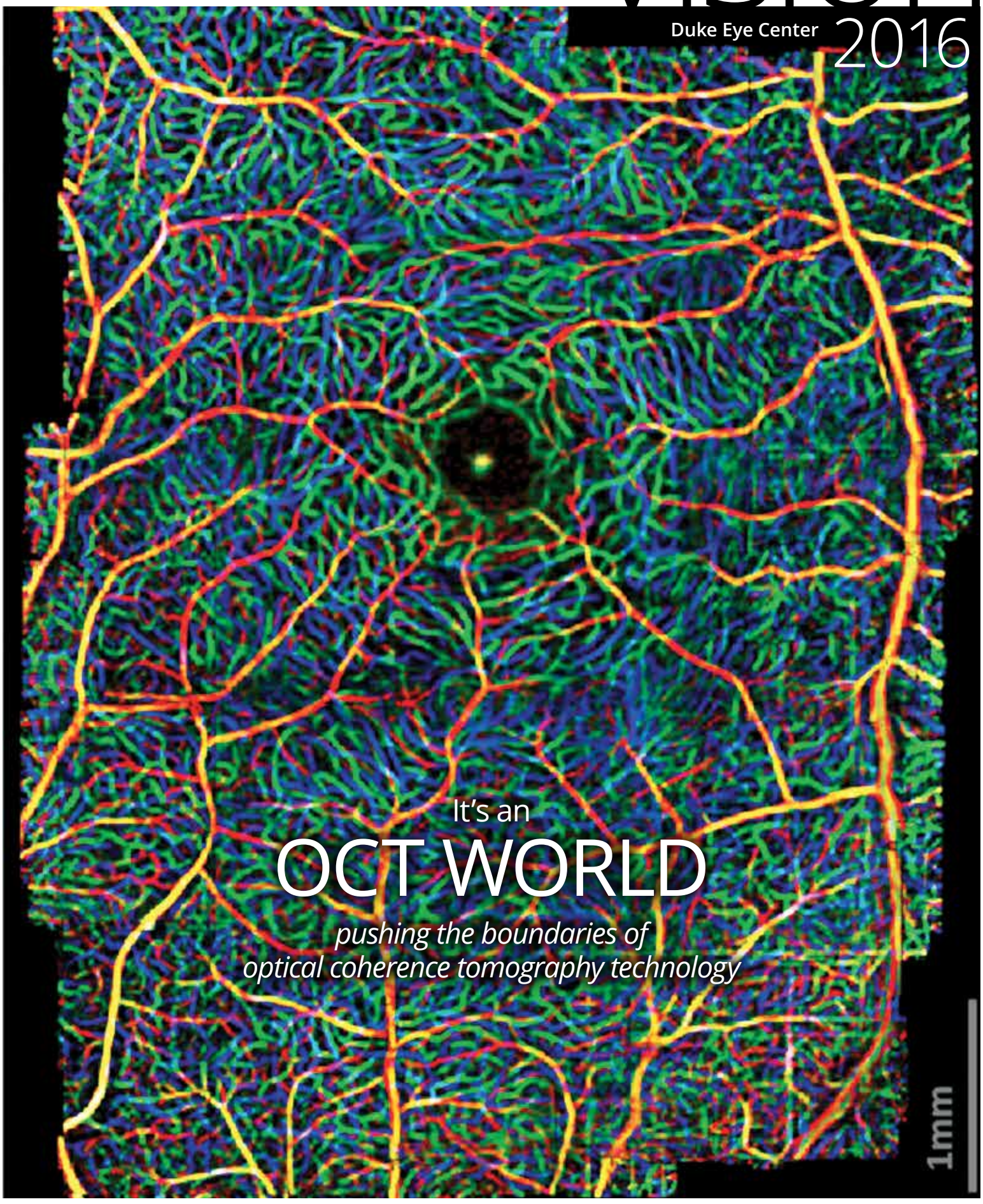
VISION

Duke Eye Center 2016



It's an

OCT WORLD

pushing the boundaries of optical coherence tomography technology

VISION

2016 VOLUME 32

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From our Chair, Edward G. Buckley, MD

What an amazing first year as Chairman of the Department of Ophthalmology. There have been so many exciting events over the past year.

- The Department celebrated its 50th anniversary in 2015.
- A long-planned dream came true with the opening of our state-of-the-art clinical facility, the Hudson Building at Duke Eye Center.
- Our faculty won awards, had clinical breakthroughs, and made advances in several areas.

While ophthalmology has been an important part of Duke Medical Center since the 1940's, the stand-alone department was established in 1965. With the appointment and vision of Joseph A. C. Wadsworth, MD, the first chairman of the Department of Ophthalmology, Duke Eye Center was established and initiated the three-building campus that we have today. I hope you enjoy reading more about our history and the timeline of events over the last 50 years.

The opening of the Hudson Building marked the future of world-class patient care at Duke Eye Center. The new clinical facility has impacted the patient experience, provided much needed additional space for our educational programs and an opportunity to expand our innovative, collaborative research space. Our faculty and staff completed the transition into the new clinics and offices—determined to make it as seamless as possible—and it was awesome! The team effort to make sure the transition was a success was immeasurable.

From the first autologous retinal transplant and expansion of our ocular oncology services to the advances in optical coherence tomography, we continue our rich history of leading the way for research and patient care in ophthalmology.

I could not be more proud to lead and represent this outstanding team. We have hit some important milestones over the last 50 years, especially in 2015. I expect the next 50 will be just as exciting and I am thrilled to be a part of it. It just keeps getting better.

Sincerely,

Edward G. Buckley, MD
Chair, Department of Ophthalmology
Vice Dean for Education
James P. and Heather Gills Professor of Ophthalmology
Professor of Pediatrics
Duke University Medical School

Duke Ophthalmology

50 Years of Excellence

1930
Duke Hospital opens. There is no staff ophthalmologist but W. Banks Anderson Sr., MD who had come to Durham from Johns Hopkins held a clinic in the hospital one afternoon a week.

1943
First Duke trainee identifying solely as an ophthalmologist is Thomas Schnoor, MD.

1944
W. Banks Anderson Sr., MD becomes the first full time ophthalmologist for the division of ophthalmology and otolaryngology within the Duke Department of Surgery. He obtains an early Zeiss carbon arc camera for retinal photography.

1959
Ophthalmology and ENT split to become separate surgical divisions with separate residency programs.

1962
W. Banks Anderson Sr., MD obtains one of the earliest fundus cameras available and a Zeiss xenon arc photocoagulator is obtained for treatment of diabetic retinopathy and retinal tears.

1965

Ophthalmology achieves departmental status. W. Banks Anderson Sr., MD retires and J.A.C. Wadsworth, MD is appointed as the chair of the new department.

1973

Duke Eye Center was established with the opening of a free standing building, later to be named the Wadsworth Building in honor of Dr. Wadsworth.

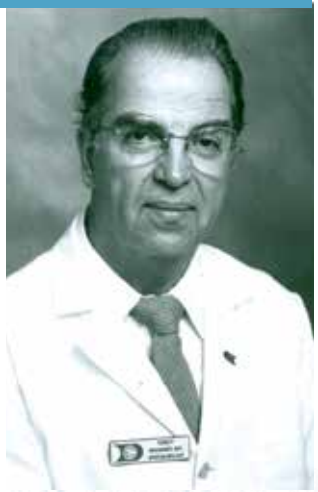
1975
First intraocular lens (IOL) inserted by W. Banks Anderson, Jr., MD

1976
Christine Nelson, MD, first female ophthalmology resident, joins Duke Eye Center.

1978

Robert Machemer, MD, the originator of closed eye vitrectomy surgery named new chair after Wadsworth steps down. He initiates post-residency subspecialty fellowship training programs and establishes a biophysics laboratory for the development of micro instruments for surgery inside the eye.

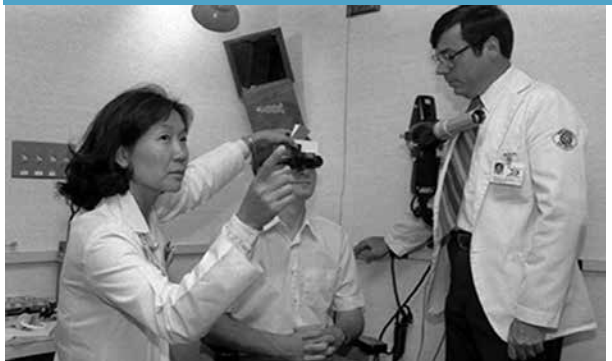
The Ophthalmic Medical Technician training program is established.



1984

Pediatric services are separated from the adult area to alleviate fears of pediatric patients. This effort is led by Edward G. Buckley, MD and Judy Seaber, MD.

1985
Buckley and Jonathan Dutton, MD implement a new treatment for blepharospasm with botulinum toxin. This new treatment had a 97% success rate.



1989

Low Vision clinic is expanded and improved.

1990

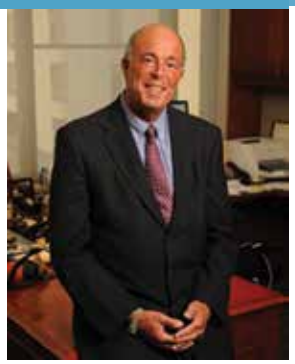
Department of Ophthalmology first recognized as top ten in the U.S. News and World Report rankings, as #9 in the country.

1991

Anderson Jr. is appointed interim chair after Machemer steps down as chair.

1992

David Epstein, MD of the Mass Eye & Ear and UCSF Eye departments becomes chair. He continues the strong departmental emphasis on research and education. He pioneers the establishment and staffing of satellite eye clinics both locally and regionally.



1993

Buckley developed a new method for safely and effectively replacing clouded lenses with artificial ones.

1994

Duke Eye Center Researchers found that treating first time optic neuritis patient with high-dose, intravenous corticosteroids, lowers their risk of developing multiple sclerosis (MS) for 2 years.

1995

The National Eye Institute awards a grant to Duke Eye Center for the purpose of searching for a gene that triggers glaucoma, one of the leading causes of blindness. R. Rand Allingham, MD leads the research effort.

2005

The Albert Eye Research Institute (AERI), opens and increases research, clinical and teaching space. The pediatric clinic is relocated to AERI.

2010

William Hudson, CEO of LC Industries located in Durham, NC, the largest employer of the visually impaired in the world, provides a major gift, one of the largest in Duke's history for the construction of a new clinical building.

Epstein receives the ARVO Weisenfeld Award for his distinguished scholarly contributions to the clinical practice of ophthalmology.

2014

Paul Hahn, MD performs the first retinal prosthesis system in North Carolina. The system is known as the Argus II or "bionic eye."

