery.[4]

Refractive corneal surgeries such as PRK or LASIK are irreversible procedures, and correction is not immediately possible. IOL exchange, especially in the case of capsular defects (capsular rupture or after Nd:YAG capsulotomy), is more traumatic and carries a higher risk of dehiscence of the zonular fibers, vitreous loss, and subsequent retinal complications. In contrast, the implantation of a second IOL is significantly less traumatic than a lens exchange and can save a refractive corneal intervention.

In addition to compensating for postoperative ametropia as the primary indication, the introduction of toric and/or multifocal optics in recent years has given rise to further indications for pseudophakic supplementary IOLs. Nowadays toric supplementary lenses enable the correction of postoperative astigmatisms, especially in pseudophakic patients after perforating keratoplasty. A major advantage compared to refractive laser surgery is the reversibility of this procedure and the much higher correction range. IOL rotation may occur more frequently than in toric capsular bag IOLs.[5]

Multifocal IOLs offer an alternative to monofocal IOLs for patients who desire to be without glasses. However, this advantage must always be weighed against the known disadvantages of multifocal IOLs, such as reduced contrast sensitivity and potential dysphotopsias.

The implantation of a supplementary IOL with multifocal optics as part of cataract surgery (Duet implantation) provides a reversible option for presbyopia correction. In the event of intolerance, supplementary IOL can easily be removed without "capsule surgery."[6]

Even with healthy eyes, later pathological changes (AMD, diabetic macular edema, etc.) cannot be ruled out; therefore the implantation of an additional multifocal lens in the context of cataract surgery is a good alternative. In case an eye disease occurs later in life, the sulcus-supported, multifocal IOL can be removed with little surgical trauma.[7]

Another field of application of supplementary IOLs is dynamic refraction cases, such as pediatric cataracts or after silicone oil filling.[4] The challenge of pediatric cataract surgery is the postoperative refraction, which changes due to ongoing growth of the eye and possibly causes a significant myopic shift. The supplementary IOL can be exchanged depending on the refraction. **Note:** The reversibility of the procedure and the different optical options expand the range of indications for refractive cataract surgery.

Conclusion

The implantation of an add-on IOL is a reversible and simple procedure to optimize the refractive result in pseudophakic cases. Refractive results are predictable.

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Presbyopic Phakic IOLs

José L Güell MD PhD

Synopsis

Several surgical approaches to deal with presbyopia have been described. Generally speaking, though, there are two: those trying to achieve some degree of multifocality and those trying to play with some degree of monovision. On the other hand, most of these approaches consist of an irreversible surgical procedure, such as the different laser corneal ones or the different IOLs used after crystalline lens surgery.

Especially important in the myopic presbyopic population, laser corneal refractive surgery may induce some limitations in the future selection of the ideal IOL at the time of cataract surgery. Also, crystalline lens surgery in this group of middle aged myopes might be associated with higher retinal risk.

The so-called phakic IOLs have demonstrated very good efficacy, predictability, and safety ratios in properly selected young myopes, having the attractive characteristic of reversibility.

We will review the actual knowledge about using standard phakic IOLs in presbyopic myopes; in particular, we will present recent data using the presbyopic models in both groups, posterior chamber and, particularly, the "iris-claw" anterior chamber type.

IOL Calculations, the Internet Way

Oliver Findl MD

In recent years many valuable IOL power calculation formulae have become available online and at no cost for users. Most of these formulae are not available on biometry devices. Therefore, the user needs to enter the biometric data online to receive the calculation.

This talk will summarize the variety of IOL formulae available and compare some of these as they have been examined in the peer-reviewed literature. Lastly, a novel online calculator on the website of the European Society of Cataract and Refractive Surgeons (ESCRS) that allows the use of multiple online IOL calculators with only 1 data entry field will be presented. This calculator allows comparison of multiple formulae, which may be especially interesting for IOL power calculation for challenging eyes, such as short and very long eyes.

My Journey in Refractive Surgery and Lessons Learned

Sheraz Daya MD

Having practiced refractive surgery for just over 30 years, the presenter will discuss how refractive surgery has evolved and his own personal journey, with pearls and pitfalls along the way. In reflecting on the course of his journey, the presenter has learned many lessons, which should both educate and resonate with the audience.

From fellowship days of radial keratotomy and observation of and involvement in excimer laser trials through to practice in the U.S. and later the UK, the presenter will recount the variety of procedures that have come and gone, along with management of problems following certain refractive procedures. He will also briefly discuss innovation, the value of involvement with ophthalmic manufacturers, and contributing to change.

Can We Restore Accommodation Today?

Luca Gualdi MD

Globally more than 1.8 billion people are affected by presbyopia, and its surgical correction continues to be considered the holy grail of refractive surgery. Current treatments for presbyopia are based on optical corrections, while surgical refractive modifications are also possible. Although near vision can be easily recovered by the use of reading glasses, there is nonetheless a great demand for more permanent solutions to avoid the use of corrective lenses. However, the available invasive surgical procedures have several limitations and are not devoid of side effects.[1]

Pharmaceutical treatments stimulating the contraction of ciliary muscles in the presence of different miotics and NSAIDs have been recently described. Also an alternative microelectrical approach partially addresses the revitalization of the accommodation system by stimulating the ciliary muscle to increase its potency so that it can overcome the higher resistance of the system (ciliary muscle and lens) that has become more stiffened due to aging.[2]

The complete pathophysiology of presbyopia still remains poorly understood. Two views were originally proposed: Donders (1864) suggested that presbyopia is caused by a decrease in the force of contraction of the ciliary muscle with age, and Helmholtz (1855) suggested that the lens becomes more difficult to deform with age due to lenticular sclerosis.

Although there are several approaches to manage the visual disability associated with presbyopia, most of the currently available treatments are compensatory optical tools rather than corrective, involving more pseudoaccommodation than true accommodation. Methods used so far for the correction of presbyopia include contact lenses and spectacles, while the surgical correction of presbyopia still remains a challenge for refractive surgeons. Optical compensation of presbyopia can be achieved by surgical approaches either on the cornea or on the lens. Corneal surgery includes presbyLASIK, conductive keratoplasty, intrastromal inserts, and intrastromal photodisruption with a femtosecond laser. Lens surgery consists of the insertion of special premium IOLs, such as accommodative, multifocal, bifocal, trifocal, extended depth of focus, pinhole, or rotational asymmetric/segmented IOLs. A different approach to presbyopia surgery is taken by methods that aim to restore accommodation, such as femtosecond laser lens softening, refilling lens, anterior scleral sclerectomy and associated techniques (implants, erbium laser), scleral expansion bands, supraciliary segments, and ciliary-zonular tension ring implantation (see Figure 1). However, a number of limitations and considerations have prevented widespread acceptance of surgical correction for presbyopia. Optical and visual distortion, induced corneal ectasia, haze, anisometropia with monovision, regression of effect, decline in uncorrected distance vision, and the inherent risks of invasive techniques have limited the utilization of presbyopia surgery.

