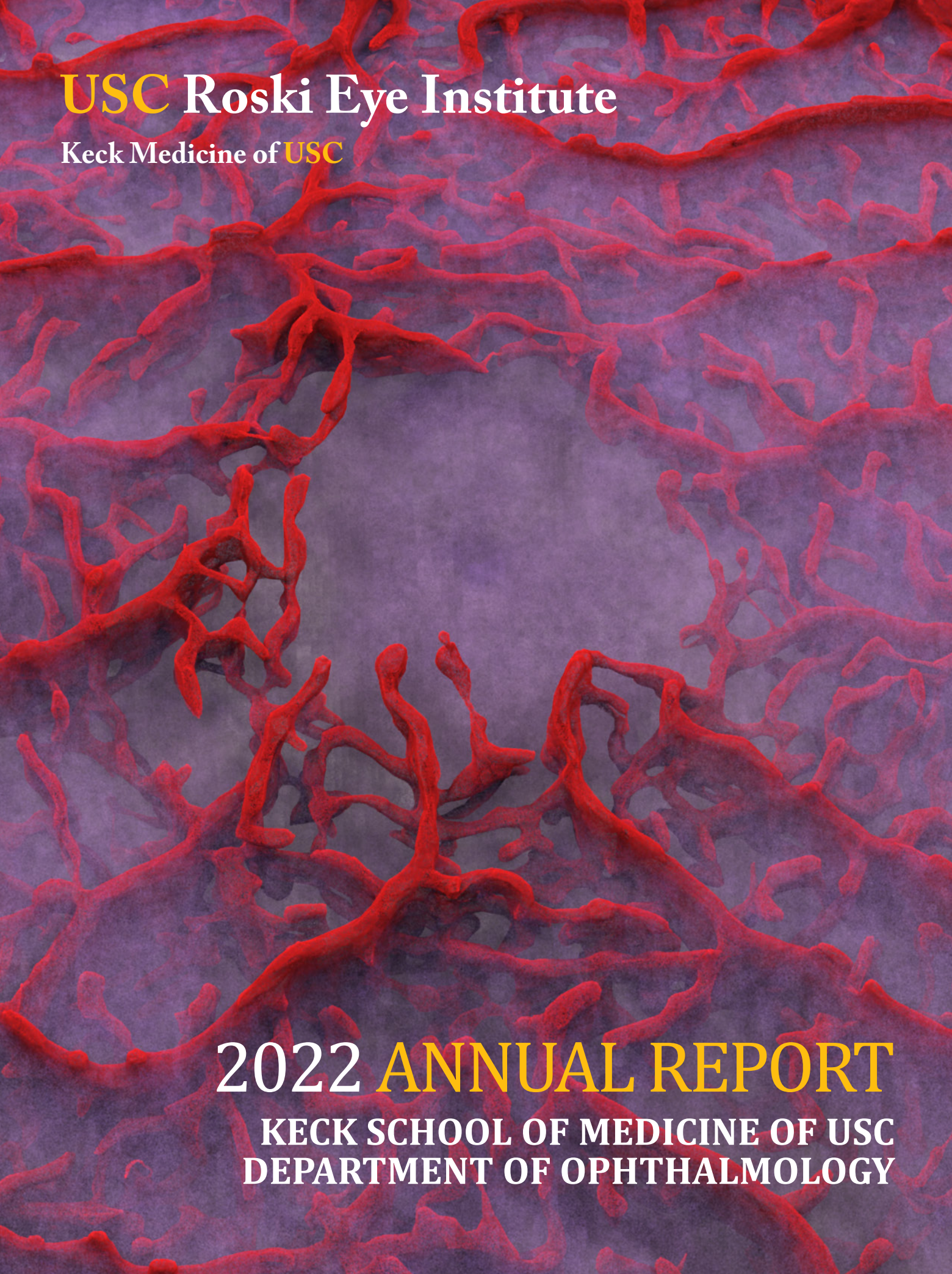


USC Roski Eye Institute

Keck Medicine of USC

2022 ANNUAL REPORT

KECK SCHOOL OF MEDICINE OF USC
DEPARTMENT OF OPHTHALMOLOGY

MESSAGE FROM THE CHAIR

The USC Roski Eye Institute's mission is to provide exceptional clinical care, train the future leaders in ophthalmology and develop novel therapies in the fight against blindness. We continue to spearhead innovation in eye care through the integration of medicine and science.

The USC Roski Eye Institute continues to offer treatments not widely available in the community, including the management of complex cornea, retina, glaucoma, neuro-ophthalmology, oculoplastic and uveitis cases.

In FY 2021, the USC Department of Ophthalmology ranked #2 among all ophthalmology departments in federal NIH Funding, according to the Blue Ridge Institute for Medical Research. With a portfolio of over 64 research funded projects amongst our faculty, we remain at the forefront of understanding the complexities of the eye in our never-ending mission to end blindness.

Our LAC+USC Ophthalmology Residency program also ranked nationally in the U.S. by Doximity. As our residency program welcomes new leadership under Program Director, Brian Song, MD, MPH; Associate Program Director, Annie Nguyen, MD; and Interim Chief of Ophthalmology, Lauren Daskivich, MD, we are poised to continue to strengthen our educational mission to train the next generation of ophthalmologists. We remain grateful to our exceptional alumni who volunteer their time at LAC+USC Medical Center to mentor our interns, residents and fellows.

Even as taking every precaution against COVID-19 remains an ever-present duty, our clinics have returned to 90% of pre-COVID volume, thanks to strictly followed safety measures and the dedication and determination of our faculty and staff.

This work could not have been achieved without the extraordinary collaborations of all our Roski community. We thank you all for your continued dedication and support of our mission. We look forward to the year ahead as we continuously strive to develop new treatments and therapies to preserve, protect and restore vision.

J. Martin Heur, MD, PhD
Professor and Interim Chair
Charles C. Manger III, M.D.
Chair in Corneal Laser Surgery
USC Department of
Ophthalmology
Keck Medicine of USC

Mark S. Humayun, MD, PhD
Cornelius J. Pings Chair in
Biomedical Sciences
Co-Director,
USC Roski Eye Institute
Director, USC Ginsburg Institute
for Biomedical Therapeutics

Narsing A. Rao, MD
Grace and Emery Beardsley
Professor of Ophthalmology
Co-Director,
USC Roski Eye Institute
Keck School of Medicine

YOUR VISION IS OUR MISSION

PRESERVE

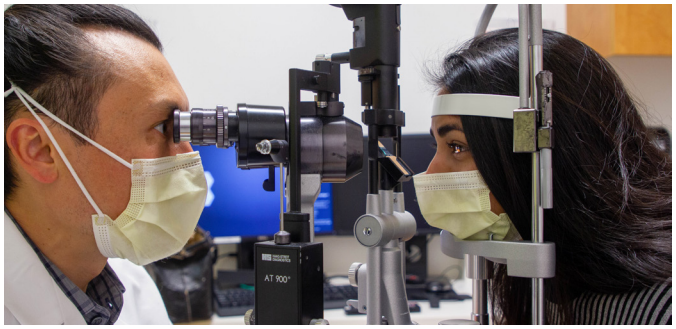
The USC Roski Eye Institute diagnoses, treats and manages the most complex eye conditions, from in utero to advanced age.

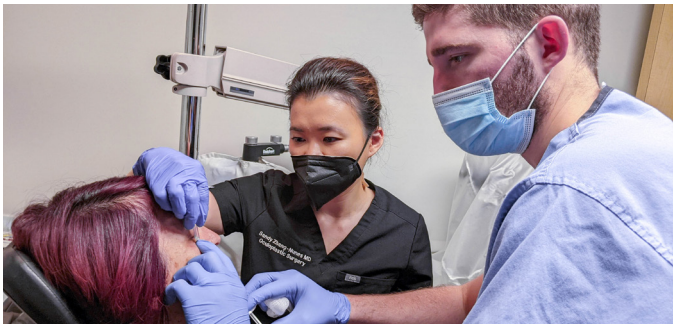
PROTECT

The USC Roski Eye Institute leads major research in the diagnosis of eye diseases with advanced imaging technology to help prevent blindness.

RESTORE

The USC Roski Eye Institute integrates and applies emerging technologies to develop new methods to restore sight to the blind.





SPECIALIZED CARE for ADULTS & CHILDREN

The USC Roski Eye Institute treats the full spectrum of eye conditions - from the most common to the most complex.