Dr. Epstein, Chair of Duke Ophthalmology for 22 years unexpectedly passes away.

2015

The new clinical building opens, named in honor of William Hudson. It adds 116,000 sq. ft. of space that houses retina, glaucoma, cornea surgical comprehensive and an enlarged Low Vision Clinic.

Buckley is selected as the new chair.


HUDSON BUILDING


VISION REHABILITATION
Welcome

The Hudson Building

Advancing the Standard for Patient Care

BY LAUREN MARCILLIAT

IT HAS BEEN ONE YEAR since the Hudson Building opened its doors to patients, and the future of Duke Eye Center has never looked so bright. For countless individuals, this four story, 116,000 square foot structure is tangible evidence of a long-awaited dream come true.

Months after the doors opened, work has continued behind the scenes to transform the Hudson Building into the world-class patient care center that it is today. "It has been incredibly exciting to have the opportunity to bring to fruition the many ideas and goals that the founders of this building had in mind," says Department of Ophthalmology Chair, Edward G. Buckley, MD. "Thanks to the Hudson Building, we can now operate in a more patient friendly environment in which the skill and expertise of our clinicians can truly shine."

A Dream Takes Shape

The concept behind the Hudson Building first began to take shape over seven years ago during a conversation between former department Chair, David Epstein, MD, Diane B. Whitaker, OD, chief of vision rehabilitation, and William Hudson, chairman of the Duke Eye Center Advisory Board. As CEO of Durham-based company LC Industries, Hudson is the largest employer in the world of people visually impaired. Through his company, Hudson provides countless employment and educational opportunities for these individuals. A true visionary, Hudson wanted to take his contribution one step further: He dreamed of joining with the world-class team at Duke Eye Center to create an ideal space for clinical care and facilitate opportunities for groundbreaking research to benefit individuals suffering from ocular disease and vision loss.

Clockwise from top left: exterior of the Hudson Building, collaboration room and inside the front entrance of the building.

The Hudson Building received LEED Silver Certification, a resource efficient building using less water, energy and reducing greenhouse gas emissions.

As other key players joined in on the conversation, a plan for a third facility in the Duke Eye Center Complex began to take shape. In support of this proposal, LC Industries contributed one of the largest donations in Duke's history to Duke Eye Center in the amount of $12 million in 2009. This astounding contribution, combined with an additional donation of $4 million toward the construction of the building and countless other philanthropic donations from Duke Eye Center supporters and faculty, enabled the building's three year, $45 million construction.

A World-Class Facility

The end result of those years of planning and unbridled generosity from Duke's supporters is a spectacular, world-class facility that is fully equipped to meet the growing needs of glaucoma, retina, vision rehabilitation, surgical comprehensive and cornea patients under one roof. It features 53 exam rooms, 25 procedure and diagnostic testing rooms, and a diagnostic imaging center. Together with the Wadsworth and the Albert Eye Research Institute (AERI) buildings, the Hudson Building at Duke Eye Center along with our satellites is now equipped to serve an estimated 180,000 patients annually.

The Hudson Building represents so much more, however, than an increase in square footage and patient volume. This new facility has served as a catalyst for change at Duke Eye Center by empowering patients, and enabling the Duke Eye Center team to streamline clinical care, combine clinical services, and place a greater emphasis on vision rehabilitation.

Empowering Patients

"Every day when I walk through the clinical spaces in the Hudson Building, I am in awe of just how much more comfortable people are in the new space," says Whitaker. "It really empowers our providers and staff to provide more convenient and efficient care to our patients, which is a beautiful thing to see," she adds.

"There are a lot of open, airy spaces where colleagues can gather, converse, and collaborate. In addition to benefiting our patients and physicians, this is incredibly beneficial to our educational program."

Edward G. Buckley, MD

Above: One of several common areas where faculty and staff can collaborate.

Opposite: Hudson building exam rooms include all of the latest equipment to streamline patient care.

Designed with assistance from the only blind architect in the U.S., Chris Downey of HOK Architectural Firm, the building is both easy to get to, and easy to navigate. It offers valet parking, an on-site parking garage, and covered walkways. Unique interior features such as easy-to-read signage and braille, color-coded pathways, and strategic lighting methods to help low-vision patients navigate with ease. These small changes have a big impact. "Our patients marvel at just how easy it is to get around the facility," says Prithvi Mruthyunjaya, MD medical director for Duke Eye Center and director for the Duke Center for Ophthalmic Oncology. "It really instills confidence in them that the treatment they are about to receive is cutting edge."

Streamlining Clinical Care

"The Hudson building is more than just a beautiful space," says Eric Postel, MD, professor of ophthalmology, vice chair of clinical operations and chief of ambulatory surgery. "It has allowed us to change the way that we see patients in our clinics and operate our clinics." The improved patient experience begins with a simpler and more convenient check-in process. Patients receive exams, imaging, physician evaluations, and customized treatment plans all in one day and under one roof. At the end of their visit, they have the opportunity to take advantage of a new mobile checkout process and schedule follow-up appointments as needed. "My clinic is now running more efficiently than it did before," says Postel. "At the end of the day, it's not just the space, but the more streamlined processes that have truly enhanced both the patient and physician experience," he explains.

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Eric Postel, MD

As Duke Eye Center expands over time to meet the needs of its growing patient population, its healthcare professionals are prepared to continuously adapt. "We are using electronic medical records data to better understand the flow of patients through our clinic and have used this technology to revise our processes and customize clinical care," explains Mruthyunjaya. "We are excited to be at the forefront when it comes to using this type of information to streamline processes here at Duke Medicine," he adds.

Combining Clinical Services

As the new Hudson Building took shape, a major reorganization and combination of clinical services to bring together physicians, technicians, and technology in the new facility was also underway. "By putting world-class healthcare professionals from various specialties within an arms reach of one another, we can share resources, discuss complex cases, diagnose and treat patients, and cross train our technicians in one common area," explains Mruthyunjaya. "The integration process was daunting at first," he confesses "in part because we also had to redefine our treatment processes, but thanks to our fantastic administrative team, it went off seamlessly," he concludes.

The logistical challenge of relocating faculty, staff and trainees onto the fourth floor of the Hudson Building was completed in early 2016. "The ability to move our faculty and learners into one space is very special," says Buckley. "There are a lot of open, airy spaces where colleagues can gather, converse, and collaborate. In addition to benefiting our patients and physicians, this is incredibly beneficial to our educational program."

The New Face Of Vision Rehabilitation

When you first walk into the new Hudson Building, you cannot help but notice the Visual Rehabilitation Center, located immediately inside the front lobby. The location of the center serves two purposes. First, because many of the center's patients suffer from physical limitations, being located at the front of the building simply makes sense. Secondly, it places a greater emphasis on vision rehabilitation and lets patients know that equipping them with the tools and techniques they need to safely maintain their independence is a top priority at Duke Eye Center. "It really is a dream come true," says Whitaker with a smile. "It is the new face of visual rehabilitation."

Top: Finishing touches being put on Mr. Hudson's portrait during the June 2015 building dedication.

Middle: Donor wall in the Hudson Building at Duke Eye Center acknowledges those who helped make this dream a reality.

Bottom: Larger waiting areas allow ample and comfortable space for our patients.

The vision rehabilitation service at Duke is unique in many ways. As a relatively new field in the practice of ophthalmology, only approximately twenty-five percent of academic institutions currently offer similar programs. Furthermore, Duke's program is one of only two in the Southeast. "We are one of the top programs in the country because of our diverse comprehensive scope of clinical care, our incredible team, and our exceptional training program," says Whitaker.

The center is comprised of a dynamic team of healthcare professionals, including optometrists, certified ophthalmic medical technicians, occupational therapists, certified low-vision rehabilitation specialists, social workers, orientation and mobility specialists, and certified driver rehabilitation specialists. Together, these professionals assess patients and provide them with personalized training to assist them in maintaining or restoring the activities of daily living.

During rehabilitation sessions, patients practice skills like cooking, shopping, and self-care. The additional space provided by the Hudson Building has allowed for several exciting new opportunities and programs to benefit patients. Two examples are a new, expedited on-site DMV medical assessment service, and the Duke Vision Rehabilitation Technology Training (VRTT) Program, which pairs blind or vision-impaired high school or college students with other visually impaired individuals, benefitting both parties in a unique way. Students earn credit and gain valuable experience, and patients learn how to master technology such as smartphones, tablets, and computers quickly and efficiently thanks to the unique insight and skill set that their instructors have to offer.

An Indescribable Benefit

At the end of the day the Hudson Building is just that—a building comprised of brick, stone and mortar. The overwhelming benefit that it has provided to the Duke Eye Center team and the future of patient care at Duke, however, is immeasurable. "By equipping our team with a facility designed for the twenty-first century practice, we have been able to dramatically enhance our mission of providing unrivaled clinical care, world-class education, and innovative research at Duke Eye Center," says Buckley. "We are exceedingly grateful to everyone that made this possible, and we consider ourselves fortunate to have the opportunity to take care of patients in this lovely environment for years to come."

"We are exceedingly grateful to everyone that made this possible, and we consider ourselves fortunate to have the opportunity to take care of patients in this lovely environment for years to come."

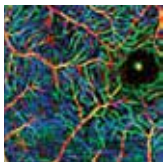
Edward G. Buckley, MD

Fay Tripp, MS, OTR/L, our occupational therapist, helping a patient in the new low-vision rehabilitation suite.

It's an OCT World

Led by two of the field's pioneers, an interdisciplinary team at Duke is pushing the boundaries of optical coherence tomography technology and application, and revolutionizing ophthalmic care as we know it.

BY LAURA ERTEL



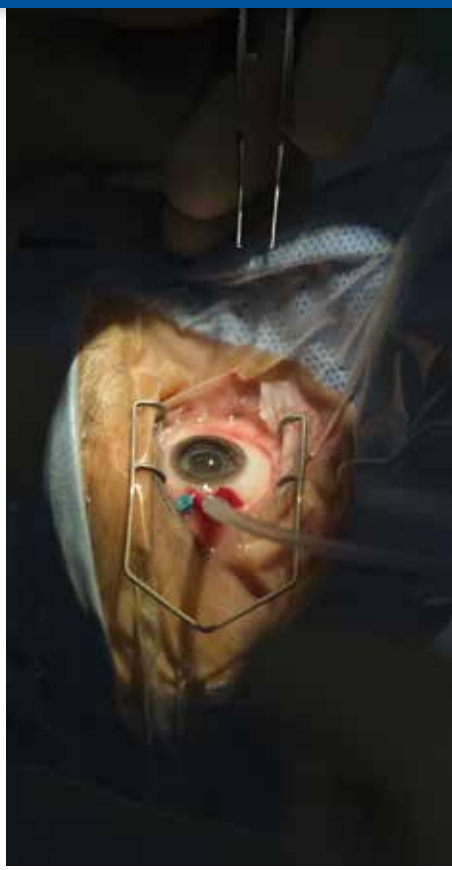
SINCE ITS INVENTION 25 YEARS AGO, OPTICAL COHERENCE TOMOGRAPHY (OCT) has—without exaggeration—transformed the practice of ophthalmology. OCT is a non-invasive imaging technology that bounces light waves off different parts of the eye, creating very high-resolution images that allow ophthalmologists to see the surface and inside the tissues of the eye in very fine detail not possible with the naked eye. (For comparison, ultrasounds use sound waves; since light travels much faster and has a smaller wave length than sound, OCT images are much higher resolution.)