Finally, pharmacological attempts to counteract presbyopia are focused on either relieving lens rigidity—for instance with

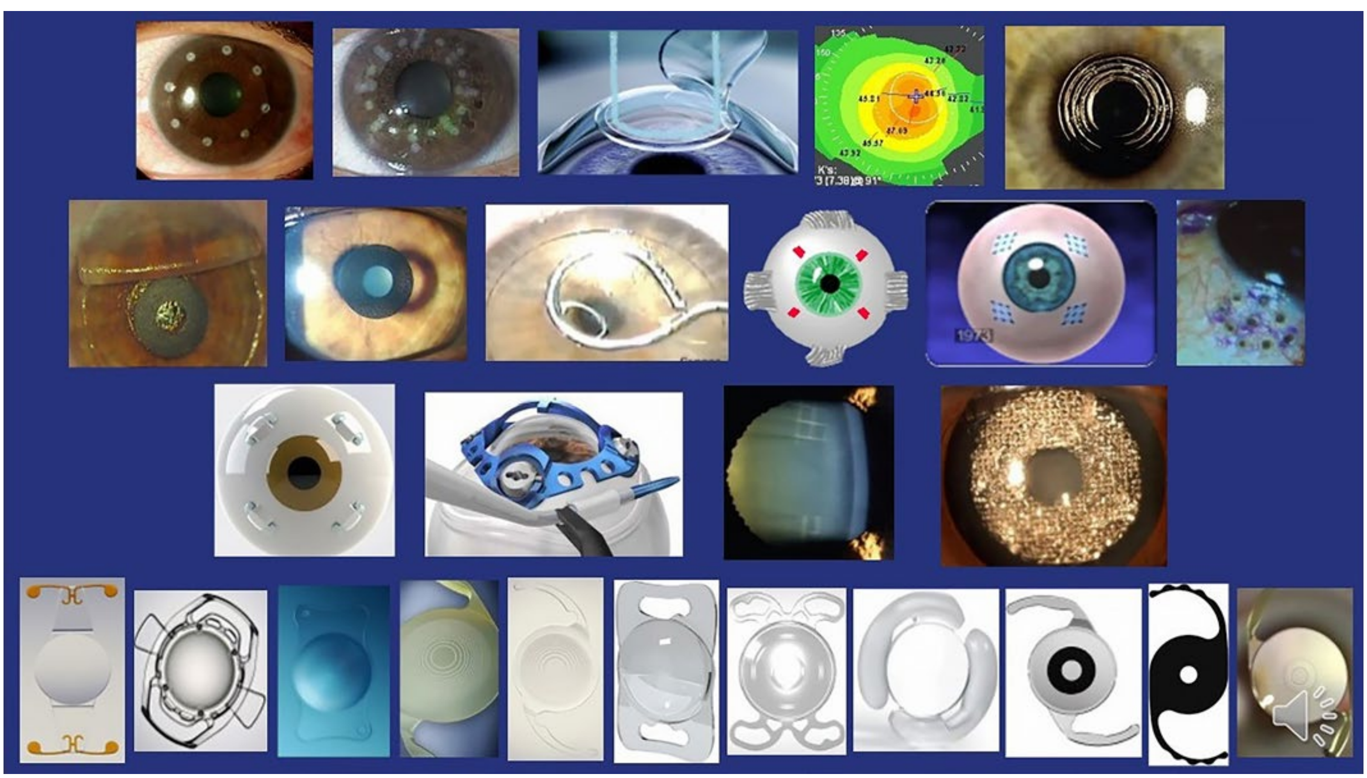

Figure 1. Different surgical strategies for correcting presbyopia.

eye drops containing lipoic acid—or on enhancing iris and ciliary muscle contractility with eye drops containing an association of a parasympathetic, an NSAID, 2 alpha-agonist agents, and an anticholinesterase agent.[3] One unique noninvasive method for restoring accommodation today are "presbydrops," but their effect is limited due to the times of instillation, the fact that they may create dependency, and potential side effects.

Another emerging approach, which is surgical but minimally invasive, is to expand the scleral space by creating small micropores with an erbium laser (laser scleral microporation). "Uncrosslinking" the scleral fibers makes it possible to increase the space for crystalline lens movement, improving the dynamic range of focus and restoring the accommodation process. Nowadays this is the only treatment that really works on accommodation and not on pseudoaccommodation. An important point is that by working far from the visual axis, you can leave the door open for eventual future treatments on the lens or even the cornea.

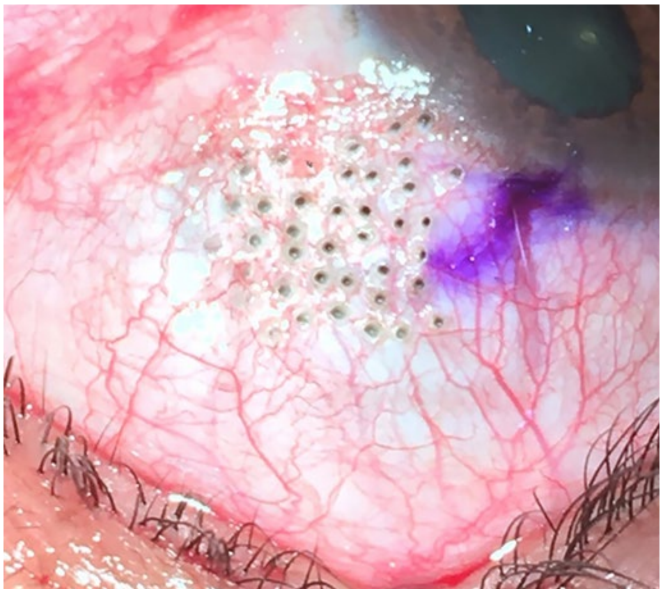

Figure 2. Laser scleral microporation, an emergent technique for restoring accommodation.