- CATARACT
- CORNEA & EXTERNAL DISEASES
- GLAUCOMA
- LASER VISION CORRECTION
- LOW VISION REHABILITATION
- NEURO-OPHTHALMOLOGY AND ADULT STRABISMUS
- OCULAR ONCOLOGY
- OCULO-FACIAL PLASTIC SURGERY
- OPHTHALMIC MOLECULAR AND IMMUNOPATHOLOGY
- PEDIATRIC OPHTHALMOLOGY
- SPECIALTY CONTACT LENSES AND PROSE
- UVEITIS AND OCULAR INFLAMMATION
- RETINA, VITREOUS AND MACULAR DISEASES & SURGERY

My Color Vision Changed

A Routine Eye Exam Saves a Patient's Life

Pictured: Anne Crile, a grateful patient.

When Anne Crile began to experience sudden changes to her vision, she never imagined that her symptoms would lead to the diagnosis of a life-threatening brain tumor.

"I was driving home one night when I noticed starburst patterns in the streetlights," Anne said. "When I'd see something bright then go back to looking at a dark road, my eyes didn't adjust. In my left eye, everything looked dialed down and muted, like looking through a fog."

She shared her symptoms with her optometrist at the USC Roski Eye Institute, Dr. Kent Nguyen. Dr. Nguyen performed several tests to determine the cause of Anne's vision loss.

"Her visual acuity and ocular health exam appeared normal," Dr. Nguyen recalled. "But when I gave her a red cap desaturation test"—a test to measure Anne's ability to perceive color saturation—"I noticed her left eye only saw at 80% saturation." Since new onset colorblindness is rare for a young adult, Dr. Nguyen referred Anne to Dr. Kimberly Gokoffski, a Neuro-Ophthalmology specialist, for further evaluation.

In search of an underlying cause, Dr. Gokoffski performed multiple tests on Anne, including the examination of her pupillary response, evaluation of her optic nerve, testing her peripheral vision with a visual field test, and imaging of her optic nerve with ocular coherence tomography. Aside from decreased color perception in her left eye, all testing results came back normal.

"Anne still had worrisome signs," Dr. Gokoffski said. "It's not normal for someone to be color blind in only one eye. I knew I wouldn't be able to sleep at night without knowing what was wrong."

Dr. Gokoffski ordered an MRI scan. Hours after Anne's MRI, a neuroradiologist called Dr. Gokoffski to share the discovery. They found a brain tumor crushing Anne's pituitary gland and optic chiasm – where the optic nerves of both eyes meet in the middle of the brain.

When Anne reflects on the moment Dr. Gokoffski delivered the diagnosis, she does not dwell on the frightening news, but on Dr. Gokoffski's transparency during the conversation. "Dr. Gokoffski reassured me that she served on the [USC Brain Tumor Center]. She knew the doctors I would be meeting with personally."

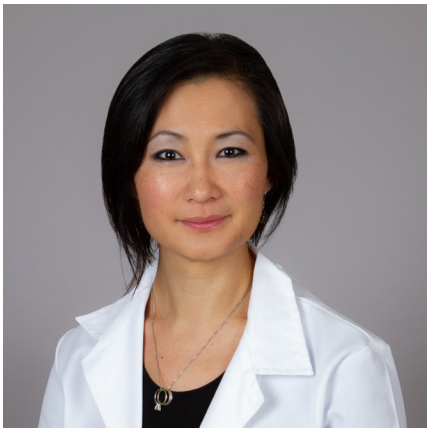
"The surgeon you'll be meeting with is someone I would let operate on my kids," Dr. Gokoffski shared during their conversation.

The USC Brain Tumor Center is a multi-disciplinary team led by Dr. Gokoffski, neurosurgeon Dr. Gabriel Zada, and endocrinologist Dr. John Carmichael, created to expedite care for patients who encounter life threatening diseases. Due to its existence, Anne had her first consultation with Dr. Zada three days after her MRI, and surgery two weeks later.

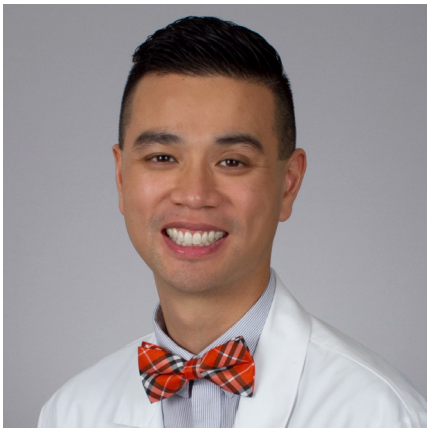
"The experience leading up to surgery was smooth," Anne said. "The handoff felt seamless, and everyone was up to speed with each other's findings."

Following Anne's surgery, her vision began to recover. She came close to normal vision six weeks post-operation, but necessary radiation therapy affected her vision. "My sight has changed, but I didn't lose any vision that would impair me."

Dr. Gokoffski assures Anne that she will need to wait a year to fully assess the recovery to her vision. "We'll continue to monitor her, but I would say her prognosis is very good."



Kimberly Gokoffski, MD, PhD
Assistant Professor of Clinical Ophthalmology



Kent Nguyen, OD
Assistant Professor of Clinical Ophthalmology

USC DEPARTMENT OF OPHTHALMOLOGY

#2

IN NIH RESEARCH FUNDING

AMONG OPHTHALMOLOGY DEPARTMENTS

FY 2021

Top NIH Principal Investigators

#1
Arthur Toga, PhD

#2
Paul Thompson, PhD

#27
Qifa Zhou, PhD

#41
Mahnaz Shahidi, PhD

#76
Sarah Hamm-Alvarez, PhD

#96
Gianluca Lazzi, PhD, MBA

*Source: Blue Ridge Institute for Medical Research

Developing a Gene Therapy to Permanently Treat Retinal Vascular Diseases

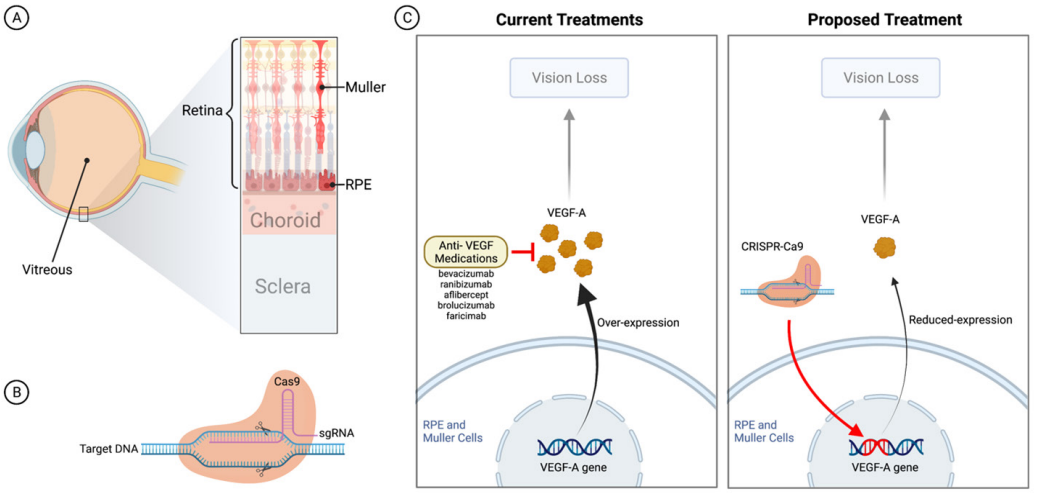


Figure 1. Schematic diagram of the eye, retina and vitreous as well as Muller and RPE cells, which are major VEGF-A producers in the eye. B) CRISPR-Cas9 attached to the target DNA is composed of Cas9 protein and sgRNA. C) Proposed treatment for retinal vascular diseases using CRISPR-Cas9 compared to current treatments using anti-VEGF medications.

Retinal vascular diseases including wet age-related macular degeneration (AMD), diabetic retinopathy, and retinal vein occlusion are common causes of blindness. Vascular endothelial growth factor A (VEGF-A) plays a major role in these conditions. Anti-VEGF-A medications, which are delivered through intravitreal injection, are effective in treating these conditions. However, a major disadvantage of current drugs is the need for frequent eye injections, in some cases as frequently as every four weeks. Unfortunately, patients may develop irreversible vision loss because of their inability to maintain regular follow-up visits for reasons ranging from social and economic issues to systemic comorbidities that are common in this patient population; many studies have reported this. The total annual intravitreal injections in the US are estimated at around 8 million, with a total annual anti-VEGF cost of over 10 billion dollars. A permanent or at least long-term treatment can significantly reduce the risk of irreversible vision loss and dramatically reduce the burden on healthcare systems worldwide.