Over the last quarter century, OCT technology has developed in amazing ways—and a multidisciplinary team at Duke University is responsible for much of that development. Led by two of the world's pioneers in this field, the Duke team is continually looking for ways to improve this technology and take it places that were never thought possible

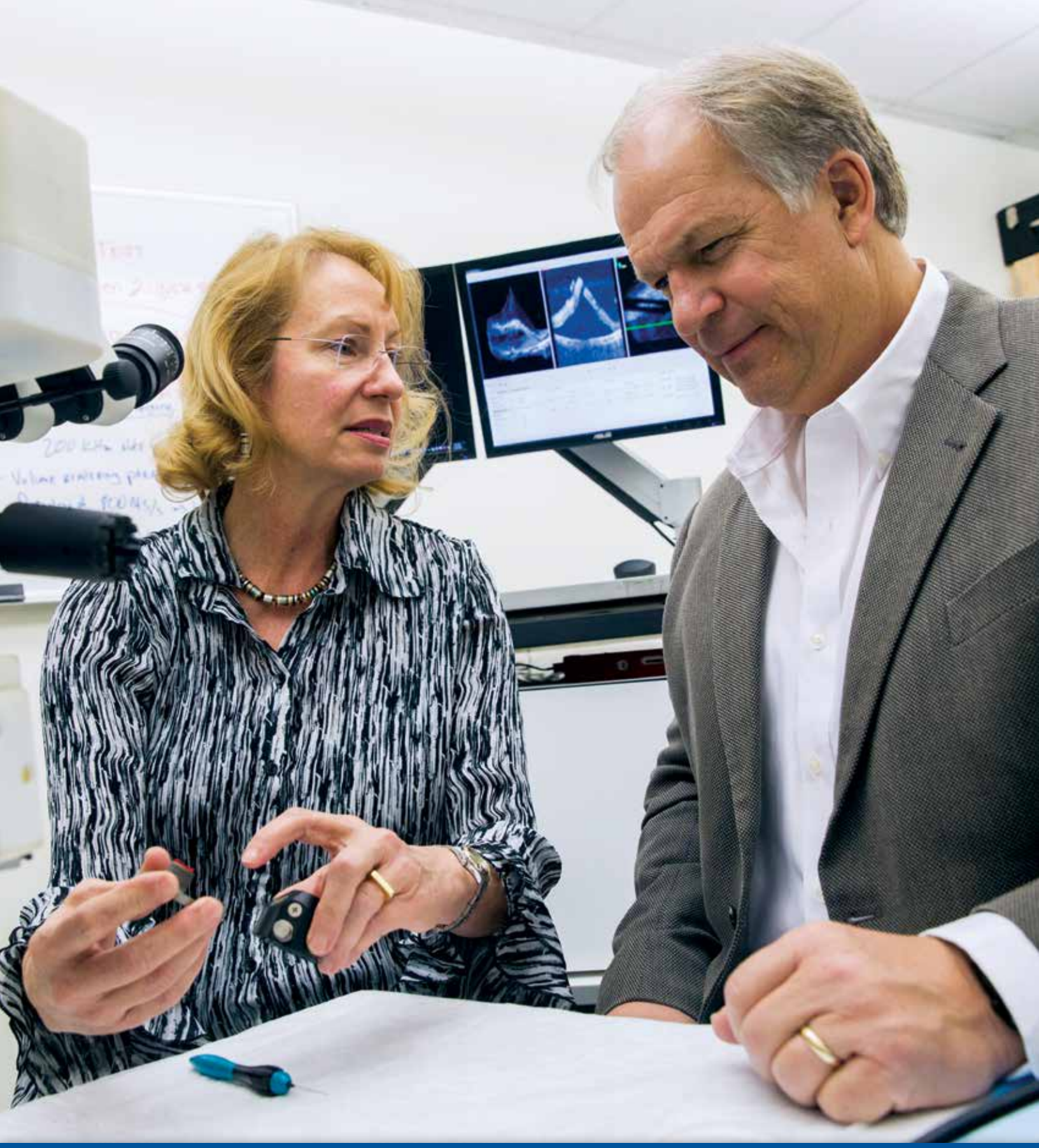
Retinal surgeon Cynthia A. Toth, MD and biomedical engineer Joseph A. Izatt, PhD have both been involved with OCT since its earliest days, and have collaborated since the mid-1990s, even before Izatt came to Duke. This collaborative team, each with faculty appointments in Ophthalmology and Biomedical Engineering, has built one of the world's leading OCT research programs, with a strong track record of technological innovation and, uniquely, a consistent history of successfully translating these innovations from the laboratory to patient care.

To do this, Toth and Izatt have built a community that bridges two of Duke University's strongest disciplines: medicine and engineering. On a weekly basis, Duke medical and surgical colleagues from virtually every ophthalmology subspecialty, bioengineering faculty and graduate and undergraduate students, medical students, ophthalmology residents, fellows and post-doctoral candidates, research technicians and neonatal specialists come together to brainstorm ways to improve eye care and then work to adapt and improve OCT technology to bring these ideas to fruition with patients.

The results are reaching into every corner of ophthalmology care and are creating what Toth calls "an OCT world," one where we are able not only to create ultra-fast, ultra-sharp three-dimensional images, but also to provide those images to surgeons in real time in a functional and useful way. Toth and Izatt's work was featured in the special 25th Anniversary Issue of Investigative Ophthalmology and Visual Science (IOVS). Here's a glimpse into the world the Duke team is creating:



A patient in surgery for which intraoperative OCT was used to help make sure her retina repair was successful.



Retinal surgeon Cynthia A. Toth, MD and biomedical engineer Joseph A. Izatt, PhD have both been involved with OCT since its earliest days, and have collaborated since the mid-1990s, even before Izatt came to Duke. This collaborative team, each with faculty appointments in Ophthalmology and Biomedical Engineering, has built one of the world's leading OCT research programs.

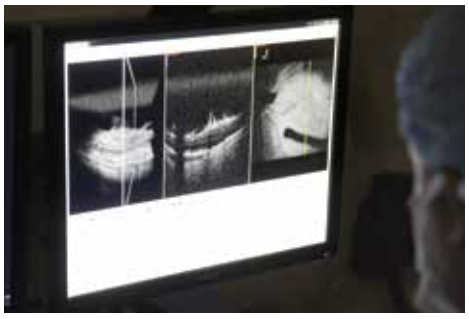
12

"Eye surgeons were using OCT *before* surgery to see what was wrong, and then *after* surgery to make sure they'd fixed the problem. Our goal was to build OCT into the surgical microscope so they could actually use it *during* the procedure itself to provide the best care for patients."

Dr. Joseph Izatt

Michael J. Fitzpatrick Professor of Engineering

Professor of Biomedical Engineering and Ophthalmology

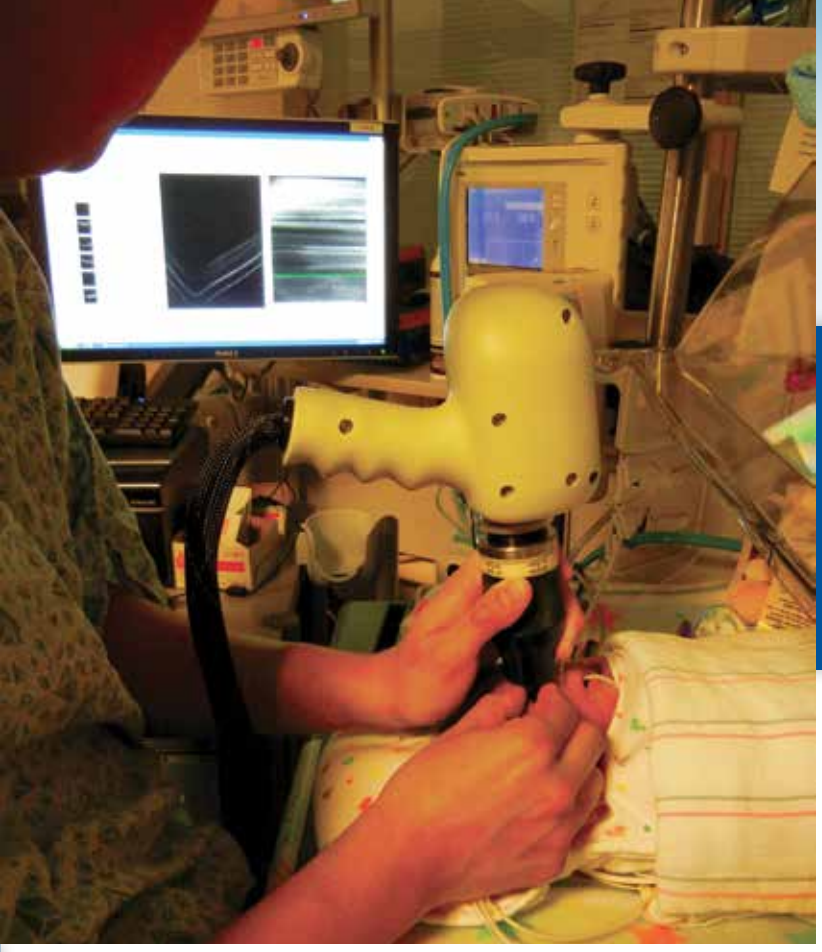


Intraoperative OCT images of the retina during surgery.

The Incredible Shrinking OCT

The first OCT machines were incredible—but they were also huge. The typical early system sat on a big table in the clinic with a computer hooked up to it. The patient put her head on the chinrest and held very still while the images were taken; those images were printed on paper or sent to a photography suite to be reviewed later. That system worked well for mobile (and very patient) adults, but it didn't work so well for fidgety kids or patients confined to a bed.