It has also been demonstrated that the lens movement and accommodation may also delay cataract formation.[4] Expanding the sclera creates more space for IOP, which is also statistically significantly reduced after the treatment.[5]

The research continues to move ahead. Today we are not as far as we were in the past from restoring accommodation for all people affected by presbyopia.

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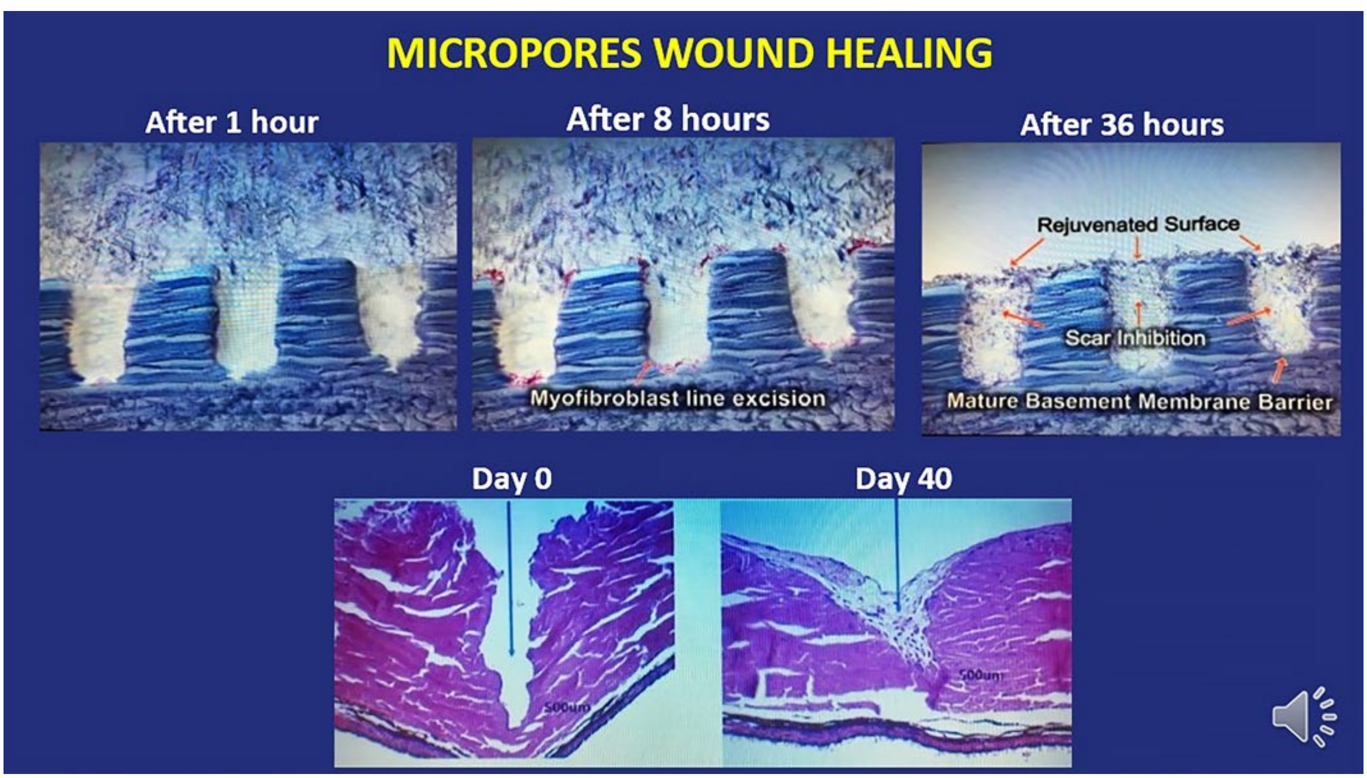

Figure 3. The micropore wound healing is very fast, and the surface rejuvenation starts just 1-2 days after the laser scleral microporation procedure with formation of a pseudo-conjunctiva.

New Concept of Light Distribution for Bilateral Trifocal IOL Implantation

Francesco Carones MD

Introduction

The basic principle by which all diffractive IOLs focus light at more than 1 distance involves splitting the light rays at different diffractive orders. Bifocal IOLs generate 2 focal points, for distance and near (orders 0 and 1). Trifocal IOLs have 3 focal points, for distance, intermediate, and near (orders 0, 1, and 2). For trifocal IOLs, order 0 is at distance and the second order has to be at a comfortable reading distance (35-40 cm). According to the law of diffraction, the first order goes intermediately between orders 0 and 2, roughly between 70 and 90 cm.

Besides the distance generated by the diffractive orders, another important concept involves the energy allocation that each order implies. This amount of energy allocation is one of the parameters the manufacturers may play with to enhance the performance of their diffractive optics.

Background and Observations

Typically, in order to produce the sharpest possible image at distance, especially when light conditions are dim, trifocal IOLs allocate higher energy at the 0 order, with relatively less energy allocation for the first and second orders. An example of energy allocation is 45% for distance and 22.5% for both intermediate and near, where the total sum equals 90% because of the roughly 10% of light dispersed by diffraction. This energy allocation tends to produce some compromise at intermediate and near, where typically patients experience a need for additional light for activities at these distances, like reading.

The New Concept

To avoid the need for light for reading and all the other tasks at near, a trifocal IOL has been developed to allocate energy distribution in the opposite way, prioritizing the near focus (Vivinex Gemetric Plus, Hoya Surgical Optics). This IOL allocates a peak of energy at the near focus (3.50 D) that is similar to that allocated at distance (39%), while the intermediate focus (1.75 D) is allocated with 11% of light energy. The sister trifocal IOL from the same company (Vivinex Gemetric) is designed with the conventional energy allocation, prioritizing the distance focus (51%) while the intermediate and the near foci receive 17% and 22%, respectively. All the other optical features and properties of these 2 IOLs are identical.

Considerations

These 2 IOLs may be implanted with different targets in the eyes of the same patient in an attempt to optimize the outcome in view of the patient's visual needs and expectations. The patient may receive a Vivinex Gemetric in both eyes when the target is improving quality of vision at distance and reducing the chances of night dysphotopsia. Alternatively, the choice for the same bilateral implant may go to the Vivinex Gemetric Plus for those patients who are more interested in the ability to read under dim light circumstances. But the greatest opportunity these 2 IOLs offer seems to be when they are implanted in a mix-and-match fashion in the same patient, to both take advantage of energy allocation strategies and minimize side effects and compromises, using the same IOL platform that provides the same focal point distances. In a short series of surgeries with limited follow-up, the results from this last approach were excellent.