Hossein Ameri, MD, PhD
Associate Professor of Clinical Ophthalmology

Dr. Hossein Ameri's laboratory aims to develop a treatment that can eliminate the need for frequent eye injections. The approach involves a gene therapy method in which CRISPR-Cas9 is used to silence the VEGF-A gene in the eye and permanently reduce the VEGF-A production. Dr. Ameri's team has demonstrated proof of concept in retinal pigment epithelial (RPE) and Muller cells, which are the primary producers of VEGF-A in the eye. They used lipid nanoparticles to deliver CRISPR-Cas9 to cells. Current efforts are focused on the optimization of the CRISPR-Cas9 delivery to maximize its effects on target cells in the eye.

Racial and Sociodemographic Disparities in the Detection of Narrow Angles Prior to Primary Angle Closure Glaucoma in the United States

Primary angle closure glaucoma (PACG) is a leading cause of permanent vision loss worldwide, currently affecting around 20 million people. It is estimated that there are around 700,000 people with PACG in the United States. Anatomical narrow angles (ANA) can lead to angle closure, which is characterized by contact between the iris and trabecular meshwork. Angle closure can impede aqueous outflow and, in severe cases, contribute to elevated intraocular pressure (IOP) and PACG (Figure 1). ANA can be effectively treated with medications, laser, or surgery when detected early, thereby reducing or eliminating the risk of developing PACG. However, there is evidence that angle evaluations are under-performed by eye care providers in the United States, and there is sparse information about other factors that delay the detection of ANA and PACG. Dr. Benjamin Xu and his colleagues used national healthcare data to assess the proportion of newly diagnosed PACG with and without prior ANA diagnosis and identify sociodemographic risk factors for late detection (PACG without prior ANA diagnosis) in the United States.

Dr. Benjamin Xu and his colleagues found that most patients with ANA that progressed to PACG in the United States remain undetected until glaucomatous damage has occurred. Specifically, 70% of all PACG cases did not have a prior ANA diagnosis regardless of age, sex and race. Risk of late detection was higher among males, Blacks, and patients aged 80 years or older. These findings highlight disparities in the detection and severity of PACG in the United States that will have important implications for patients, eyecare providers and healthcare systems as PACG prevalence is expected to rise rapidly due to aging of the general population. These findings also highlight the need for better diagnostic tools to detect patients with ANA and at risk for PACG, which is another primary focus of Dr. Xu's ongoing glaucoma research.

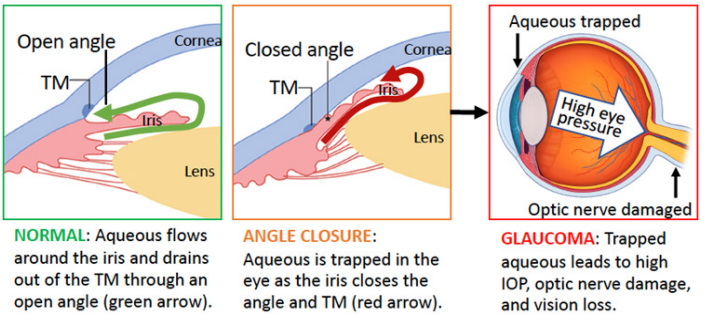


Figure 1: Pathogenesis of angle closure and PACG.

Benjamin Xu, MD, PhD
Assistant Professor of Clinical Ophthalmology

Quantifying Visual Function in Children with Cortical Visual Impairment (CVI)

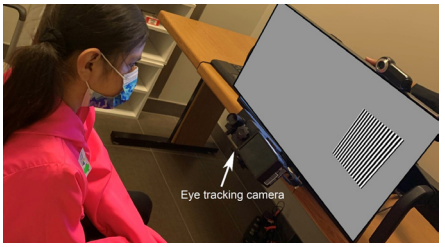


Figure 1: A child with cortical visual impairment (CVI) performs eye tracking in the Chang laboratory at the Saban Research Institute at Children's Hospital Los Angeles. The eye tracking camera (arrow) uses infrared light to calculate the direction of eye gaze with high precision while the child watches visual stimuli on a computer monitor.

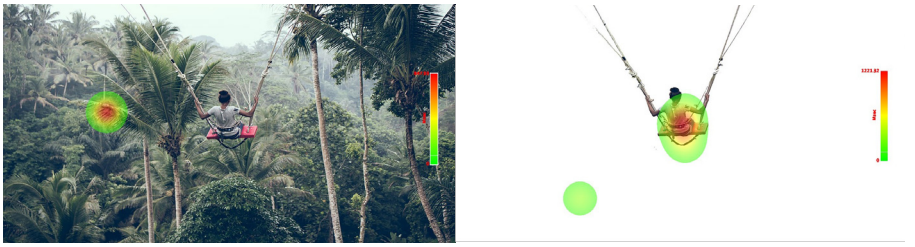


Figure 2: Heat map demonstrating eye tracking results in a child with CVI. Red indicates regions where the child fixated longer, whereas green signifies shorter fixations. In the left panel, the child fixated on the background rather than the subject of the image (central figure on swing) when presented with a visually complex picture. In the right panel, the child fixated accurately on the subject of the image when the background was plain white. This qualitatively demonstrates the 'crowding' effect in CVI, wherein patients have difficulty interpreting visually complex scenes.

Cortical, or cerebral, visual impairment (CVI) is the leading cause of pediatric visual impairment in the United States and other developed countries. CVI results from damage to visual pathways in the brain in young children, frequently around the time of birth. Causes of CVI include hypoxic-ischemic encephalopathy, hydrocephalus, structural brain abnormalities, trauma and genetic disorders. Children with CVI typically have serious neurologic comorbidities, including intractable seizures, cerebral palsy, and global developmental delay. Because of this, their ability to cooperate with standard tests of visual function is often severely limited. Furthermore, the visual deficits experienced by children with CVI differ from those with ocular causes of visual impairment, because the cortical damage affects pathways involved in visual processing. Finally, there is no evidence-based treatment for CVI. A quantitative, objective measure of visual function in children with CVI is necessary to promote optimal clinical care and research studies of therapies for CVI.

The pediatric neuro-ophthalmology team at USC/CHLA, led by Dr. Melinda Chang, is developing and testing multiple methods of visual assessment in children with CVI. One promising technique involves eye tracking, in which a specialized camera tracks the direction of eye gaze while the child watches a series of images and videos on a computer monitor. This technology generates a high volume of data (2,000 coordinates per second), and Dr. Chang is collaborating with a group of artificial intelligence experts at USC Viterbi School of Engineering (including Dr. Shrikanth Narayanan) to develop a machine learning model of eye tracking in children with CVI. The preliminary data demonstrates that eye tracking is highly reliable and able to quantify deficits in higher-level visual processing in pediatric CVI. Ultimately, the team hopes to incorporate eye tracking as outcome measure in future multi-center clinical trials. Additionally, eye tracking may inform individualized therapeutic regimens for children with CVI.

Melinda Chang, MD
Assistant Professor of Clinical Ophthalmology

Epigenetic Signatures in Aqueous Humor Predict Retinoblastoma Aggressiveness and Treatment Response

The Aqueous Humor (AH) Lab (Drs. Jesse Berry and Liya Xu) at the USC Roski Eye Institute and the CHLA Vision Center has been focused on developing an ocular liquid biopsy platform using the aqueous humor, the clear fluid from the front chamber of the eye. This AH liquid biopsy platform will enable physicians to diagnose retinoblastoma with in vivo molecular signatures and monitor its treatment responses in a real time manner.

Recently in *Nature Communications*, the AH Lab identified 294 genes directly regulated by DNA methylation that are implicated in tumor suppression and oncogenic pathways by examining tumor-derived cfDNA found in the aqueous humor of retinoblastoma eyes. The current findings expand on the AH Lab's prior research, which had first raised the possibility of performing liquid biopsies in the eye after discovering retinoblastoma-related copy number variations in cfDNA found within the aqueous humor. The AH Lab teamed up with Dr. Gangning Liang, an expert in epigenetics, to perform genome-scale DNA methylation profiling of cfDNA and their corresponding primary retinoblastoma tumors, integrating the results with existing retinoblastoma tumor DNA methylation profiles. Although they now have a way to potentially estimate which retinoblastomas will be more aggressive, questions remain regarding whether and how a signature might change in the case of a relapse.

Jesse Berry, MD
Associate Professor of Ophthalmology (Clinical Scholar)

Liya Xu, PhD
Assistant Professor of Clinical Ophthalmology

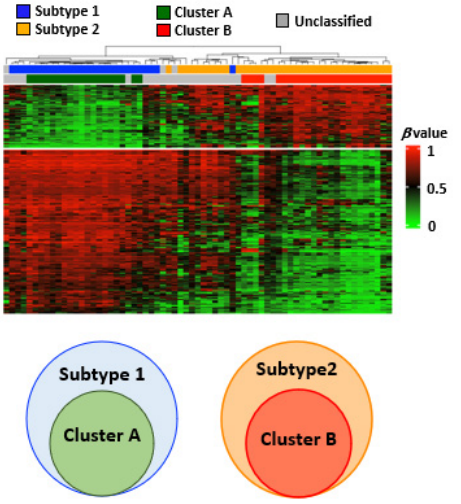


Figure 1: The DNA methylation signature for retinoblastoma (RB) treatment outcome prediction. 320 differentially methylated probes between Clusters A and B can separate Subtype 1 (blue) and Subtype 2 (red) RB.