Izatt brought the concept of a portable, cart-based handheld OCT system to Duke, where Toth recognized its potential to bring OCT to new patient populations. Using a portable hand-held system built by the Izatt Laboratory's spin-off company Bioptigen, Inc., Toth and her colleagues were the first to bring high-resolution OCT imaging to the infant bedside. While the original handpiece was the size and shape of a small hair dryer, the latest handpieces developed by the Duke collaboration don't weigh much more than a cell phone and take pictures in a fraction of a second (very important for squirming children). Linked by a cord to a computer display, these devices made it possible—for the first time—to take the technology wherever it was needed, be in the neonatal nursery, pediatric eye clinic or operating room. Fast, portable OCT has opened up whole new avenues for application.



Handheld OCT being used to examine a premature infant for serious eye issues common with early births.

There's a saying: "The eyes are the windows to the soul." Using OCT with newborns, Duke investigators are also finding they're the windows to the brain, and to human development.

Seeing Human Development Through an Infant's Eyes

Every week, Duke Chief of Pediatric Ophthalmology, Sharon Freedman, MD or her partner, David Wallace, MD, visits the neonatal intensive care unit (NICU) in Duke Hospital to examine premature infants for serious eye issues common in early births. These babies, of course, cannot yet sit or hold their heads in a traditional OCT machine. So, Toth wondered, could the new handheld OCT make it possible to bring this technology to the infants?

Duke's recognition by The Hartwell Foundation as one of the top ten places in the country for pediatric biomedical engineering, coupled with an investigator award for Toth, enabled her, Freedman and Izatt to move forward with their efforts to bring OCT to prematurely born infants. A pilot grant from the National Eye Institute (NEI) and support from the Andrew Family Charitable Foundation were important in making this work possible.

"We have known for a long time that newborn babies don't see as well as they will after a month or two because the central portion of the retina, which is part of the developing brain, hasn't fully developed," Freedman explains. "Using OCT we can, for the first time, actually ***watch*** how the central retina (the macula) develops, in living babies, by following the OCT images."

With parents' permission, OCT imagers accompany Freedman to the NICU each week and use the handheld OCT to take high-resolution images of the infants' retinas. (These are quick, noninvasive and do not cause discomfort to the infant.) While these images are currently taken as part of ongoing OCT research, they also allow doctors to see swelling or other abnormalities, and should eventually help track the impact of new treatments on the eye.

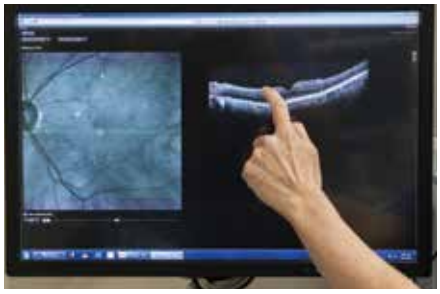
In February 2016, Toth, co-investigators Freedman and Izatt and others in neonatology received another NEI grant to use their new OCT to study eye-brain development.

"The eye is a window into the developing brain," says Freedman, who has used OCT with older children for as long as commercial OCT has been around. "When a premature infant is suspected of brain injury, neurodevelopmental testing is performed at age two (years) as a standard. We suspect that handheld OCT imaging of the retina and optic nerve will soon provide a sort of 'advanced warning' of developmental delay in these infants, something with great promise to allow more timely evaluation of interventions in the nursery that may improve vision and brain outcomes for these tiny children."

"I believe that using OCT information is making us all better surgeons."

Dr. Cynthia Toth

Joseph A.C. Wadsworth Professor of Ophthalmology
Professor of Biomedical Engineering



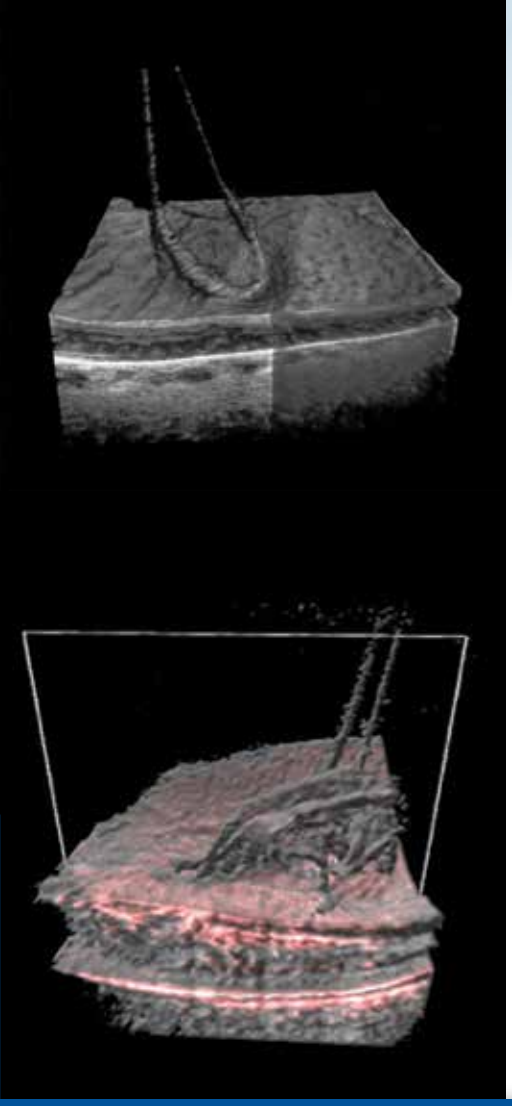
Toth showing medical students the retina repair needed for a patient.

Bringing OCT into the OR

Even before the handheld system was developed, Toth and Izatt were asking the question: How could eye surgeons use OCT to improve their view of surgery? With the NEI's support, Toth first used the commercial handheld OCT device next to the surgeon's microscope in the operating room during pauses in surgery. Motivated by these results, the engineering team figured out how to actually integrate OCT directly into the microscope itself. Now the surgeon could see the high-resolution images in their eye pieces *while* performing a delicate surgery. Duke was the first to develop microscope-integrated intraoperative OCT. Subsequent improvements at Duke have added three-dimensional OCT images, a heads-up display controlled by a foot "joystick" to let the surgeon see different angles while still under the microscope, and other technologies to display ever-sharper images revealing critical details about a patient's eye.

Cornea specialist Anthony Kuo, MD worked closely with Toth and Izatt on the microscope-integrated OCT system design, and has found that it changes what he can do as a surgeon. In particular, OCT makes it possible to do less invasive surgeries with faster recovery times for patients. For instance, in patients with very cloudy corneas that would normally require removing the entire damaged cornea and stitching on a new one, Kuo can now use microscope-integrated OCT to see with enough detail to perform a partial thickness corneal transplantation: a newer technique that requires only a small incision.

"Without OCT, we needed to rely strictly on experience to judge depth and tissue relationships, but with the 3-D OCT we can easily examine cross-sections of the



entire cornea and close up any unwanted gaps that we find between the host and transplanted corneas before we leave the operating room," Kuo explains. "Similarly, for other types of corneal transplants, we use microscope-integrated OCT to help guide our instruments to the correct depth."

This amazing degree of precision is bringing us closer to the day when surgeons will operate guided almost exclusively by OCT, Toth believes. "In retina, for example, we work on tiny tissues inside the eye that are microns thin. As we peel off these layers, we can use the OCT to actually look from all angles to check for any pulling or tearing as we go. Our ophthalmology residents recently studied how using OCT impacted their performance in suturing in the laboratory. Because the OCT images gave them better feedback, they were more precise and better surgeons when they used it. Thus I believe using OCT images can make us all better surgeons."

Commercial versions of intraoperative OCT have now become available from several companies, including Duke spin-off Bioptigen (now part of Leica Microsystems) and others. However, through continued collaboration with Duke biomedical engineers, Duke Eye Center still has the most advanced research version available, and is the only place using real-time 3-D OCT imaging. Many Duke eye surgeons use this research technology in the OR. For instance, vitreoretinal surgeon Tamer Mahmoud, MD, PhD recently used intraoperative OCT to perform the first human autologous macular transplant—and made an unexpected discovery that may lead to life-changing improvements in functional vision (see page 16).

"The thing that's so special at Duke is the incredible collaboration we have across disciplines. We have these terrific biomedical engineers and then those of us who work with patients, and the ideas go back and forth as we explore the possibilities."

Dr. Sharon Freedman
Chief of Pediatric Ophthalmology

Top image is 3-D constructed volume from an intraoperative Microscope Integrated OCT (MIOCT) scan of a surgical loop on the retinal surface. Bottom image shows the OCT 3-D volume of the forceps peeling the membrane.

Endless Potential

The potential applications for OCT to improve ophthalmic care are endless, Toth notes. Already, the Duke team is working on a version of the handheld device that can take images without getting very close to the eye, to use with toddlers who will watch a video from arm's length but are too small and apprehensive to sit in a chinrest for standard OCT imaging. As they continue to push the limits of high-resolution and high-speed imaging, the team is also exploring ways to incorporate robotics into the intraoperative OCT to help surgeons—who are only human, after all—operate at the finest level of precision. And, decades into the program at Duke, many physicians and engineers who trained under Toth and Izatt have gone on to make contributions of their own to the development of this technology nationally and internationally.

But wherever OCT can be used to improve ophthalmic care next, two things are certain: OCT technology will continue to evolve, and Duke will continue to lead the way in creating the new OCT world.

Tamer Mahmoud, MD, PhD
with patient Virginia Hall

Vision Gains after Innovative Macular Surgery Defy Expectations

Duke Eye Surgeon's Breakthrough Procedure to Repair Macular Hole Yields Surprising, Potentially Life-changing Improvements in Functional Vision

BY LAURA ERTEL

This was the first human autologous retinal transplant ever performed, and the early results were encouraging: The innovative surgery seemed to be a success, but the question remained: "Would the transplanted retina stay in place and continue to plug the hole to prevent a detachment?"

A day went by. A week. A month. The transplant was still staying in place.

Then something completely unexpected happened.

A HOLE IN THE RETINA is not an entirely uncommon occurrence, and vitreoretinal surgeons have some very successful, routine procedures to fix this. But when the hole occurs in the macula (the retinal area in the dead center of vision) things can get a bit trickier, as these holes can increase risk for retinal detachment, resulting not just in loss of central vision but total blindness. Still, surgeons have options.

In the most challenging cases, a patient with a macular hole is very nearsighted ("highly myopic"). Myopic patients have very thin retinas, and are at increased risk for both macular holes and retinal detachments. In these cases, standard surgeries to repair the hole won't work. Often, the retina is stretched too thin to create and flip an adjoining flap onto the hole to seal it; or prior surgeries have already removed that membrane. Surgeons can generally repair the retinal detachment, but they cannot fix the hole, so central vision continues to deteriorate—*and* the patient is still predisposed to another detachment.