Epi-On Crosslinking at Slit Lamp: Latest Advances

Farhad Hafezi MD PhD FARVO

Introduction

Corneal crosslinking (CXL) has been in clinical use as corneal ectasia therapy for over 20 years.[1] CXL involves the application of riboflavin and UV light to the corneal stroma. UV energy photoactivates riboflavin molecules in the stroma to produce reactive oxygen species (ROS). These crosslink together stromal molecules (principally collagen and proteoglycans), strengthening the stroma and counteracting the weakening effect of the ectasia. CXL as a concept was born in Dresden, Germany, and this is why the original CXL method is called the "Dresden protocol" (although the entire implementation of the procedure to treat corneal ectasias into clinical practice occurred in Zurich, Switzerland). What could not have been predicted at the time the Dresden protocol was first used is that 2 decades later it would remain the most effective CXL protocol for treating corneal ectasia, and that it would take most of this period to successfully work around the biggest drawbacks associated with the technique.

Oxygen is essential to CXL.

The CXL photochemical reaction needs 3 factors to be able to crosslink stromal tissue: UV, riboflavin, and oxygen. Oxygen is rapidly depleted during the CXL reaction, and its availability is rate limiting: the reaction speed is limited by oxygen availability.[2,3] Part of the reason the Dresden protocol is so effective was that it requires epithelial cell debridement before riboflavin application, making this an epithelium-off (or "epi-off") procedure. This is necessary, as riboflavin molecules are too large to pass through the epithelial cell tight junctions, but the epi-off approach also has other advantages: the epithelium also absorbs UV energy and acts as an additional barrier to oxygen diffusion into the stroma.[4] However, the central ~8-mm epithelial debridement then requires careful handling after the procedure. Patients need to have their haze, pain, inflammation, and foreign body sensations managed, and although the risks are still very low, there is a risk of postsurgical corneal infection, especially if the cornea is not correctly handled after surgery and during the recovery period. To make CXL an effective epithelium-on ("epi-on") procedure requires not only a method of effectively delivering riboflavin into the stroma but also optimization of the crosslinking protocols to ensure that Dresden protocol–like corneal strengthening occurs.

Dresden protocol CXL is a slow procedure: it involves UV irradiation at 3 mW/cm² for 30 minutes to deliver a fluence of 5.4 J/cm².[1] Attempts to accelerate the procedure in epi-off CXL by increasing UV intensity and decreasing the irradiation time accordingly to deliver the same fluence fail to achieve the same level of strengthening as the Dresden protocol; in other words, greater acceleration results in diminishing strengthening effects.[5,6] Once again, it is the rate of oxygen diffusion into the cornea that underlies this: the greater the UV intensity, the faster oxygen is consumed.[2,3]

Or is it? Preclinical experimental work by our group has shown that we can recover some of the efficacy lost by accelerating the irradiation by increasing the fluence from 5.4 J/cm² to 10 J/cm², and clinical validation is currently ongoing.[7]

Achieving Successful Epi-On CXL

How do we deliver the riboflavin to the stroma without removing the epithelium? There are essentially 2 approaches: iontophoresis and the use of penetration enhancers. In iontophoresis, electric current is used to electrostatically "push" the riboflavin through the cornea and into the stroma, whereas penetration enhancers like benzalkonium chloride break down the tight junctions between the corneal epithelial cells, enabling riboflavin to diffuse through the epithelium and into the cornea.[8] The next step is to address the lack of oxygen: some surgeons have tried supplemental oxygen in their protocols in an effort to replenish the oxygen that is consumed in the photochemical riboflavin-UV-A reaction, whereas others have deployed pulsed irradiation in an attempt to let oxygen diffuse back into the stroma while the reaction is not proceeding during the UV-off part of the pulsed irradiation cycle.[9]

Oxygen is essential to CXL.

The work of Cosimo Mazzotta and his colleagues has combined many of the treatment effect–enhancing measures to bring the efficacy of an iontophoresis epi-on crosslinking up to what looks like the Dresden protocol standard of stiffening efficacy.[10] By pulsing the light (to increase oxygen availability), gently increasing the fluence (to overcome the UV energy absorbed by the epithelium), and moderately accelerating the treatment, Mazzotta and colleagues have been able to successfully perform effective epi-on crosslinking that continues to show ectasia prevention efficacy after 3 years of clinical follow-up.

Outlook

Evaluating the combination of penetration enhancers and riboflavin, we have found that in vitro, we can achieve epi-on riboflavin penetration and crosslinking stiffening effects equivalent to Dresden protocol crosslinking, without requiring supplemental oxygen or iontophoresis,[7] and we are currently evaluating this approach in the clinic. This approach would therefore be the simplest epi-on protocol yet: no other apparatus would be required. It is therefore possible to soon envisage an accelerated epi-on CXL protocol using riboflavin with a penetration enhancer, and a pulsed high-fluence protocol that provides Dresden protocol-like corneal strengthening.

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Dr. Hafezi holds a patent on a UV light source (PCT/CH2012/000090).

Refractive Correction With Tissue Addition

Michael Mrochen PhD

NOTES

Using AI to Optimize Excimer Ablations

A John Kanellopoulos MD

NOTES

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Bausch + Lomb: C,L
Glaukos Corp.: C,L
Johnson & Johnson Vision: C,L
Novartis: C
Oculus, Inc.: C,L
Omega Ophthalmics: C
Omeros: C
Perfect Lens, LLC: C
Refocus Group: C
Shire: L
SRD Vision: C
Visiometrics, S.L.: C
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Bruder Healthcare Company: C
BVI: C
Carl Zeiss Meditec: C,L
CorneaGen: C
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Katena Products, Inc: C
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Melt: C
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Staar Surgical: C
Surface: C
Tarsus: C,S
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Revai Care: C
Teleon: C

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Innovation

Advanced IOL Power Calculations After Incorporating Total Corneal Power Measurements Using High-Resolution Scheimpflug Imaging in Keratoconus Eyes Undergoing Cataract Surgery
RP30071611

Senior Author: Navaneet S C Borisuth MD PhD
Coauthors: Abhishek Gowda BA and Neeraj Singh Chawla MD