Intraocular Exosome with Active Targeting of Wet AMD

Wet age-related macular degeneration (AMD) is a leading cause of blindness in people older than 60. Over 5 million intravitreal injections of vascular endothelial growth factor (VEGF) inhibiting agents are performed each year in the United States to treat it. Despite its vision-saving benefit, some patients fail to respond to the treatment because of the insufficient therapeutic effect and/or the socioeconomic burden of frequently required repeat injections.

To overcome these shortcomings of intravitreal injection of a single anti-VEGF agent, a research group led by Dr. Sun Young Lee has been developing a new strategy to develop superior or adjunctive approaches to the current anti-VEGF therapy that can provide active targeting of wet AMD, deliver multiple drugs and maintain long-term efficacy.

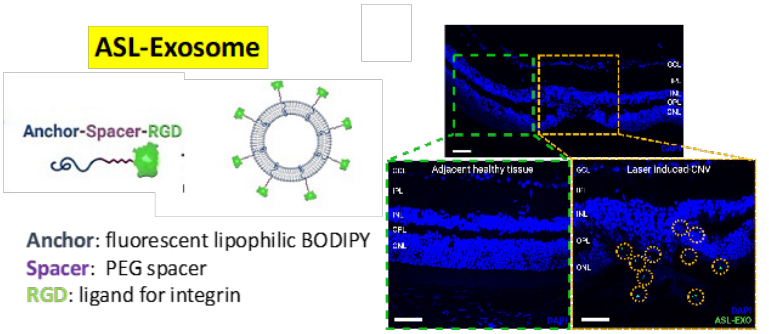


Figure 1. ASL-exosomes are composed of Anchor, Spacer and Arg-Gly-Asp acid (RGD) Ligand modification. When ASL exosomes were injected into the mouse AMD model eye in which abnormal choroidal blood vessels were grown, most of ASL-exosomes were found to be in the area of abnormal blood vessels. *Cells*. 2022 Aug 18;11(16):2573.

Dr. Lee's group recently showed that intraocular ASL-exosome, a small peptide-directed drug delivery vehicle, can actively target the area of wet AMD. This intraocular multi-drug delivery combined with an active targeting strategy has great potential to improve intraocular treatment by 1) delivering multi-drug targets simultaneously, 2) increasing therapeutic efficacy and tissue penetration by active targeting, and 3) possibly sustained drug delivery in the eye. Unlikely other types of artificial drug delivery vehicles that have been studied in the past by multiple other investigators, exosomes are naturally occurring, cell-secreted, and nano-sized extracellular vesicles capable of carrying various cargos such as RNAs, proteins, and lipids for cell-to-cell communication. Therefore, exosomes are less immunogenic or inflammatory in the eye.

This technology is a relatively new field and takes much more work with multidisciplinary approaches involving bioengineering, retina cell biology and translational animal studies for future clinical application. Dr. Lee's team is one of the few leaders in this field of ophthalmology. If the ongoing efforts of Dr. Lee's team are successful, and this strategy applies to patients who need numerous intravitreal anti-VEGF treatments, there is great potential for less frequent treatment and better outcomes for wet AMD.

Sun Young Lee, MD, PhD
Assistant Professor of Ophthalmology

Developing Chemically Induced Cell Replacement Therapy for Optic Neuropathies

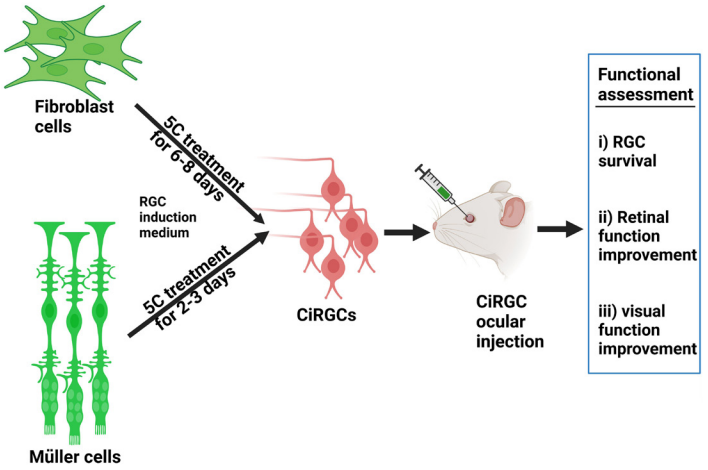


Figure 1. Scheme for chemical induction of RGCs from fibroblasts and Müller cells, and their functional assessment in ON rodent models.

Optic neuropathies (ON), such as glaucoma and optic nerve hypoplasia (ONH), are the leading cause of irreversible blindness worldwide in children and adults. ON is caused by progressive damage to the optic nerve due to the loss of retinal ganglion cells (RGCs). Currently, there is no treatment to prevent or reverse vision loss in these patients. RGC replacement therapy, both in vitro and in vivo, is a promising approach to treat these diseases.

Dr. Biraj Mahato's laboratory has major interests in developing a chemically induced RGC replacement therapy for glaucoma and ONH using a combination of cellular reprogramming, next generation sequencing, and periclinal rodent models. Previously, Dr. Mahato and colleagues demonstrated a chemical cocktail that can reprogram fibroblast into photoreceptors (*Nature,* 2020). These chemically induced photoreceptors restored vision when injected into blind animals. Extending this research, the Mahato laboratory defined a set of small molecules (5C) that can convert fibroblasts and Müller cells into RGCs (Fig. 1). These cells express cardinal gene/protein RGC markers, including an RGC-specific reporter (Brn3b), and are functional in single cell patch clamp experiments. When transplanted, fibroblast derived RGCs survived and improved retinal function in a retinal degeneration rodent model. The Mahato lab is also involved in looking at in vivo retinal neuron regeneration for the restoration of visual functions in preclinical rodent glaucoma models using small molecules. The lab identified a small molecule and growth factor combination that induces endogenous Müller cells into RGCs in mice. These regenerated RGCs express pan RGC and proliferation markers. The Mahato lab's future goals are to develop an in vitro RGC transplantation strategy in various rodent ON models and a chemically induced in vivo RGC regeneration strategy from Müller cells in ON disease models.