A Complex Case

When Duke vitreoretinal surgeon Tamer Mahmoud, MD, PhD met Virginia Hall, a 52 year-old from western North Carolina, in spring 2015, that was exactly the situation he faced. Hall was highly myopic and had multiple surgeries outside of Duke that repaired a retinal detachment but the large macular hole remained, so a retinal flap was not an option. Her local surgeons thought coming to Duke Eye Center was her best hope to keep her limited vision from deteriorating further.

"It was like a black blind coming down," said Hall. "Even though my retina doctor in Asheville was able to fix the retinal detachment, the macular hole was still there. That's when I was referred to Dr. Mahmoud. I feared I was going blind forever," she added

Mahmoud decided the best plan was to cut a thin layer/flap of the patient's retina from the periphery and move it to the site of the hole to try to close it. That wouldn't improve her central vision, but it would hopefully prevent future detachments and loss of peripheral vision.

Tamer Mahnoud, MD, PhD talks with Virginia Hall in a follow-up checkup, early 2016.

After 3 months, Hall came back to Duke for another checkup. Shocked, Mahmoud and his team checked her vision and found that she could count fingers from several feet away, and was able to read 20/80 on the eye chart.

An Innovative Solution

But when they got into the operating room, Mahmoud found that Hall's retina was too thin to work with the existing peripheral flap. Instead, he decided to take a full piece of the retina, rather than just one layer, and use it to plug the hole. A laser was used on the retinal tissue around the newly formed hole to prevent a future detachment at that site. The transplanted plug was kept in place initially using silicone oil.

This was the first human autologous retinal transplant ever performed, and the early results were encouraging: The innovative surgery seemed to be a success, but the question remained: "Would the transplanted retina stay in place and continue to plug the hole to prevent a detachment?"

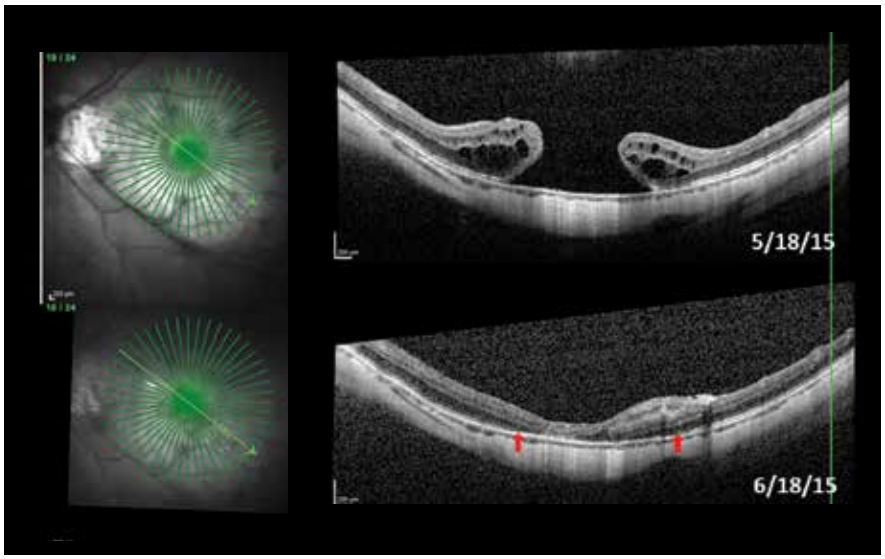
A day went by. A week. A month. The transplant was still staying in place.

Then something completely unexpected happened.

A Surprising—and Exciting—Outcome

One month after the surgery, Hall returned to Duke for her checkup. Because of the macular hole, she had had a large black spot at the center of her vision. That

Pre-operative OCT on 5/18/15 shows a full-thickness macular hole and post-operative OCT on 6/18/15 shows macular hole closure with overlying neurosensory retinal free flap.



day, she told Mahmoud that the spot had become less dense—it was now gray.

"That was very exciting, and entirely unexpected," Mahmoud says. "We tested the sensitivity of the retina using microperimetry, and found that her sensitivity had indeed improved."

After 3 months, Hall came back to Duke for another checkup. Shocked, Mahmoud and his team checked her vision and found that she could count fingers from several feet away, and was able to read 20/80 on the eye chart. They performed the microperimetry test and found her sensitivity had increased again.

"After just three months, that black area in the center of my vision was almost gone. It's not great, but it's better than before," says Hall.

The transplanted tissue continued to look good, and eventually Mahmoud decided to take out the silicone oil to prevent future complications. To avoid dislodging the plug, he used Duke's state-of-the-art intraoperative optical coherence tomography (OCT) technology; the transplant stayed in its exact location after oil removal. After the surgery, Mahmoud saw another surprise with the OCT.

"The piece of retina that we moved from the periphery was initially very thin when we moved it to the center of the vision. But it had started to change. It had started developing layers that you can only see in retinal tissue at the center of the vision!"

Just the Beginning

This is something we have never seen before, Mahmoud notes, and it leads to more questions than answers. Most importantly: ***How—hypothetically—does the peripheral retina acquire the morphologic and functional changes to start behaving like the central retina?***

We are still very early in this process, Mahmoud cautions, but the results are encouraging. Hall returned to Duke Eye Center for her six-month follow-up; her vision has remained 20/80 and her retinal sensitivity has continued to improve.

"I am so thankful my retina doctor referred me to Dr. Mahmoud and Duke Eye Center," said Hall. "If not for him, I may have been blind in that eye. I just hope my sight continues to improve," she added.

Mahmoud has since performed two more autologous retinal transplants and is sharing his findings with colleagues at conferences and in journals.[1] Perhaps most importantly, he is working with Duke Colleagues to try to understand the science behind these results.

"It is incredibly gratifying to have success, not only in developing a new way to close macular holes, but also to see this completely unanticipated functional improvement in retinal sensitivity and vision. Now we need to understand more about those cells, because the surgery itself isn't very complicated, but the implications go far beyond macular holes. If the retina from the periphery starts changing behavior, then there may be applications for other types of retinal diseases where the central vision is lost. That's what's truly exciting," said Mahmoud.

"I am so thankful my retina doctor referred me to Dr. Mahmoud and Duke Eye Center. If not for him, I may have been blind in that eye."

Virginia Hall

[1] Grewal DS, Mahmoud TH. Autologous Neurosensory Retinal Free Flap for Closure of Refractory Myopic Macular Holes. JAMA Ophthalmic. 2016;134(2):229-230.

2015 DUKE

Employees

368 health staff

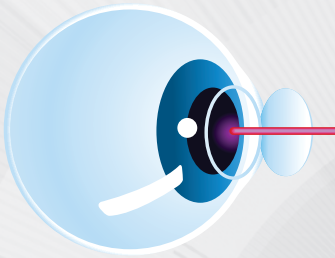
58 clinical physicians

21 ophthalmology fellows

19 residents

14 research scientists

Surgeries



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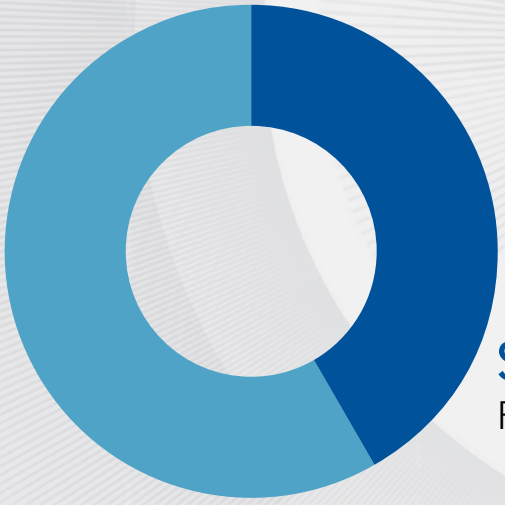
Award Funding

Total: $17,555,103



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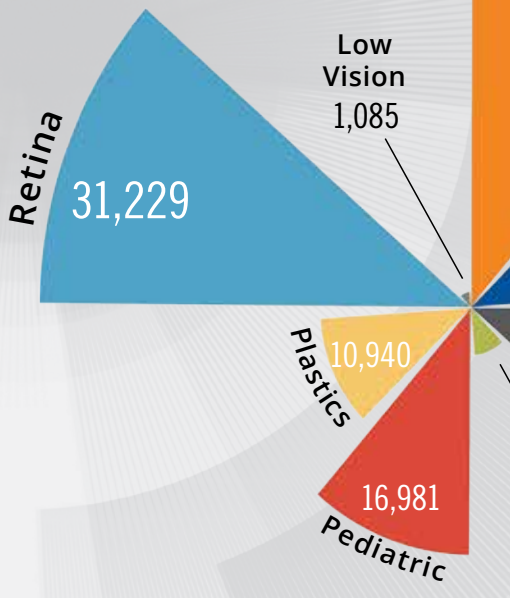
Non-Federal

$7,323,061
Federal

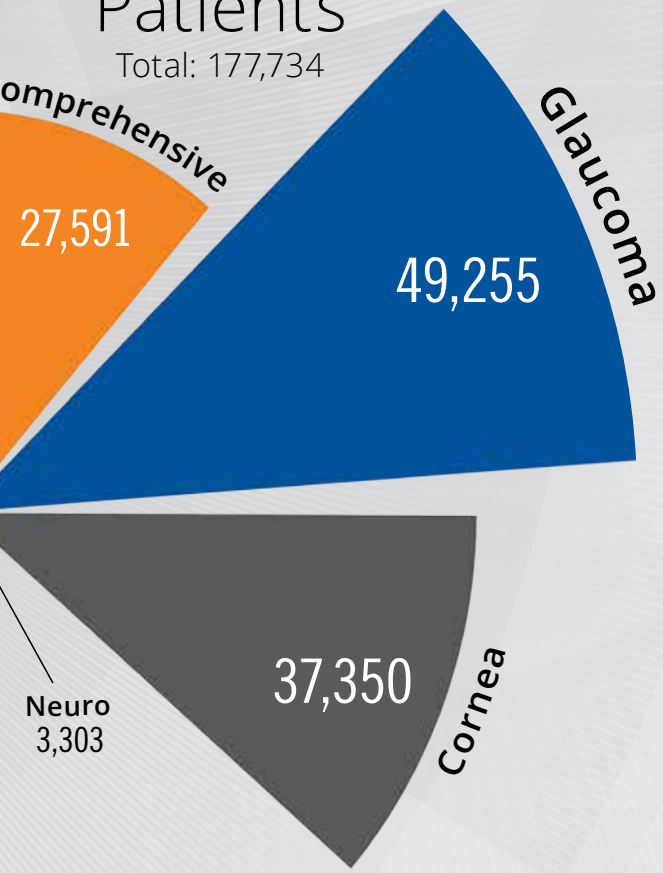


EYE CENTER STATS

10
Duke Eye Center Locations

26
NIH Grants

Patients
Total: 177,734



Ranking

8

US News & World Report
Best Hospitals in Ophthalmology

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U.S.News
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The Art of Reconstructive Surgery

Basal cell carcinomas are the most frequently occurring form of skin cancer. When basal cell carcinomas are removed from the eyelids, the expertise of an oculoplastic surgeon is frequently required to reconstruct the area.