Purpose: To assess the refractive accuracy of multiple IOL formulas incorporating total corneal power (TCP) in eyes with keratoconus (KCN) undergoing phacoemulsification (PE). **Methods:** Thirty eyes of 18 patients with KCN underwent PE with IOL implantation. We compared the mean prediction error (MPE) of multiple formulas after incorporating TCP in a central 3-mm pupillary zone to standard keratometry (SK). SK was used for the Kane KCN formula because it utilizes a theoretical modification of the anterior corneal power to represent the anterior/posterior ratio in keratoconic eyes. **Results:** For SK vs. TCP, the MPE significantly decreased ($P < .001$) for all IOL formulas tested: Barrett Universal II (BUII): 0.39 ± 0.84 vs. −0.26 ± 0.88; SRK/T: 0.22 ± 0.76 vs. −0.54 ± 0.59; Holladay 1: 0.49 ± 0.95 vs. −0.36 ± 0.77; Haigis: 0.55 ± 1.00 vs. −0.39 ± 0.83; and Hoffer Q: 0.61 ± 0.93 vs. −0.31 ± 0.78. MPE for the Kane KCN formula was 0.16 ± 0.99. **Conclusion:** Incorporating TCP measurements in KCN eyes undergoing PE led to significantly less hyperopic outcomes than the Kane KCN formula ($P = .017$). There were no statistically significant differences between the IOL formulas that incorporated TCP.

325° Arch-Length Intracorneal Ring Implantation Strain Maps Visualized With New Optical Coherence Elastography
RP30071614

Senior Author: Emilio A Torres Netto MD
Coauthor: Sabine Kling PhD

Purpose: The objective of this study was to record the axial corneal strain field in the cornea that resulted directly after creating a stromal tunnel as well as after implanting an intracorneal ring segment (ICRS). **Methods:** Eyes were assigned either to 325° Arch-Length ICRS implantation, to tunnel creation only, or to virgin control. Displacements between subsequent OCT scans were retrieved using a vector-based phase difference method. **Results:** Corneal tissue presented a localized compressive strain in the direct vicinity of the stromal tunnel. The central and peripheral (exterior to the ICRS) cornea demonstrated compressive strains upon IOP increase, and tensile strains upon IOP decrease. ICRS induced an annular-shaped tensile strain at its inner border. Corneal curvature changes were limited to the corneal regions subjected to strain. **Conclusions:** Tunnel creation and ICRS implantation induce localized strains in cornea regions that coincide with those of refractive changes, suggesting that corneal strain and curvature are directly related.

Incorporating Total Corneal Power Measurements in Keratoconus Eyes Undergoing Cataract Surgery With Astigmatism Correction Improves the Accuracy of Advanced Toric Power Calculations
RP30071616

Senior Author: Navaneet S C Borisuth MD PhD
Coauthors: Abhishek Gowda BA and Neeraj Singh Chawla MD

Purpose: To assess the accuracy of toric calculations using high-resolution Scheimpflug imaging to measure the total corneal power (TCP) in eyes with keratoconus (KCN) undergoing phacoemulsification (PE) with toric IOL implantation. **Methods:** Fifteen eyes of 10 patients with keratoconus underwent PE with toric IOL implantation. We compared the absolute prediction error (AE) in refractive astigmatism for TCP in a central 3-mm pupillary zone to standard keratometry (SK). For the Kane formula only, SK was used because of its proprietary theoretical modification of the anterior/posterior ratio in KCN eyes. **Results:** For SK vs. TCP, the AE in refractive astigmatism decreased for the Barrett (0.70 ± 0.83 vs. 0.59 ± 76) and the Holladay (0.72 ± 0.89 vs. 0.71 ± 0.64) toric calculators. The AE for the Kane KCN formula was 0.74 ± 0.91. The AE for the Barrett with TCP adjustment was statistically lower than the Kane formula ($P = .025$). **Conclusion:** By incorporating TCP, we lowered the AE in refractive astigmatism in KCN eyes undergoing toric IOL implantation. The Barrett toric calculator with TCP adjustment had the lowest prediction error and was statistically better than the Kane KCN formula.

Machine Learning Approach to the Identification of Candidates for Photorefractive Keratectomy Using Scheimpflug Tomography RP30071617

Senior Author: Zachary P Skurski DO

Purpose: To assess applicability of machine learning (ML) to preoperative clinical and Scheimpflug tomographic data obtained from Oculus Pentacam HR to identify candidates for photorefractive keratectomy (PRK). **Methods:** Retrospective, single center pilot study. Preoperative Pentacam data was gathered from 166 patients (332 eyes). Six machine learning classification models were trained and validated on 82 feature vectors to predict candidacy for PRK against expert clinical evaluation. Performance was assessed by area under the receiver operator curve (AUC) following 10-fold cross-validation. **Results:** AUC of the optimized logistic regression (LR), K-nearest neighbor (KNN), multilayer perception (MLP), random forest (RF), support vector classifier (SVC), and AdaBoost models was 0.929, 0.762, 0.842, 0.973, 0.925, and 0.957, respectively. The RF model outperformed KNN ($P \leq .0001$), and MLP ($P < .0001$) but was not statistically superior to LR ($P = .088$), SVC ($P = .068$), or AdaBoost ($P = .469$). **Conclusion:** RF, LR, SVC, and AdaBoost were accurate ML models in predicting PRK candidacy, while KNN and MLP were the least powerful in this small population.

Vault Predictability After Implantable Collamer Lens Implantation Using Anterior Segment OCT and Machine Learning in Caucasian Eyes RP30071623

Senior Author: Andrea Russo MD
Coauthors: Ottavia Filini DMath and Giacomo Savini MD

Purpose: To compare the vault predicted by machine learning with the achieved vault using the online manufacturer's nomogram in patients undergoing posterior chamber implantation with an implantable collamer lens (ICL; Staar Surgical). **Methods:** This retrospective study included 449 eyes from 238 patients who underwent ICL placement surgery between 2018 and 2021. All biometric measurements were obtained by anterior segment OCT (AS-OCT). **Results:** High correlation between the predicted and achieved vaulting was detected by regression tools random forest (RF; $R2 = 0.42$), extra tree (ET; $R2 = 0.50$), and extreme gradient boosting ($R2 = 0.41$). High residuals were observed between the achieved vaulting and the values predicted by the multilinear ($R2 = 0.32$) and ridge regression ($R2 = 0.32$). The ET and RF models showed significantly lower mean absolute errors and higher percentages of eyes within ±250 µm of the intended ICL vault than the conventional nomogram ($P < .001$). **Conclusion**: Machine learning models, trained on AS-OCT metrics, provide surgeons with a prediction of ICL vault for each lens size, allowing precise tailoring of ICL sizing.