Biraj Mahato, PhD
Assistant Professor of Research Ophthalmology

ACTIVE RESEARCH FUNDING - DECEMBER 2022

PRINCIPAL INVESTIGATOR	PROJECT	SOURCE
Jesse Berry, MD	Harnessing the Power of Data to Save Lives: Building the Retinoblastoma Data Commons	CCRF
Jesse Berry, MD	Molecular Characterization of Retinoblastoma in Vivo Using the Aqueous Humor Liquid Biopsy	COG
Jesse Berry, MD	Sensitive Detection of Minimal Residual Intraocular Disease by Analysis of Cell-free DNA Tumor Fraction in the Aqueous Humor of Eyes with Retinoblastoma: A Step Towards Precision Medicine	Wright
Jesse Berry, MD	Development of a Surrogate Liquid Biopsy from the Aqueous Humor in Retinoblastoma Eyes	NIH/NCI
Melinda Chang, MD	Validation of Eye Tracking in Children with Cortical/Cerebral Visual Impairment (CVI) and Correlation with Neuropsychological Testing	TSRI
Melinda Chang, MD	Validating a Machine Learning Model of Eye Tracking in Children with Cortical Visual Impairment (CVI)	NIH/NEI
David Cobrinik, MD, PhD	Trans-cytoplasmic Transport of Repetitive Element DNAs	TSRI
David Cobrinik, MD, PhD	Successive Responses to Oncogenic Aberrations in Retinoblastoma Genesis	NIH/NCI
David Cobrinik, MD, PhD	RE DNA as Cancer Biomarkers	TSRI
David Cobrinik, MD, PhD and Aaron Nagiel, MD, PhD	Predictive Medicine Inherited Retinal Dystrophy Gene Correction Program	KTEF
Maria Edman, PhD	Role of Cathepsin S in Dry Eye Associated Neuropathic Pain	NIH/NEI
Kimberly Gokoffski, MD, PhD	Wearable Early Intervention Electric Stimulation for Optic Nerve Regeneration	DoD
Kimberly Gokoffski, MD, PhD	Electric Fields Collaborate with Rac1 to Direct Optic Nerve Regeneration	Baxter
Kimberly Gokoffski, MD, PhD	Novel, Large-Field Gradient, Electrical Stimulator to Accelerate Peripheral Nerve Regeneration into Split Thickness, Skin Graft Donor Sites	USC
Kimberly Gokoffski, MD, PhD	In vivo Application of Electrical Fields Directs Retinal Ganglion Cell Axon Regeneration	NIH/NEI
Kimberly Gokoffski, MD, PhD	Electric Fields Collaborate with Cdc42 to Direct Optic Nerve Regeneration	BrightFocus
Kimberly Gokoffski, MD, PhD	Bioengineered Neuro-Modulation for Neuroprotection and Neuro-regeneration	USC
Sarah Hamm-Alvarez, PhD	Development of a Novel Tear-based Biomarker Assay for Diagnosis of Parkinson's Disease Using RT-QuIC	NIH/NIA
Sarah Hamm-Alvarez, PhD	Characterization Of Recombinant Protein Expression In Hek293 T Cells	OysterPoint
Sarah Hamm-Alvarez, PhD	Defining the Interplay of Interferon-gamma and Cathepsin S in Age-related Dry Eye	NIH/NEI
Sarah Hamm-Alvarez, PhD	Microtubule-Based Transport in Lacrimal Gland Function	NIH/NEI
Sarah Hamm-Alvarez, PhD	Protein-polymer Nanomedicine for Sjogren's Syndrome	NIH/NEI
J. Martin Heur, MD, PhD	Research to Prevent Blindness Unrestricted Grant	RPB
J. Martin Heur, MD, PhD	Enhanced Preservation of Donor Corneas	OneLegacy
Mark Humayun, MD, PhD	USC Roski Eye K12 Clinician-Vision Scientist Training Program (USC Roski Eye K12)	NIH/NEI
Mark Humayun, MD, PhD	EFRI CEE: Engineered Retinal Epigenomics	NSF
Mark Humayun, MD, PhD	The Cost Effectiveness and Value of Treating Combat Ocular Trauma	DoD
Xuejuan Jiang, PhD	Intrauterine Exposure to Tobacco Smoke, DNA Methylation, and Vision Disorders in Preschool Children	NIH/NEI
Xuejuan Jiang, PhD	Validation of Imaging and Blood-based Small Vessel VCID Biomarkers in Multiethnic Population	NIH/NINDS
Xuejuan Jiang, PhD	Systemic Interindividual Epigenetic Variants in African Americans: Identification, Characterization, and Prospective Associations with Obesity	NIH/NIDDK
Xuejuan Jiang, PhD	Assessment of Retinal Capillary Density, Morphology and Function in Retinal Vascular Disease Using Novel OCT Angiography Based Metrics	NIH/NEI

Xuejuan Jiang, PhD	Integrative Analysis of Genetic and Epigenetic Variation in Maternal Smoking's Effect on Child's Eye	UC - TRDRP
Gianluca Lazzi, PhD, MBA	Predictive Modeling of Bioelectric Activity on Mammalian Multilayered Neuronal Structures in the Presence of Supraphysiological Electric Fields	NIH/NIBIB
Gianluca Lazzi, PhD, MBA	CRCNS: US-Spain Research Proposal: Computational Modeling of PNS Stimulation	NIH/NIBIB
Gianluca Lazzi, PhD, MBA; Mark Humayun, MD, PhD (Co-PI); Kimberly Gokoffski, MD, PhD (Co-PI)	GCR: Reprogramming Biological Neural Networks with Field-Based Engineered Systems	NSF
Sun Young Lee, MD, PhD	Exosome Based Intraocular Therapy Combined with Active Targeting of Ocular Neovascularization	NIH/NEI
Hsiao-Chuan Liu, PhD	Development of Non-contact Rheometry for Measuring Rheological Properties of Biological Fluids	NIH/NIBIB
Biraj Mahato, PhD	Chemically Reprogrammed Retinal Ganglion Cell Therapy to Treat Glaucomatous Neuropathy	GRF
Biraj Mahato, PhD	Chemically reprogrammed Müller cell derived retinal ganglion cells to study and treat optic nerve hypoplasia	KTEF
Juan Carlos Martinez, MD	Motor, Visual, and Olfactory Changes in Genetic Subtypes of Alzheimer's Disease	NIH/NIA
Aaron Nagiel, MD, PhD	Development and Maintenance of the Human Photoreceptor-Bipolar Cell Synapse	NIH/NEI
Aaron Nagiel, MD, PhD	Role of Non-canonical Wnt Signaling in the Developing Human Photoreceptor-bipolar Cell Synapse	RPB
Aaron Nagiel, MD, PhD	Hippo Pathway Inhibition for the Treatment of Geographic Atrophy	TMF
Mahnaz Shahidi, PhD	Imaging of Retinal Oxygen Metabolism in Diabetic Retinopathy	NIH/NEI
Mahnaz Shahidi, PhD	Imaging of Retinal Oxygenation and Metabolism	NIH/NEI
Mahnaz Shahidi, PhD	Retinal Vessel Features as a Marker of Idiopathic Intracranial Hypertension Treatment Response: A Secondary Analysis of the Idiopathic Intracranial Hypertension Treatment Trial	NIH/NEI
Mahnaz Shahidi, PhD	Center Core Grant for Vision Research	NIH/NEI
Mahnaz Shahidi, PhD	Two-photon Imaging of Oxygen and Blood Flow in Retinal and Cerebral Vasculature	NIH/NINDS
Noelle Stiles, PhD	Restoring Sight to the Blind: Neural Imaging with Retinal Prostheses	NIH/NEI
Biju Thomas, PhD	VRC: A Stem Cell-Based Treatment Strategy for Laser-Induced Permanent Retinal Damages	NIH/NEI
Biju Thomas, PhD	Integration and Functionality of Retinal Organoid Transplants	NIH/NEI
Brian Toy, MD	Health Disparities in the Development, Persistence, and Progression of Uveitis and Ocular Inflammation in the United States	NIH/NEI
John Whalen, PhD	Reversibly Adhesive Hydrogel for Temporary Treatment of Traumatic Open Globe Injury in Austere Environments	DoD
Benjamin Xu, MD, PhD	Development and Validation of Quantitative Anterior Segment OCT-based Methods to Evaluate Patients with Primary Angle Closure Disease	NIH/NEI
Benjamin Xu, MD, PhD	Treatment Patterns and Clinical Outcomes in Newly-Diagnosed Cases of Angle Closure With and Without Glaucoma: A Cross-sectional and Longitudinal Analysis	AGS
Benjamin Xu, MD, PhD	Dimensions of the Angle Recess for Glaucoma Implants	Ocular
Liya Xu, PhD	Single Particle Analysis of Extracellular Vesicles in the Aqueous Humor of Retinoblastoma Eyes: Moving Towards an Integrated Liquid Biopsy	KTEF
Liya Xu, PhD	Integrative, Multi-parametric Characterization of Extracellular Vesicles in the Aqueous Humor of Retinoblastoma Eyes	TSRI
Qifa Zhou, PhD	Non-invasive Ultrasound Stimulated Retinal Prosthesis	NIH/NEI
Qifa Zhou, PhD	Large Aperture and Wideband Modular Ultrasound Arrays for the Diagnosis of Liver Cancer	NIH/NCI
Qifa Zhou, PhD	High-resolution Elastographic Assessment of the Optic Nerve Head	NIH/NEI
Qifa Zhou, PhD	Biomechanical Mapping of the Optic Nerve Head and Peripapillary Sclera Using High Frequency Ultrasonic Elastography	NIH/NEI
Qifa Zhou, PhD	High Resolution Ultrasound in Interventional Radiology	NIH/NCI
Qifa Zhou, PhD	Phase Resolved Arf Optical Coherence Elastography for Intravascular Imaging	NIH/NHLBI

AGS (American Glaucoma Society) • Baxter (Baxter Foundation) • BrightFocus (BrightFocus Foundation) • CCRF (Children's Cancer Research Fund) • COG (Children's Oncology Group) • DoD (Department of Defense) • GRF (Glaucoma Research Foundation) • KTEF (Knights Templar Eye Foundation) • NCI (National Cancer Institute) • NEI (National Eye Institute) • NHLBI (National Heart, Lung and Blood Institute) • NIA (National Institute on Aging) • NIBIB (National Institute of Biomedical Imaging and Bioengineering) • NIDDK (National Institute of Diabetes and Digestive and Kidney Diseases) • NINDS (National Institute of Neurological Disorders and Stroke) • NSF (National Science Foundation) • Ocular (Ocular Therapeutix, Inc.) • OneLegacy (OneLegacy Foundation) • OysterPoint (OysterPoint Pharma) • RPB (Research to Prevent Blindness) • TMF (Thome Memorial Foundation) • TSRI (The Saban Research Institute) • UC-TRDRP (University of California - Tobacco-Related Disease Research Program) • USC (University of Southern California) • Wright (Wright Foundation)

Celebrating 46 Years of
Preserving, Protecting & Restoring Sight

On Saturday, June 25th, USC Roski Eye Institute faculty, alumni, and guests gathered at a symposium to celebrate 46 years of excellence in ophthalmic care at USC. The symposium provided attendees with updates on the latest aspects of ophthalmic best practices across the field, and research updates regarding recently approved therapies for ophthalmic diseases.