Elizabeth Ann Badgett, 62 from Clayton, NC noticed a scaly spot on her nose that would heal and return repeatedly over six months. Each time it recurred, it was larger, finally reaching the corner of her left eye. At last, she consulted her primary care physician that referred her to a dermatologist for evaluation.

The diagnosis was basal cell carcinoma, requiring surgery to remove the cancer then reconstructive surgery to improve the function and appearance of her eye and face. Her dermatologist, Jonathan Cook, MD, an expert in Mohs surgery, the most effective technique to remove skin cancer, performed the cancer excision surgery.

"I knew the surgery was necessary, but I was scared because of the cancer's proximity to my eye. I wondered if my eye and face would ever look normal again," said Badgett.

Badgett's dermatologist referred her to Julie A. Woodward, M.D., associate professor of ophthalmology and dermatology, who was assisted by Nicole Langelier, M.D., M.B.E, an oculoplastic fellow at Duke Eye Center.

"The eyes are the face's focal point of expression," Woodward said. "People want to look like themselves, and reconstruction allows that," she added.

To cover a lower eyelid defect, oculoplastic surgeons harvest skin, from the upper eyelids because it most closely matches the lower-lid. If that's unavailable, they graft skin from the retroauricular area, the subaxillary area, or the supraclavicular area, just above the collar bone. In some cases, flaps of skin can be lifted and rotated from the forehead or eye lid to cover the incision site as in this patient's case. This type of reconstruction requires a second procedure to revise the pedicle flap.

The most critical step is connecting blood vessels to supply the eyelids. Without proper blood flow, the tissue will die. To keep the puffiness down, smooth out the transplanted skin, and recapture a natural color, surgeons inject either steroids or anti-inflammatories under the skin. Facial fillers can reduce the appearance of scars and also make eyes appear fuller over time "The reconstructive surgery not only maintains eye sight, but it also gives people a more normal appearance, helping them live their daily lives," said Woodward.

Today, Badgett's cancer is gone, the surgery site has healed nicely, and she looks like herself again.

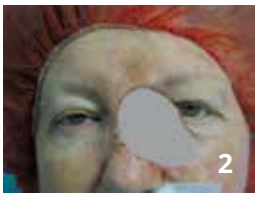
"I'm pleased that I was sent to Duke for this surgery," Badgett said. "Dr. Woodward and Dr. Langelier did a great job. I am happy with the results," she added.

"I'm pleased that I was sent to Duke for this surgery. Dr. Woodward and Dr. Langelier did a great job. I am happy with the results."

Elizabeth Ann Badgett

Above: Elizabeth Badgett, 5 months after reconstructive surgery following Mohs removal of basal cell carcinoma.

Below: timeline of treatment. 1: Pre-Op; 2: day of surgery; 3: Post-Op 1.5 weeks; 4: Post-Op 4 months.



Duke Fellowships Offer Future Ophthalmology Leaders Opportunity to Make a Difference in the Field

DILRAJ GREWAL, MD, IS A VITREORETINAL SURGERY FELLOW AT DUKE EYE CENTER. As such, he is a position to be able to collaborate with experts not only throughout the medical center but the entire university. This, says Grewal, is is one the greatest assets about fellowships at Duke.

"I can collaborate and work with a lot of different people across many specialties," he says. "It's a huge strength of Duke."

Grewal cites the Department of Biomedical Engineering as an example. "Duke has one of the strongest imaging-focused biomedical engineering departments. We have outstanding imaging specialists here, and as a fellow I can take advantage of that expertise," he says.

The team approach of clinicians and engineers working together — taking knowledge from the laboratory bench to the clinic to better serve patients — has made Duke Eye Center a pioneer in translational research. "We can use the cutting edge tools that our imaging colleagues are working on and directly apply them to patient care," says Grewal.

- As a fellow, Grewal has had the opportunity to work with Glenn Jaffe, MD, chief of the vitreoretinal division and head of the Duke Reading Center. "Using images collected as part of a clinical trial evaluating new therapeutics in patients with uveitis, we were able to evaluate a new biomarker as a strong predictor of vision in eyes with uveitic cystoid macular edema," he says. This biomarker, called Disorganization of Retinal Inner Layers, outperformed the traditionally used parameters in predicting vision in patients with uveitic cystoid macular edema, which can result in decreased vision.
- With retinal surgeon and ocular oncologist Prithvi Mruthyunjaya, MD, Duke has been among the first centers to evaluate the efficacy of using a new biopsy technique (called 27-gauge microincision vitrectomy-based chorioretinal biopsy) for various eye tumors.
- Working with Tamer Mahmoud, MD, PhD, vitreoretinal fellowship director, has allowed Grewal the opportunity to work on developing novel surgical techniques such as a retinal graft for closure of challenging macular holes.
- Collaborating with Sina Farsiu, PhD, and his team at the Department of Biomedical Engineering has resulted in improved segmentation and automation for detecting changes in retinal layers in diseases like macular holes

"Duke has one of the strongest imaging-focused biomedical engineering departments. We have outstanding imaging specialists here, and as fellowship trainees we can take advantage of that expertise."

Dilraj Grewal, MD, vitreoretinal surgery fellow

and vitreomacular traction. This has given new insight into the recovery of the retina following surgery for these conditions.

- Using prototype wide field OCT imaging built by Anthony Kuo, MD, and his team, they looked at changes in the peripheral retina in various diseases that were not described before.
- Working with Cynthia Toth, MD, and her team at the Duke Advanced Research in Spectral Domain OCT Imaging (DARSI) laboratory, Grewal has looked at real-time OCT imaging during retinal surgery in scenarios like implantation of the retinal prostheses, and during biopsies for cancers in the choroid of the eye.

"Several of these projects are ongoing, and we hope to continue working on improving the clinical diagnostic and therapeutic options available for our patients," says Grewal.

Fellowship programs at Duke Eye Center are oriented toward the development of the future leaders in ophthalmology. The collaborative approach of clinicians and researchers working together to make enormous strides in the field has made Duke Eye Center a leader research and patient care.

You can support Duke Ophthalmology trainees by making a gift at

http://dukeeyecenter.duke.edu/donate-and-give

Supporting Scientific Discovery

When Frances Foster was a child, she lost the sight in one eye due to improper care for her uveitis. Now, Frances and her husband, renowned ophthalmologist C. Stephen Foster, MD, want to make sure that never happens to others.

Stephen, a Duke alumnus, and his wife gave $2.5 million for the Stephen and Frances Foster Professorship in the field of ocular immunology and inflammation, to support research in Duke Eye Center's Uveitis Clinic, where doctors take a multi-specialty approach combined with novel drugs and drug-delivery systems.

"The research done at Duke is among the best in the world. We knew that Duke would put our support to the most productive and beneficial use," says Frances.

To learn more about opportunities to support Duke Eye Center, visit dukeeyecenter.duke.edu/donate-and-give or contact Jillian Ream at jillian.ream@duke.edu.

Pediatric Glaucoma Patient Sets Out to Help Others

SARAH SMALE, 13 year-old glaucoma patient at Duke Eye Center, has been a patient of Sharon Freedman, MD, pediatric glaucoma specialist and chief of pediatrics at Duke Eye Center since she was 3 years old. With Sarah and her family living in Seattle, Washington, they found it challenging to manage her glaucoma with Freedman on the opposite side of the country.

Several years ago, Sarah and her parents learned about an in-home glaucoma pressure monitor (tonometer) called Icare and they thought it may help make things less burdensome. The Icare tonometer analyzes eye pressure by lightly touching the cornea. It's painless and fast, making it perfect for children who otherwise might need either painful anesthetic eye drops or general anesthesia to comply with a pressure measurement.

Once Sarah and her parents started using the Icare at home, it completely changed the way her glaucoma is managed and they saw vast improvements. She decided other kids with glaucoma should have the same opportunity.

"I really want people to have the same access to care as I do, said Sarah."

She worked with Freedman to establish "Sarah's Fund for Saving Sight" and began to hold fundraisers to collect enough money for a "Lending Library" at Duke Eye Center – a supply of Icare tonometers that can be used by Freedman's patients with uncontrolled glaucoma facing potential surgery, or to those with particularly difficult-to-control or advanced glaucoma. Sarah raised over $40,000 from family, friends, and martial arts board-breaking events.

"Without the Icare, I could be blind, and I don't want other kids to go blind either. I want the Lending Library to help everyone who needs it," Sarah added.

According to Freedman, selected families with a child under her care may borrow the tonometer under a protocol approved by the Duke Medicine Institutional Review Board (IRB). The Lending Library has a two-fold objective; as patients use the Icare at home to measure and monitor their child's eye pressures, they share the data with Freedman who, in turn, uses it not only to assist in managing the child's glaucoma, but also to study variations in eye pressures in hopes of improving management and also outcomes of childhood glaucoma. Once Freedman determines the patient no longer needs monitoring as often, the device is returned so that another family can use it.

"I hope to spread the realization that we have the ability to consider what happens to eye pressures outside the office," Freedman said. "We might have the opportunity to learn more about how pressure is monitored and ultimately managed at home."

Freedman teaching Quinn's mom Karin how to check his glaucoma pressure at home with their ICare Tonometer. Being able to check pressure at home will help Karin and Freedman better manage Quinn's glaucoma.

One of the tonomers has been given to 4-year-old Quinn Crozier of Chapel Hill, NC. Quinn's mother said using the device to monitor her son's Axenfeld-Rieger syndrome-associated glaucoma has been, and will continue to be, beneficial.

"Based on Quinn's history, I anticipate his pressure will continue to rise," she said. "Icare will help me monitor the pressure in the run-up to potential surgery."

Ultimately, Freedman said, she'd like to see the Lending Library expand beyond Duke Eye Center to a true national or international endeavor, expanding the ability of other glaucoma specialists to better monitor not only the pressures, but also the disease itself in their pediatric patients.