JRS—Hot, Hotter, Hottest Late Breaking News

Intrastromal Ring Segment Implantation Results in Corneal Mechanical Strengthening Visualized With Optical Coherence Elastography
RP30071613

Senior Author: Emilio A Torres Netto MD
Coauthors: Farhad Hafezi FARVO MD PhD and Sabine Kling PhD

Purpose: To quantify the mechanical impact of intracorneal ring segment (ICRS) implantation of different dimensions. **Methods:** Eyes were assigned either to ICRS implantation (thickness, 300 µm; angle, 120°, 210°, or 325°), tunnel creation only, or virgin control. The effective E-modulus was derived from the overall induced strain as a measure of global mechanical impact. **Results**: ICRS implantation increased the E-modulus from 146 and 163 kPa in virgin and tunnel-only eyes to 149, 192, and 330 kPa in eyes that received a 5-mm ICRS with 120°, 210°, and 325° arc length, respectively, and to 209 kPa in a 6-mm ICRS with 325° arc length. The most consistent effect was a shift toward positive strains in the posterior stroma. **Conclusions**: ICRS implantation reduces the overall tissue strain under the load of the IOP. This is more dominant the longer the arc length and the smaller the optical zone of the ICRS is. ICRS have not only a geometrical but also a mechanical impact on corneal tissue.

Synthetic Corneal Endothelial Layer in Chronic Corneal Edema: Interim Trial Reports
RP30071633

Senior Author: Lional Raj Daniel Raj Ponniah MD

Purpose: To evaluate safety of implanting synthetic corneal endothelial substitute in cases of chronic endothelial dysfunction. **Methods**: A prospective open-label clinical safety evaluation. Cases of chronic corneal edema with endothelial dysfunction were subjected to synthetic corneal implant after a central 7.5-mm descemetorhexis and attached under gas similar to endothelial keratoplasty (EK). Pre- and postop central corneal thickness (CCT), vision (ETDRS characters), and pain scores were analyzed, in addition to rebubbling rates and toxic reactions to the implant. **Results**: Five cases enrolled. Vision at baseline was 9.75 ± 1.7 characters, which improved to 41.75 ± 8.7 and was retained after 3 months at 50 ± 7.1. CCT reduced from a mean of 659 µm to 504 and was well retained at 507.5 by Month 3. Out of a scale of 1-100, pain was 90.5 ± 2.3 at presentation and 68.25 ± 4.03 at 1 month, further improved by Month 3. No immunologic reactions were noticed in any cases. One case needed rebubbling at Day 7 and Day 21. **Conclusion**: Synthetic endothelial layer improved vision, reduced chronic corneal edema, was not associated with toxicities, and may be an effective alternative to EK procedures.

Pearls From Around the World in Refractive Surgery

Myopic Regression Following LASIK Surgery—An Indian Perspective
RP30071609

Senior Author: Aastha Singh MS

Purpose: To study demography, etiology, and outcome of treatment of myopic regression following LASIK in an Indian cohort. **Methods**: The study was conducted prospectively over 12 months at a tertiary care eye hospital in India. Patients who presented with myopic regression following uneventful LASIK were included the study. Demographic characteristics, time to presentation, and individual risk factors were recorded and analyzed. **Results**: Twenty-nine eyes of 15 patients were enrolled in the study. Mean age of the patients was 23.55 years. Mean pre-LASIK refractive error was –7.48 ± 2.9 D, and mean regression SE was –1.02 ± 1.1 D. High pre-LASIK refractive error, lower central corneal thickness, steeper keratometry reading, and high IOP were significant risk factors in developing regression. Successful reversal of regression with timolol maleate (0.5%) eyedrops was observed in 76% of the patients. **Conclusions**: Myopic regression following LASIK can be circumvented by careful preoperative assessment of high-risk factors, and timolol maleate is an effect treatment modality for regression.

Bilensectomy Outcomes in a Large Series of Cases With Previous Angle-Supported, Iris-Fixated, and Posterior Chamber Phakic IOLs
RP30071626

Senior Author: Jorge L Alio MD PhD
Coauthors: Veronica Vargas and Saad Abdulrahman Alamri MD

Purpose: To report a large bilensectomy case series including causes and visual and refractive outcomes of eyes previously implanted with angle-supported (AS), iris-fixated (IF), and posterior chamber (PC) phakic IOL (pIOL), as well as the intra- and postoperative complications in these different groups. **Methods**: A multicenter, retrospective study included 234 eyes that underwent bilensectomy from 2005 to 2021. Main outcome measures were etiology, duration between pIOL implantation and bilensectomy, uncorrected and corrected distance VA (UDVA and CDVA), efficacy, safety, and intra- and postoperative complications. Of the 234 eyes, 101 had a PC pIOL, 59 eyes had an IF pIOL, and 74 eyes had an AS pIOL. **Results:** Main reason for bilensectomy was cataract in all groups, followed by endothelial cell density loss in IF and AS groups. Mean time between pIOL implantation and bilensectomy was 7 years in the PC group, 11 years in the IF group, and 12 years in the AS group. Significant improvement in UCVA and CDVA after bilensectomy in all groups (*P*:0.001). **Conclusion**: Bilensectomy following PC pIOLs was shown to be the safest, with a higher efficacy index, but it had a shorter time between pIOL implantation and bilensectomy, mostly due to cataract.

Seven-Year Refractive Outcomes Comparing SMILE and Femtosecond LASIK for Myopia
RP30071629

Senior Author: Tian Han MD
Coauthors: Ye Xu and Xingtao Zhou

Purpose: To compare the 7-year refractive outcomes of SMILE and femtosecond (FS)-LASIK for myopia. **Methods**: This retrospective cohort study included 97 eyes of 53 patients who had undergone SMILE or FS-LASIK for myopia 7 years prior. Measured parameters included uncorrected and corrected distance visual acuity (UDVA and CDVA) and manifest refraction. **Results**: There were no significant differences between the SMILE and FS-LASIK groups in logMAR UDVA, cylinder, and logMAR CDVA at 7 years postoperatively ($P > .05$). However, there were significant differences between the 2 groups in sphere and spherical equivalent ($P = .035$ and $P = .016$, respectively). UDVA was better than or equal to 20/20 in 81% of the eyes after SMILE and in 63% after FS-LASIK ($P = .045$). The efficacy indices of the SMILE and FS-LASIK groups were 1.04 ± 0.23 and 0.97 ± 0.23 ($P = .405$), and the safety indices were 1.18 ± 0.19 and 1.10 ± 0.17 ($P = .543$), respectively. **Conclusion**: This study demonstrates the good predictivity of both SMILE and FS-LASIK. SMILE might offer refractive outcomes superior to those of FS-LASIK during a 7-year follow-up in correcting myopia and myopic astigmatism.