During the symposium, the USC Roski Eye Institute presented four awards (*pictured below*).

The symposium included a tribute to A. Linn Murphree, MD, a Professor of Ophthalmology at USC and world-renowned ocular oncologist, who passed away in March of this year.

2022 Narsing A. Rao, MD Endowed Lecture Award
Dr. Mark Humayun
for groundbreaking research in development of the Argus II

2022 Laureate Award
Dr. Joel Schuman
for groundbreaking research in early detection of disease and its progression, specifically glaucoma

2022 USC Roski Distinguished Lecturer
Dr. David Huang
for his lecture titled
"Anterior Segment Optical Coherence Tomography"

2022 Distinguished Alumni Lecture
Dr. David Tse
for his lecture titled
"Emerging Therapeutic Advancements in Oculoplastic Surgery: Intersection of Science and Patient Care"

Narsing A. Rao, MD Endowed Lectureship Fund

Dr. Narsing Rao has ensured that his passion for teaching will impact generations to come by making a generous gift to establish the Narsing A. Rao, MD, Endowed Lectureship Fund at the USC Roski Eye Institute and the Department of Ophthalmology. The lectureship will bring together distinguished scholars and practitioners of ophthalmology with the field's emerging minds at the Keck School of Medicine.

Dr. Rao shaped the field of ophthalmology and made critical scientific contributions that advanced understanding of eye disorders. As a former interim dean of the Keck School of Medicine of USC, previous chair of the Department of Ophthalmology, and co-director of the USC Roski Eye Institute, his leadership has had a tremendously positive ripple effect.

Now, through this remarkable philanthropic contribution, he is making a new and lasting mark on USC.

"It is a big thing," Dr. Rao said. "With a named lectureship, we can attract an inspirational leader who is an academician and a research-oriented clinician—an internationally recognized leader who can inspire our students, residents and fellows to pursue an academic career. Training the next generation of academicians is critical. Unless doctors are academically oriented, they cannot provide the best evidence-based care possible to their patients."

Given their prestige, a named lectureship makes it far easier to attract the biggest names nationally and internationally in the field.

"Dr. Rao has been outstanding in every aspect of his career," said J. Martin Heur, MD, PhD. "The named lectureship will cement his legacy by helping our department and school remain at the forefront of innovation and education in ophthalmology now and in the future."

Dr. Rao earned his medical degree from Osmania University, in Hyderabad, India. He moved to the U.S. in 1968 and completed residencies in pathology and ophthalmology at Georgetown University, and a fellowship in ophthalmic pathology at the Armed Forces Institute of Pathology, in Washington, D.C. He joined USC in 1983.

Through his teaching, research, clinical care and leadership, Dr. Rao has impacted the lives of countless people around the world. Now, the Narsing A. Rao, MD, Endowed Lectureship Fund will sustain that impact in perpetuity.

Education and Training

RESIDENCY PROGRAM

Each year, over 500 hundred medical students apply for one of seven positions in the ophthalmology residency training program. In addition to clinical rotations at the **USC Roski Eye Institute**, clinical training is also provided at **Los Angeles County+USC Medical Center (LAC+USC)**, **Children's Hospital Los Angeles (CHLA)**, and the **VA Downtown Los Angeles Medical Center**. With a total of 28 residents, the USC Roski Eye Institute and LAC+USC Ophthalmology Residency Program is one of the largest training programs in the country.

PROGRAM LEADERSHIP

J. Martin Heur, MD, PhD
Professor and Interim Chair

Brian J. Song, MD, MPH
Program Director

Annie Nguyen, MD
Associate Program Director

Lauren Daskivich, MD
Interim Chief of Ophthalmology, LAC+USC Medical Center

- Our residency program maintains its large volume of clinical encounters, consistently excellent hands-on training and high research output within the resident body. Our residents have been in the top 5% of programs nationwide for the past nine consecutive years in total ophthalmologic surgeries and procedures performed.
- Our residency is supplemented by a robust didactic curriculum that includes a yearly overview of the American Academy of Ophthalmology's Basic and Clinical Science Course, Distinguished Lecture series consisting of key opinion leaders from across the world in addition to presentation opportunities at the biannual Resident and Fellow Case Series and weekly departmental grand rounds.
- Our AUPO-compliant fellowship programs continue to thrive and attract fellows from across the nation choosing our institute to further their subspecialty training.
- Our faculty remain very involved in medical student education through lectures, workshops, hands-on teaching in the clinic and OR, and mentoring research projects. There is also a thriving ophthalmology student interest group that engages in several community outreach activities each year with faculty guidance, led by Dr. Jessica Chang, Director of Medical Student Education.

USC Roski Eye Institute
Keck Medicine of USC

LAC+USC HEALTHCARE NETWORK

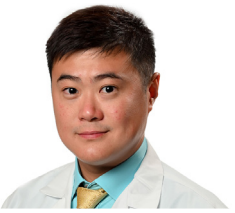
Children's Hospital LOS ANGELES
We Treat Kids Better

2022-2023 Graduating Residents

Kyle Bolo, MD

Medical School
Columbia University
New York, NY

Glaucoma Fellowship
Shiley Eye Institute
UC San Diego
San Diego, CA



Xuan Cao, MD

Medical School
Drexel University
Philadelphia, PA

Rahul Iyengar, MD

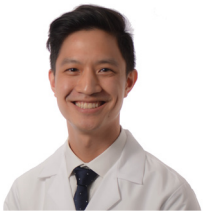
Medical School
University of Michigan
Ann Arbor, MI

Retina Fellowship
USC Roski Eye Institute
Los Angeles, CA

Eric Jung, MD

Medical School
USC
Los Angeles, CA

Retina Fellowship
Cole Eye Institute
Cleveland Clinic
Cleveland, OH



Paul Lang, MD

Medical School
USC
Los Angeles, CA

Cornea Fellowship
Shiley Eye Institute
UC San Diego
San Diego, CA

Jennifer Lopez, MD, Co-Chief

Medical School
New York University
New York, NY

Retina Fellowship
University of Colorado
Aurora, CO

Sona Shah, MD, Co-Chief

Medical School
USC
Los Angeles, CA

Cornea Fellowship
USC Roski Eye Institute
Los Angeles, CA

2022-2023 Graduating Fellows

Frank Abella-Ayala, MD
Neuro-Ophthalmology
MedStar Georgetown University Hospital
Washington, D.C.

Jordan Conger, MD
Oculoplastics
University of California, Irvine
Irvine, CA

Nicole Koulisis, MD
Surgical Retina
USC
Los Angeles, CA

Benjamin Lee, MD
Glaucoma
Louisiana State University Health Sciences Center
New Orleans, LA

Chang Sup Lee, MD
Surgical Retina
West Virginia University
Morgantown, WV

Cindi Yim, MD
Cornea
USC
Los Angeles, CA

Grand Rounds Case Study

"Crying in the Kleb"

CHALLENGING EYE CARE

Christopher Chung, MD, MS
PGY-3 Ophthalmology Resident

Juan Carlos Martinez, MD
Associate Professor of Clinical Ophthalmology

HISTORY

- 50-year-old woman with a history of diabetes presents with 5 days of left temporal headache, which progressed to left eye pain, vision loss, redness, photophobia, pain with eye movements, periorbital swelling, headache, and nausea. Also endorses night sweats.

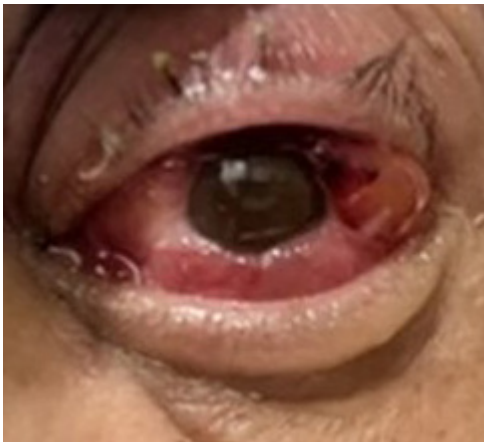


Figure 1: External photograph of left eye demonstrating periorbital edema, erythema, conjunctival injection, chemosis, hypopyon.