"Icare is really catching on, and it's exciting to be on the forefront of something that can be really enabling," Freedman adds. "It's a new opportunity."

Sarah with Quinn, the first Icare tonometer recipient from the Lending Library, created by the money Sarah raised to help purchase the instruments.

Expanding Ocular Oncology

Exploring New Methods to Prevent, Diagnose, and Treat Ocular Surface Tumors

BY LAUREN MARCILLIAT

New Duke Eye Center Assistant Professor of Ophthalmology, Gargi K. Vora, MD, has big plans for the future of ocular oncology at Duke. Vora, who completed her fellowship in cornea, external disease & refractive surgery at Duke in 2015, has a special clinical and research interest in ocular surface tumors. Over the last year, under the mentorship of Prithvi Mruthyunjaya, MD, medical director for Duke Eye Center and director for the Duke Center for Ophthalmic Oncology, she has been rapidly gaining experience in treating patients with these rare conditions, and conducting research that will ultimately lead to improved prevention, earlier diagnoses, and enhanced treatment of these diseases.

Ocular surface tumors are extremely rare, affecting only a small percentage of the population, but can indicate serious diseases such as ocular surface squamous neoplasia (OSSN) and conjunctival melanoma. One of the greatest challenges of working with this patient population is that because these tumors are so rare, it is very difficult to conduct studies on a large scale. "Although research has been done to pinpoint some genetic mutations in conjunctival melanomas, most of the time we simply do not know what causes these tumors," says Vora. "It's part of what makes this research so exciting and so important," she adds.

To address this need, Vora is gathering information to create a tumor registry at Duke. This registry will include clinical data gathered during exams and surgeries, as well as patient outcomes. Organizing and analyzing this data will help answer several important questions. For example: What are the risk factors for a specific type of tumor? Which form of treatment had the better outcome? How many patients had recurrences of the tumor? Does this type of tumor show a tendency to metastasize?

"Our goal is to put Duke on the map as a center for excellence in ocular oncology," explains Vora. "A tumor registry like this one would serve as an excellent resource for ocular oncologists across the nation, and could lead to additional studies and research that would improve prevention and early diagnosis."

In addition to generating a tumor registry, Vora and her colleagues hope to develop and tailor the technology that they use to treat these patients. In recent years, cutting-edge imaging technology such optical coherence tomography (OCT), has greatly improved diagnoses of these tumors. Surgical biopsy, however, remains the gold standard of diagnosis.

Conjunctival Melanoma, top; Benign tumor, bottom.

Vora and Assistant Professor of Ophthalmology, Lejla Vajzovic, MD are collaborating with The Warren Group laboratory within Duke's Department of Chemistry led by Warren S. Warren, PhD, to use an imaging modality called a pump-probe laser on pigmented conjunctival tumors. The team hopes to eventually create a new imaging modality which will allow them to image a pigmented spot on the eye, and determine whether it is pre-cancerous, cancerous, or benign. The result of this research could dramatically improve the way that pigmented tumors are diagnosed on the eye. At the moment, this project is in the early stages of development, but the team has achieved good success in analyzing pigmentation patterns and the subcomponents of melanin by using this technology to image human biopsy specimens.

"My job is incredibly gratifying," says Vora. "In working as a cornea specialist, I have the unique opportunity to restore vision in my patients. In working with patients with eye tumors, in many cases, I have the potential to save lives," she adds. Vora believes that she is uniquely positioned to succeed at Duke because of the myriad resources she has at her disposal such as the Duke Cancer Institute and Duke Clinical Research Institute (DCRI). Her colleagues, however, are her greatest asset. "Dr. Edward Buckley, chairman for the department of ophthalmology, Dr. Terry Kim, chief of the cornea and external disease division, Dr. Mruthyunjaya, and others who encouraged and inspired me to stay on at Duke have a vested interest in my future," she explains. "I have them to thank for everything I have accomplished so far," she adds. "There is still so much left to discover, and with the unique combination of resources and support that exist here, I have every opportunity to succeed."

Pathology image of an ocular surface tumor biopsy. Photo by Thomas Cummings, MD.

Duke Eye Center Working to Develop New Therapies for

Age-Related Macular Degeneration

Center for Macular Diseases Studying New Treatments for Both Dry and Wet Forms of Disease

THE DUKE CENTER FOR MACULAR DISEASES is focused on advancing the care of patients with age-related macular degeneration (AMD) through clinical trials of novel, cutting-edge therapies and an active drug development program.

AMD affects more than 15 million Americans, a number that is expected to double by 2030. Patients with early dry AMD experience problems with everyday visual function, including reading and seeing in dim-light conditions and adapting from light to dark, while patients with advanced dry AMD, also called geographic atrophy, have severe central vision loss. Currently, there are no treatments for the dry form of AMD, which accounts for about 85 percent of all cases worldwide. While there are effective treatments for wet AMD, called anti-VEGF medications, many patients have persistent disease and poor vision in spite of treatment.

"Our understanding of AMD disease mechanisms has grown tremendously, but so many of our patients still suffer from debilitating vision loss," says Scott Cousins, MD, director of the Duke Center for Macular Diseases and vice chair for research at Duke Eye Center. "Our goal is to help develop promising new drugs in clinical trials and to invent new medications here at Duke that can one day help all patients with AMD."

The Duke Eye Center is offering several new clinical trials of potential treatments for dry AMD (see list opposite). Additionally, Duke AMD specialists are conducting observational studies to better understand how different types of visual function, including dim-light vision, night vision, and color vision, are affected in patients with early and advanced stages of dry AMD. "We are working to identify novel clinical trial 'endpoints' needed to accurately measure the success of potential therapies," says Duke AMD specialist Eleonora (Nora) Lad, MD, PhD, who is leading these studies. "These endpoints are crucial to facilitate dry AMD drug development efforts."

Duke is also offering trials of new treatments for wet AMD (see list opposite), to extend benefits for patients not currently helped by anti-VEGF medications and to boost vision even further through combination therapies. Also underway are studies to predict which eyes will respond to anti-VEGF treatment. "We especially want to understand disease mechanisms for patients who are resistant to anti-VEGF medications so that we can develop appropriate treatments for these patients," says Duke AMD specialist Prithu Mettu, MD, who is spearheading these studies.

Research efforts at the Duke Center for Macular Diseases also extend into the laboratory, where the team of clinician-scientists is working with experts in Duke Chemistry and Duke Engineering to invent new medicines. Duke macula specialists have invented and patented new classes of medications for the treatment of early dry AMD and for anti-VEGF resistant wet AMD; companies have been "spunout" of Duke for each endeavor, with successful early-stage grants and funds from institutional, federal, and private funding sources. Future innovation efforts will include new targets and drugs for diabetic retinopathy. "We believe there is an opportunity to restore the "cellular fluid pumps" of the retina, which can become sick in diabetic macular disease," says Mike Allingham, MD, PhD, who is leading the medication development efforts. "This could complement existing medications to boost vision for affected patients."

"Given the strengths of our macular research program and the unique opportunity to partner with other talented scientists here at Duke, we believe we can make significant contributions to retinal drug development," adds Dr. Cousins.

From left: Mike Allingham, MD, PhD; Scott Cousins, MD; Eleonora (Nora) Lad, MD, PhD: and Prithu Mettu, MD.

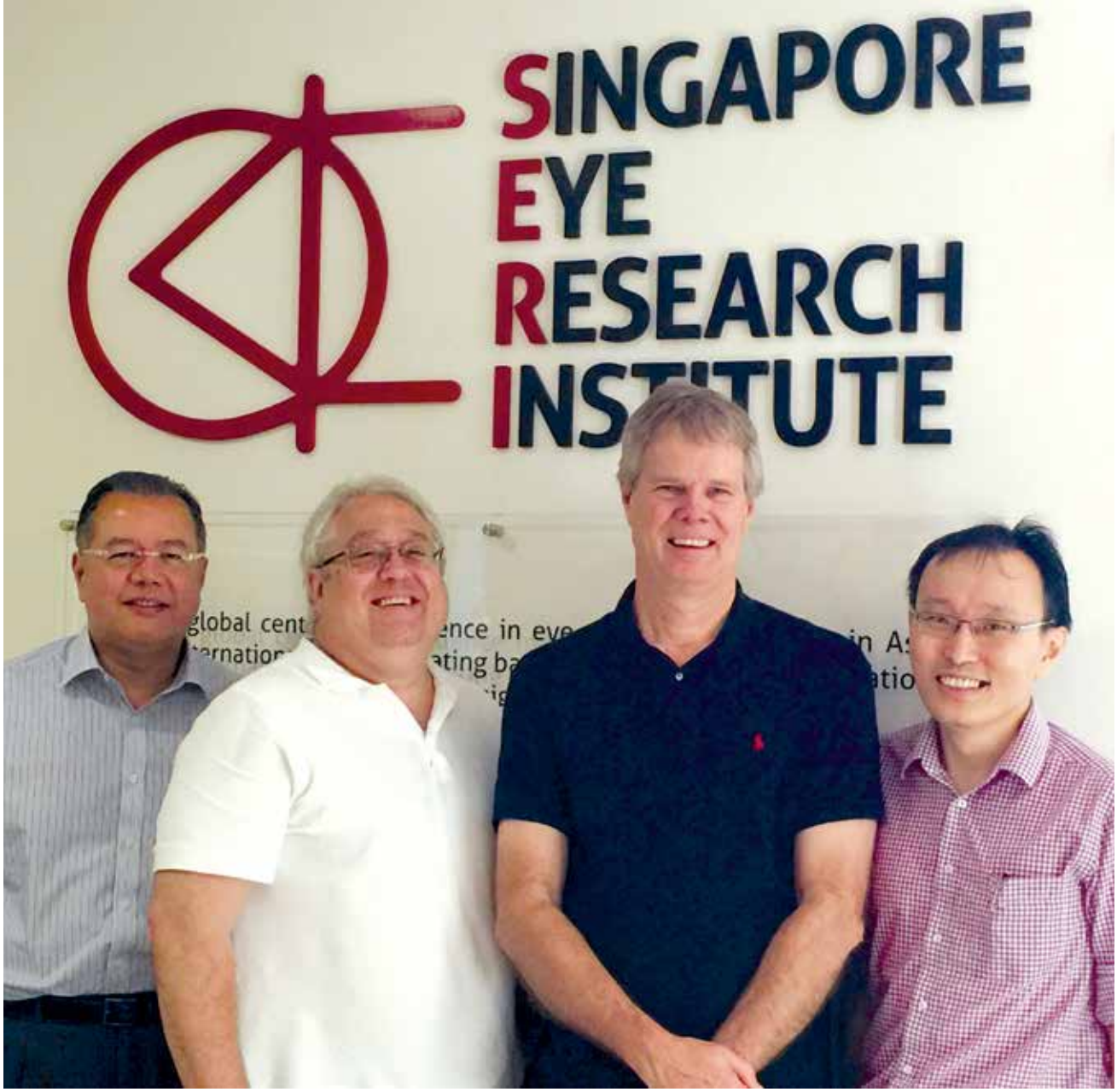
Interventional Clinical Trials for Dry AMD

- ***MTP-131 (Mitochondrial Protective Therapy) for Early Dry AMD (Stealth Biotherapeutics, Phase 1 Studies):*** determine whether restoration of mitochondrial function in retina can boost dim-light vision and can prevent development of advanced AMD disease.
- ***Human Umbilical Tissue Cells for Advanced Dry AMD (Geographic Atrophy) (Jannsen, Phase 1/2 Study):*** surgical placement of umbilical cells under the macula that release special factors to improve survival and function of retinal tissue.
- ***Lampalizumab (Complement Factor D Inhibition) for Advanced Dry AMD (Geographic Atrophy) (Genentech, Phase 3 Study):*** monthly injection of a medication that blocks complement activation (complement factor D) to prevent worsening of advanced AMD.
- ***APL-2 (Complement Factor 3 Inhibition) for Advanced Dry AMD (Apellis, Phase 2 Study):*** injection of medication, APL-2, that blocks complement activation (C3) to prevent worsening of advanced AMD disease.