Sequential Custom Therapeutic Keratectomy for Granular Corneal Dystrophy Type 1: Four-Year Results
RP30071630

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

Purpose: Granular corneal dystrophy type 1 (GCD1, Groenouw type 1) causes progressive VA decrease and recurrent erosions. We present long-term follow-up of sequential custom therapeutic keratectomy (SCTK) for GCD1. **Methods:** Thirty-seven eyes with GCD1 severely hindering visual acuity underwent SCTK. Mean follow-up period was 41.3 ± 0.28.7 months, with 14 eyes followed for at least 5 years. **Results:** SCTK provided significant CDVA improvement, from 0.33 ± 0.22 decimal to 0.63 ± 0.24 ($P < .0001$) at last follow-up. Mean corneal curvature and the spherical component did not show statistically significant change or hyperopic shift. Mean corneal pachymetry difference was 78.42 µ ± 62.26 µ SD. Astigmatism, spherical aberration, and higher-order aberration reduction was statistically significant. No patient reported corneal erosions recurrence. **Conclusion:** Four years after SCTK, eyes with GCD1 showed CDVA improvement, stability of refraction, and no recurrent erosion.

Interface Fluid Syndrome 2 Decades After LASIK
RP30071631

Senior Author: Yishay Weill MD
Coauthors: Elishai Assayag MD, David Smadja MD, Eduardo Roditi MD, David Zadok MD, and Adi Abulafia MD

Purpose: To report a case of late-onset interface fluid syndrome (IFS) after LASIK. **Methods**: A 94-year-old man was referred for evaluation due to persistent corneal edema 10 days after Descemet-stripping automated endothelial keratoplasty (DSAEK) for pseudophakic bullous keratopathy. **Results**: Following an uneventful DSAEK, the patient was treated with topical antibiotics and steroids. On presentation, a well-positioned and oriented DSAEK graft was observed in the right eye, yet the cornea was edematous. Applanation tonometry was normal. Anterior segment OCT (AS-OCT) revealed a LASIK flap with a fluid cleft beneath it. Requery confirmed that LASIK was performed 21 years ago. Topical steroids were stopped, and after 2 weeks the cornea was clear and AS-OCT revealed complete resolution of the interface fluid. **Conclusion:** Even decades later, IFS should be considered as a source of corneal edema in patients after LASIK. Monitoring these patients with AS-OCT is recommended.

Refractive Surgery in the New Era

A Novel Modeling System Based on Artificial Intelligence for Keratoconus Detection From SIRIUS Images
RP30071591

Senior Author: Soheil Adib-Moghaddam MD
Coauthors: Moein Bahman PhD, Mojdeh Mohseni PhD, Maryam Mohammadzadeh MD, and Majid Mohebbi MD

Purpose: Keratoconus progression diagnosis with help of a modeling system based on artificial intelligence would be a promising approach for ophthalmologists. In this research, we aimed to develop a novel model based on a chaotic system from SIRIUS images to extract the non-constant-coefficients in every individual eye. **Methods:** The designed model was implemented on 65 healthy cases and 32 keratoconus patients (54 men and 43 women). The patients were divided into 2 separate subgroups to evaluate the results of each group separately. Subgroup 1 included 34 men and 27 women, and subgroup 2 included 28 men and 24 women. **Results:** Our obtained results indicate a sensitivity of 88% and 92% for subgroup 1 and subgroup 2, respectively, and specificity of 90% and 96% for subcategory 1 and 2, respectively (subgroup 1 *P*-value 0.028 and subgroup 2 *P*-value 0.025). **Conclusion:** We have developed a novel chaotic AI-based system that can be used successfully to diagnose keratoconus. Despite the results being promising in terms of accuracy and repeatability, it seems that a larger study might give even greater credibility to this novel model.

Neuropathic Ocular Surface Changes, Corneal Nerve Imaging, and Neuromediator Profiles in SMILE and Femtosecond LASIK
RP30071620

Senior Author: Yu-Chi Liu MD
Coauthor: Jodhbir S Mehta MBBS PhD

Purpose: To evaluate neuropathic ocular surface, corneal nerves, and neuromediators in SMILE and femtosecond LASIK. **Methods:** Fifty SMILE eyes and 50 LASIK eyes were followed up for 1 year. Five clinical neuropathic ocular surface assessments, 7 corneal nerve parameters, and 4 tear neuromediators were evaluated. **Results:** SMILE had significantly better corneal sensitivity up to 6 months, better tear breakup times (TBUT) at 3 months, and lower NEI and Oxford scores at 1 week. SMILE had significantly better corneal nerve fiber length, density (CNFD), branch density, fiber area and width (CNFW) and fractal dimension (CFracDim) throughout 1 year. There were significant increases in NGF and decrease in substance P (SP) at 1 month in LASIK. CNFD, CNFW, CFracDim, and SP levels were significantly associated with TBUT. Tear SP levels were significantly correlated with all nerve parameters. **Conclusion:** SMILE was associated with less negative impact on ocular surface, less neuroinflammation, and faster restoration of nerve status.

Ten-Year Global Publications on SMILE: A Bibliometric Analysis
RP30071627

Senior Author: Tian Han MD
Coauthors: Liang Zhao MD, Jinhui Tian MD, and Xingtao Zhou MD

Purpose: To analyze the 10-year development process of SMILE surgery and anticipate future publication trends. **Methods:** We conducted a literature search for SMILE research from 2011 to 2020 using the Science Citation Index Expanded (SCIE) of the Web of Science Core Collection (WoSCC) and the VOS viewer and CiteSpace software to conduct the bibliometric analysis. **Results:** A total of 574 publications from 2011 to 2020 were retrieved. Annual publication records grew from 2 to 123 during this period. China had the largest number of publications ($n = 249$, 43.37%). Fifty keywords that appeared more than 4 times were classified into 7 clusters: femtosecond laser technology, corneal nerve recovery, biomechanics, visual quality, complications, presbyopia, and hyperopia. According to the co-citation timeline view outcomes, clusters referring to predictability, complications, and astigmatism were shown to be the hotspots in the future. **Conclusion:** The SMILE field is rapidly developing. Articles related to predictability, complications, and astigmatism will continue to attract interest.