EXAM FINDINGS

- Visual Acuity was 20/30 OD and LP OS
- Intraocular pressure normal
- There was no apparent relative afferent pupillary defect
- Slit lamp examination showed left periorbital edema and erythema, diffuse chemosis with moderate injection, a hypopyon and fibrin with 4+ cell/flare in the anterior chamber, scattered posterior synechiae and trace heme on the anterior lens capsule
- Dilated fundus exam revealed moderate NPDR OD. There was no view to the back OS. B scan OS revealed diffuse vitreous consolidations with posterior hyaloid thickening concerning for vitreitis

LABS AND IMAGING

- WBC, ESR, and CRP were elevated
- CT Orbits demonstrated pre-septal inflammation and posterior uveoscleral thickening of left globe
- MRI Orbits notable for posterior uveoscleral thickening of the left globe
- Vitreous tap cultures revealed Klebsiella Endophthalmitis, hypermucoviscous/hypervirulent strain

DIFFERENTIAL:

- Endogenous Endophthalmitis (bacterial, fungal: candida, aspergillus, cryptococcus, coccidioidomycosis)
- Infectious Posterior Uveitis (Syphilis, TB, Toxoplasma, Toxocariasis)
- Noninfectious Hypopyon Uveitis (Bechet's)
- Noninfectious Posterior Uveitis (Vasculitis, VKH, SLE, idiopathic)
- Mucormycosis
- Pre-septal/Orbital Cellulitis/NSOI
- Cavernous Sinus Thrombosis
- Carotid-Cavernous Sinus Fistula
- Masqueraders (Acute Retinal Necrosis, Intraocular Lymphoma)

KLEBSIELLA ENDOPHTHALMITIS

- Klebsiella endophthalmitis is rare in the United States, but is the most common microbe responsible for endogenous endophthalmitis in East Asia
- Diabetes is a strongly associated risk factor for the development of endogenous Klebsiella endophthalmitis. Proposed mechanisms for this association include chronic immunocompromised state, altered gastrointestinal tract host

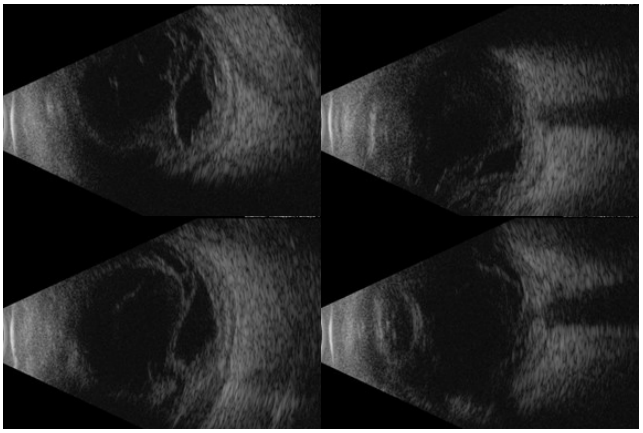


Figure 2: B scan of left eye demonstrating diffuse vitreous debris and consolidations consistent with vitreitis, posterior hyaloid thickening, scleral thickening.

defense and physiology, and increased blood-retina barrier permeability.

- An emerging hypervirulent strain of Klebsiella has been described to cause a syndrome of multifocal metastatic infections affecting, the eye, liver, lung, kidney, brain, bone, and soft tissue
- The incidence of Klebsiella endophthalmitis is reportedly 3-12% in patient with pyogenic Klebsiella liver abscesses. Conversely 66% of patients present with ocular symptoms prior to the diagnosis of liver abscess
- The treatment of endogenous Klebsiella endophthalmitis consists of a multidisciplinary/multimodal approach including to address both the ocular and systemic infections to reduce both morbidity and mortality
- The role of early vitrectomy in endogenous endophthalmitis remains controversial, further studies are warranted in this regard
- Klebsiella endophthalmitis is associated with poor visual outcomes: some reports of >75% of cases resulting in HM or worse vision and most cases resulting in enucleation/evisceration

TREATMENT AND OUTCOME:

- Ocular treatment: Intravitreal vac/ceftaz/voriconazole, followed by two additional intravitreal injections of ceftaz q48h
- Systemic treatment: Initiated on broad spectrum IV antibiotics (vancomycin, ceftriaxone, metronidazole), transitioned to IV ciprofloxacin, then IV cefepime, discharged on 8 weeks of PO ciprofloxacin, additionally completed 2 weeks of PO Bactrim for metastatic osteomyelitis lesion of right tibia
- Patient eventually underwent evisceration on hospital day 8
- Patient currently doing well after evisceration and completion of her antibiotic regimen. Repeat CT scans have demonstrated resolution of her infection and she has been fitted with an ocular prosthesis
- Timely diagnosis of not only the patient's ocular infection, but also her systemic involvement led to reduction in morbidity/mortality risk and a favorable outcome

Figure 3: CT Head demonstrating posterior uveoscleral thickening of left globe. CT Abdomen demonstrating abscess in right kidney.

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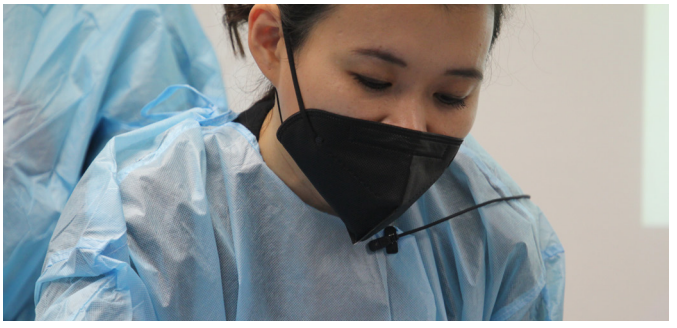
The Cutting Edge

Oculofacial Plastic Surgery Surgical Skills Course



Pictured: Ophthalmologists and ophthalmology fellows participate in the two-day surgical skills course.

On Friday, June 3rd and Saturday, June 4th, the USC Roski Eye Institute hosted "The Cutting Edge: The USC Oculofacial Plastic Surgery Surgical Skills Course." Due to the course's unique teaching methods and hands-on approach to surgery, The Cutting Edge is attended by physicians, fellows, and residents from around the world. It has quickly ascended to being one of the most popular and unique oculoplastic courses in the U.S. (attendance sold out amongst fellowships within a week).

The Cutting Edge was founded and is led by Sandy Zhang-Nunes, MD, an Associate Professor of Clinical Ophthalmology and Chief of Oculofacial Plastic Services at the USC Roski Eye Institute. Dr. Zhang-Nunes set out to create a course that covered the breadth and depth of her oculofacial subspecialty.

"I was looking for the course that I wish I had during and even after fellowship. I realized there was no unifying course out there, so I had to create it!" said Dr. Zhang-Nunes. "I wanted to provide an opportunity for everyone to learn from preceptors around the country, and for our subspecialty to cross-pollinate with other subspecialties. By creating this course, I continue learning myself and help others learn in the process."

Unlike many surgical skills courses that use videos or medical devices to simulate the surgical experience, The Cutting Edge allows those in attendance to hone their surgical skills by operating on fresh human tissue. The approach provides a valuable learning environment for attendees, who have the ability to not only learn surgical techniques, but also get a better feel for the real tissue planes

of the orbit and face, and build muscle memory while operating.

"You can learn surgical and non-surgical work," said Chris Zoumalan, MD, an oculoplastic surgeon based in Beverly Hills and Adjunct Clinical Assistant Professor of Ophthalmology who helps leads the course. "You can learn how to use fillers to rejuvenate the eye, practice how to become a better blepharoplasty surgeon, and take it beyond. I'm so excited to be part of this event and deliver it to all these doctors who've come from around the world."

"It's great for the safety of patients because the doctors have been able to work on real tissue," added David Samimi, MD, an Adjunct Clinical Assistant Professor of Ophthalmology at Eyesthetica, who also helps lead the course.

Throughout the two-day course, the human tissue is used to its full potential. The course starts with filler injections and fat repositioning on day one and ends with brow lifts and face lifts on day two. This approach allows attendees to see the progress they've made step-by-step, while still maximizing the use of the heads from a conservational standpoint.

"This is the course I wish I had as a fellow," said Allison McCoy, MD, a guest faculty from SENTA Clinic. "It allows all of us to learn the latest and greatest in a safe environment and it helps to fill in the gaps in every trainee's education, preparing us for our careers."

Due to the course's advanced, hands-on approach, attendees are expected to have fellowship-level experience or higher to get the most out of the two-day workshop. However, Roski ophthalmology residents also participated in the course to get a jumpstart on their surgical knowledge.