Measurement of the Bulbar Conjunctival Microvasculature in Ocular Surface Inflammatory Diseases
RP30071607

Senior Author: Sunkyoung Park MD
Coauthor: Kyung-Sun Na

Purpose: To compare the blood flow rate (BFR), blood flow velocity (BFV), vessel diameter (D), and vessel density (VD) of the bulbar conjunctival microvasculature between patients with nonimmunologic and immunologic dry eye disease. **Methods:** A total of 60 patients, including 40 patients of nonimmunologic and 20 patients of immunologic dry eye disease, were prospectively evaluated. BFR, BFV, D, and VD were measured using a deep learning–based algorithm that was estabilished in our previous study. **Results:** In patients with immunologic dry eye disease, the mean value of BFR, BFV, and VD were lower than in patients with nonimmunologic dry eye disease, while the mean value of D was higher. There was significant difference between groups only in the mean value of D. **Conclusion:** We quantified the conjunctival microvasculature scales such as BFR, BFV, D, and VD using a noninvasive deep learning–based method. Further studies should be conducted in order to utilize the microvasculature scales as objective parameters for diagnosing dry eye disease.

What's New for Me in 2022

Clinical Retinal Image Quality of a Nondiffractive Wavefront-Shaping Extended-Depth-of-Focus IOL (Vivity) Compared With Trifocal and Monofocal IOLs
RP30071625

Senior Author: Jorge L Alió MD PhD
Coauthors: Saad Abdulrahman Alamri MD, Jorge Alio Del Barrio MD PhD, and Ziyad Abdullah Alharbi MBBS MD

Purpose: To evaluate clinical retinal image quality after implanting a new extended-depth-of-focus (EDOF) IOL compared to that of monofocal and trifocal IOLs by analyzing point spread function Strehl ratio (PSF) in pyramidal WaveFront-based sensor (PWS) aberrometer at 2 different pupil sizes. **Methods:** Prospective case-control study included 88 eyes (50 patients) implanted with monofocal SA60AT (control), Vivity Alcon IOL, or AT LISA Tri Zeiss IOL. Outcomes: PSF with low-order aberrations (PSF with LOA), PSF excluding LOA (PSF w/o LOA), total root-mean-square (RMS), ocular LOA/HOA. MTF values were deduced from the aberrometry data. **Results**: AT LISA Tri showed higher PSF w/o LOA than monofocal and Vivity IOLs ($P < .01$). Despite comparable postoperative spherical equivalent (LOA) among groups ($P > .05$), AT LISA Tri retinal image quality (PSF with LOA) was severely affected by small residual refractive error. **Conclusion**: Vivity and monofocal IOLs showed comparable retinal image quality, and they were also comparable with diffractive trifocal IOLs when considering the clinically real PSF (the one that takes into account the unavoidable low amount of residual ametropia).

Predictors of Tear Film and Ocular Surface Disruptions After Cataract Surgery: An Exploratory Study
RP30071632

Senior Author: Lional Raj Daniel Raj Ponniah MD

Purpose: To study the various baseline factors contributing to ocular surface damage after uneventful cataract surgery and to develop a plan for rational surface protector use. **Methods**: Nonrandomized, double-masked comparative clinical trial. Cataracts with and without diabetes mellitus (DM) based on age were grouped as Group 1 (no DM, age < 60, $n = 43$), Group 2 (DM, <60, $n = 39$), Group 3 (no DM, >60, $n = 51$), and Group 4 (DM, >60, $n = 67$). Preop Meibography and quantitative tear functions including noninvasive tear breakup time (NIBUT) and blink rate were analyzed and compared with postoperative day 21 (POD21) and 3 months. Ocular Protection Index (OPI) was calculated by dividing NIBUT by blink interval. OPI < 1 is unfavorable. **Results**: NIBUT was 11.80, 9.50, 10.30, and 7.88 sec across Groups 1-4, reduced to 8.34, 7.31, 7.36, and 6.11 by POD21, restored at 3 months. ANOVA for OPI had time effect, Wilks lambda = 0.813, $P < .0001$. Preop OPI was 1.88, 1.26, 1.67, and 0.88 across Groups 1-4, reduced to 1.68, 0.91, 1.03, and 0.75 at POD21, restored by 3 months. Group 4 had poor OPI at all times. DM had 12.1% MG loss; non-DM, 6.64%. Elderly and DM were 6.29 and 1.79 times more susceptible. **Conclusion**: Elderly age and DM influence post-cataract ocular surface damage. Diabetics over 60 years require long-term surface protectors.

Safety and Efficacy of CSF-1 in Participants With Presbyopia: The NEAR-2 Phase 3 Randomized Clinical Trial
RP30071634

Senior Author: Nicole R Fram MD
Coauthors: Preeya K Gupta MD, David L Wirta MD, Edward J Holland MD, and Richard L Lindstrom MD

Purpose: To evaluate the safety and efficacy of CSF-1 (0.4% pilocarpine HCl ophthalmic solution) for temporary correction of presbyopia. **Methods**: Randomized, double-masked, parallel-group study. 304 participants randomized to 2 groups: CSF-1 ($n = 154$) and vehicle ($n = 150$). Participants applied 1 drop of CSF-1 or vehicle twice a day for 2 weeks. Ophthalmic assessments were performed on days 1, 8, and 15. Key efficacy endpoints were the percentage of participants with ≥ 3-line gain in distance-corrected near visual acuity (DCNVA) at 4 timepoints on Day 8: 1 and 2 hours after doses 1 and 2, without a loss of 1 line or more in corrected distance VA (CDVA). **Results**: 286 completed the study (CSF-1 = 144, vehicle = 142). The vast majority of adverse events (AE) were mild. No serious AE was reported. CSF-1 had a statistically significantly higher percentage of participants who achieved ≥ 3-line gain at all timepoints. At 1 hour after dose 1, 42.2% of CSF-1 treated participants achieved ≥ 3-line gain in DCNVA, vs. 21.4% of participants who received vehicle ($P < .0001$). **Conclusion**: CSF-1 met the primary and all key secondary efficacy endpoints and was well tolerated with a favorable safety profile.