"It's really exciting to attend, because we have attendings and faculty from all over the country who are here to teach," said Sona Shah, MD, a third-year chief resident. "It's educational to see what different approaches there are to procedures and surgeries, and it's great to have the ability to practice during the course as well."

With the weekend concluded, Dr. Zhang-Nunes is already preparing to begin the next Cutting Edge course. "Our current space is really tight for the amount of people who want to come, so I plan to expand it and continually keep it updated to teach the most cutting-edge procedures."

Sandy Zhang-Nunes, MD
Associate Professor of Clinical Ophthalmology

Eye Care for All

Immersion Program for Underrepresented Communities in Medicine

Pictured: USC undergrads pose with faculty.

The USC Roski Eye Institute recently held a two-day in-person summer program designed to introduce USC undergraduate students from underrepresented groups to careers in eye care. The event, "Eye Care for All: An Introduction to a Career in Eye Care," garnered participation from students across USC.

"Eye Care for All" was spearheaded by two Roski optometrists: Lernik Torossian, OD, and Kent Nguyen, OD; both Assistant Professors of Clinical Ophthalmology.

"There is a need for more diverse professionals in healthcare," said Dr. Nguyen. "Our goal in creating this program was to inspire underrepresented students to pursue careers in eye care and vision sciences. We wanted to encourage them to explore these fields through fascinating presentations, inclusive discussions, and engaging hands-on activities."

Throughout the two-day program, students had the opportunity to attend lectures on ophthalmology, optometry and vision science research delivered by Roski faculty from diverse backgrounds. Faculty shared with the students what it is like to work in the fields of retinal surgery, oculoplastics, sports vision, corneal surgery, binocular vision, strabismus and more. Faculty also discussed their experiences as healthcare providers and gave advice about medical education and careers in eyecare.

"I'm inspired to see healthcare professionals in all shapes and sizes, and how that impacts comprehensive care," said Darryl Payton, a Human Biology major from the Class of 2023.

"This event helped me learn about different careers in the medical field," added Matthew Vega, a Health and Human Sciences major from the Class of 2025. "What we learned about the specific research being done to slow down the loss of eyesight was of particular interest to me."

A highlight of the program included an opportunity for undergraduates to meet one-on-one with current Keck School of Medicine of USC (KSOM) medical students, to ask questions about their training and career paths. Under Dr. Nguyen's supervision, medical students also led the attendees through a hands-on cow eye dissection. The experience allowed students to get a close-up look at the inside of an eye, seeing the lens, cornea, vitreous, retina and optic nerve for the first time.

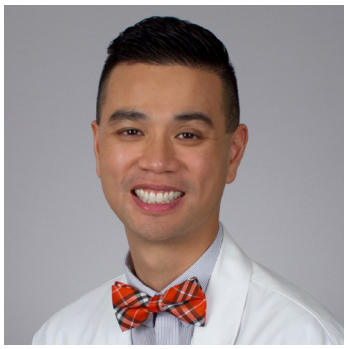
"I'm eager for more information on optometry because that's my intended career path," said Irene Kang, a Biological Sciences major from the Class of 2024. "Even though I've seen a ton of pre-med resources, optometry is one of those specialties that's often overlooked. When I heard about this event, I knew I had to show up!"

The students echoed a desire for more exposure to medical specialties during their undergrad careers. As a result, Dr. Torossian and Dr. Nguyen hope to make "Eye Care for All" an annual program, which can be offered to more undergrads in future years.

"We are grateful to the students that chose to learn and grow in this small supportive setting during their last couple days of summer," said Dr. Torossian. "We will continue to support them and invite them to other events in the hopes of helping them nurture the relationships they've built. We hope to share their many successes with other students, to inspire future generations and further diversity in healthcare."

The 2022 program would not have been possible without the support provided by Justice through Equity, Diversity, Inclusion, Well-being and Social Transformation (JEDI-WeST) and the office of KSOM Dean Carolyn C. Meltzer. They, along with many others at USC, see the importance of diversity in healthcare and helped make the program a success this summer.

Lernik Torossian, OD
Assistant Professor of Clinical Ophthalmology



Kent Nguyen, OD
Assistant Professor of Clinical Ophthalmology

TRAINING the NEXT GENERATION at LAC+USC

Residents at LAC+USC Medical Center engage in a rich and diverse clinical learning environment seeing everything from trauma to complex neurological conditions involving the eye to common eye ailments, including diabetic retinopathy, cataracts, and glaucoma. They simultaneously manage the complex inpatient and emergency consult service for ophthalmology in addition to providing care for the busiest outpatient clinic in the hospital system. Between 250-350 patients are seen in the ophthalmology clinic daily with upwards of 8-10 surgeries being performed on any given day. Residents graduate from the program with an unparalleled clinical and surgical experience that prepares them well for their chosen career path.

ALUMNI BY THE NUMBERS

68 **VOLUNTARY FACULTY**

15 **DEPARTMENT CHAIRS**

292 **RESIDENTS TRAINED**

317 **FELLOWS TRAINED**

Notable Accolades & Achievements

Melinda Chang, MD
Elected to Fellow, North American Neuro-Ophthalmology Society (NANOS)

Mark Humayun, MD, PhD
Elected to Fellow, American Association for Advancement of Science (AAAS)
2022 Narsing A. Rao, MD Endowed Lecture Award

Sun Young Lee, MD, PhD
Elected to New Member, Retina Society

Thomas C. Lee, MD
2022 Williford Distinguished Visiting Professor (DVP) Lecture, Hamilton Eye Institute

Andrew Moshfeghi, MD, MBA
Elected to New Member, Club Jules Gonin

Aaron Nagiel, MD, PhD
Elected to New Member, Macula Society

Arthur Toga, PhD
Authored multiple papers in the last decade ranked in the top 1% by citation for his field and year of publication

Brian Toy, MD
Elected to New Member, Retina Society

Kristina Voss, MD
2022 Southern California Super Doctor Rising Star, *Super Doctors Magazine* (distributed by *Los Angeles Times*)

Sandy Zhang-Nunes, MD
Keynote Speaker, Distinguished Lecture Series, Truhlsen Eye Institute

Andrew Moshfeghi, MD, MBA;
Charles Flowers, Jr. MD;
J. Martin Heur, MD, PhD;
Mark Humayun, MD, PhD;
Narsing Rao, MD
Top Doctors 2022, *Castle Connolly*

Andrew Moshfeghi, MD, MBA;
Narsing Rao, MD;
Benjamin Xu, MD, PhD
America's Best Eye Doctors 2022, *Newsweek*

Mark Borchert, MD;
Andrew Moshfeghi, MD, MBA;
Linda Lam MD, MBA;
Brian Toy, MD;
Benjamin Xu, MD, PhD
Top Doctors 2022, *Pasadena Magazine*

Jesse Berry, MD;
Michael Burnstine, MD;
Mark Borchert, MD;
Jessica Chang, MD;
Gloria Chiu, OD, FAAO, FSLS;
Steven Dresner, MD;
Kimberly Gokoffski, MD, PhD;
J. Martin Heur, MD, PhD;
Linda Lam, MD, MBA;
Andrew Moshfeghi, MD, MBA;
Annie Nguyen, MD;
Lernik Torossian, OD, FAAO;
Brian Toy, MD;
Benjamin Xu, MD, PhD;
Sandy Zhang-Nunes, MD
L.A.'s Top Doctors 2022, *Los Angeles Magazine*

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PEER-REVIEWED PUBLICATIONS AMONG FACULTY IN 2022

Annual Report Cover Image: 3D Retinal Vessel Density Mapping with OCT-Angiography.
Image credits: Courtesy of Jiong Zhang, Amir H. Kashani, Yonggang Shi, James Stanis and Arthur Toga, USC Stevens Neuroimaging and Informatics Institute.

The USC Roski Eye Institute sees patients at the following locations:

Keck School of Medicine of USC
Department of Ophthalmology
USC Roski Eye Institute
1450 San Pablo Street, 4th Floor
Los Angeles, CA 90033
(323) 442-6335

USC Roski Eye Institute - USC Village
835 W. Jefferson Boulevard,
Suite 1720
Los Angeles, CA 90089
(833) USC-EYES

USC Roski Eye Institute - Arcadia
65 N. First Avenue, Suite 101
Arcadia, CA 91006
(626) 446-2122

Children's Hospital Los Angeles
The Vision Center
4650 Sunset Boulevard
Los Angeles, CA 90027
(323) 660-2450

USC Roski Eye Institute - Pasadena
625 S. Fair Oaks Avenue, Suite 400
Pasadena, CA 91105
(323) 442-6335

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YOUTUBE.COM/USCEYEINSTITUTE

BE VISIONARY

Give the gift of sight today

For more information, please contact
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