Clinical Trials for Wet AMD

- ***Photodynamic Therapy for Wet AMD (Bausch + Lomb):*** assess whether photodynamic therapy, targeted activation of light-activatable medication in the abnormal blood vessel, improves disease response in wet AMD patients who are resistant to anti-VEGF medications.
- ***PAN-01-101 (Eyedrops) for Wet AMD (PanOptica Phase 1 Study):*** new eyedrop medication can function as an anti-VEGF treatment to treat wet AMD.
- ***Anti-VEGF/anti-Ang2 Combotherapy (Regeneron Phase 2 Study):*** injection of combination therapy to improve disease control and boost vision in patients with wet AMD.

For more information on these trials, contact Kim Riley, PhD at 919-684-8798.



From left: Tin Aung, PhD; Michael Hauser, PhD; Rand Allingham, MD and C. C. Khor, PhD.

New Partnership with Singapore Scientists Accelerates Duke Research on

Glaucoma Genetics

BY LAURA ERTEL

MOST OF US ALIVE TODAY—WHATEVER OUR COUNTRY OR RACE—CAN TRACE OUR GENETIC ROOTS BACK TO AFRICA. So when Duke Ophthalmology investigators wanted to search for the genes linked to glaucoma to find the cause and the cure they knew where they needed to start.

For over two decades, Duke glaucoma specialist Rand Allingham, MD has been going to Africa to study glaucoma. Allingham started his research in West Africa, which was the natural place to begin since most African-Americans—who are much more likely to develop glaucoma than their white counterparts—can trace their ancestry to that region. He and molecular biologist Michael Hauser, PhD have been working with colleagues in all over Africa to collect DNA samples from people who have glaucoma and those who don't.

The Duke team has collected DNA samples from more than 5,000 people—the world's largest glaucoma

genetics database of African ancestry—and are closing in on genes that will enable early diagnosis and targets to treat or even cure several types of glaucoma, the leading cause of irreversible blindness worldwide.

Now, Allingham and Hauser have partnered with colleagues at the Singapore Eye Research Institute and Singapore Genome Institute to take this research to the next level. The Duke investigators, who have joint faculty appointments at the Duke-National University of Singapore Medical School, met ophthalmic genetics experts Tin Aung, PhD and C.C. Khor, PhD and immediately saw the potential for a valuable partnership.

"Both Duke and Singapore have discovered genes that cause all of the major forms of glaucoma," Allingham says. "We have a strong foundation in African genetics, and our Singaporean colleagues have the expertise and infrastructure to analyze massive global genetic datasets, so it didn't take long realize that this would be a natural and mutually beneficial collaboration. What we didn't know at the time was how much fun it would be to work with each other!"

The international team has leveraged connections throughout the African continent to set up new sites where partners are collecting blood and saliva for DNA samples from patients with and without glaucoma. Enrollment sites are operational or soon will be in Ghana, Nigeria, South Africa, Malawi, Mali, and the Congo. Additional sites are being pursued in Ethiopia and Kenya. Covering all of these regions is critical, Allingham notes, because genetic makeup varies significantly across this vast continent, so in order to fully understand how various genes increase risk or protect from glaucoma the full genetic spectrum of genes from various African populations is critical.

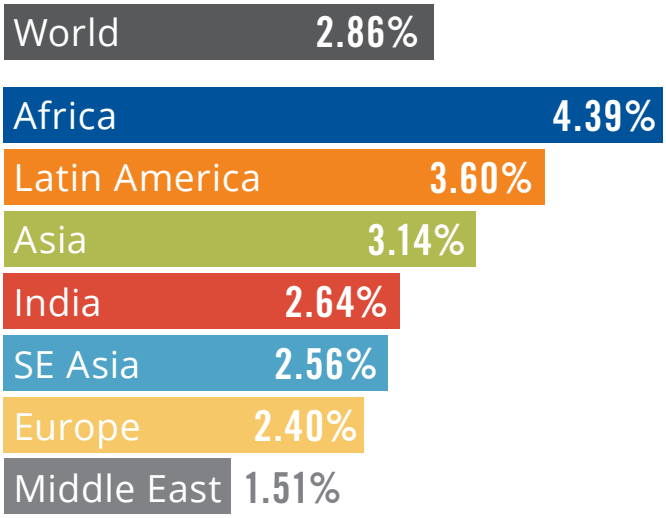
It is estimated that the size of the database to identify the first major genes that cause glaucoma in Africa will require DNA samples from 10,000 people. The Singaporean partnership should enable Duke to double the size of the current glaucoma genetics database and reach this goal in the next two years. A major accomplishment that has come out of the partnership is the recent discovery of gene variants that may lead to an entirely new treatment, or even a cure, for exfoliation syndrome, a common disorder associated with an aggressive form of glaucoma. Exfoliation syndrome affects an estimated 80 million people worldwide.

"We have worked for many years to identify the genes that are responsible for increasing our risk of glaucoma," Hauser says. "The next step is to understand: What is it about those genes—what is happening at the molecular level—that actually leads to the development of this disease? The answers can give us ideas for new therapeutic interventions to alter the disease process. Right now, there is no cure for glaucoma, but we hope this research partnership will bring us closer to finding one."

"We have worked for many years to identify the genes that are responsible for increasing our risk of glaucoma. The next step is to understand: What is it about those genes—what is happening at the molecular level—that actually leads to the development of this disease?

Michael Hauser, PhD

Estimated Percentage of Population with OAG and ACG combined in 2020



Adapted from: Table 5, Br J Ophthalmol. 2006 Mar; 90(3): 262–267. Reproduced at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1856963/

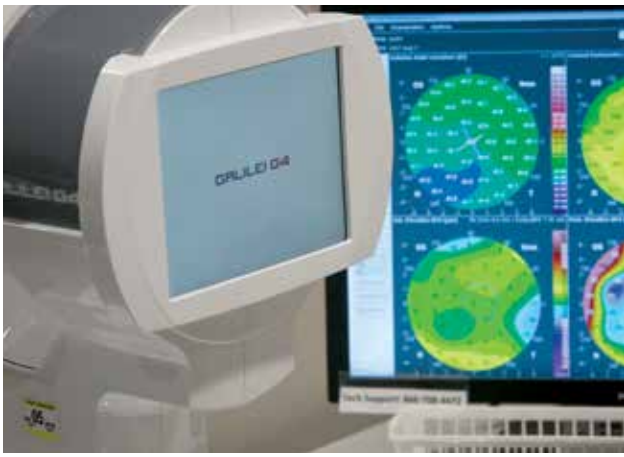
Duke Eye Center
Ophthalmic Medical Technician Program

During construction of the Hudson Building, the Duke Ophthalmic Medical Technician Program (OpTech) relocated to a School of Medicine space in the Duke Clinic. The program will soon be moving back home to Duke Eye Center, with a new and improved facility designed specifically for the OpTech program. It includes an additional practice lane that provides more equipment and time for students to hone their skills. The enlarged classroom offers much more comfortable didactic space and may allow for additional student capacity in the program. Updated audio-visual equipment opens the possibility of distant learning opportunities. The space also offers more flexibility for expanding the curriculum, creating staff development programs, and permitting more active and convenient participation by our faculty.

Deborah Smith, COMT, BSBA, director of the program is excited to move back to the Eye Center. "Our new facilities will be a wonderful learning environment, and I will be able to more easily observe the progress of our students. In addition, our dynamic faculty, fellows, residents, and staff generate powerful education energy, and I am looking forward to once again be in the midst of those who inspire me."

The Duke Ophthalmic Medical Technician Certificate Program is an excellent educational option for anyone desiring an in-demand, allied-health career. The program is accelerated, affordable, accessible, and fully accredited, which makes it attractive to career-minded individuals seeking an alternative to traditional college but demanding the quality education and training that our highly regarded Duke Eye Center faculty and staff can provide.

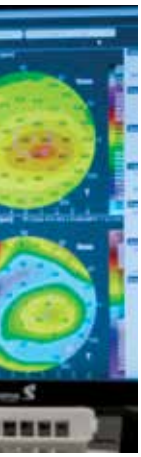
Lindsay Lawter, COT a 2015 graduate of the program has always known that she wanted to have a career that involved the eyes. Once she discovered the Duke OpTech program, she thought it would be a great fit. "Coming into the program, I didn't know anything about the eyes other than the fact that I found them interesting," says Lawter. "By the time, I graduated, I felt completely prepared to begin my career and it opened up a door for me to a job that I enjoy coming to every day," she adds.



To learn more about the **Duke OpTech** program, visit dukeeyecenter.duke.edu/optech.

Above: OpTech class of 2016 studying for an exam.

Right: OpTech students learning how to use Lenstar, an instrument that measures the shape and size of the eye, used to calculate the power of intraocular lenses (IOL) required for cataract surgery.




LENSTAR

Patience, Precision, and Pediatric Ophthalmology

Changing the Future of Patient Care at The Duke Pediatric Retina and Optic Nerve Center (DPROC)

BY LAUREN MARCILLIAT

Lejla Vajzovic, MD with a Duke Pediatric Retina Clinic patient.

As a vitreoretinal surgeon, Assistant Professor of Ophthalmology, Lejla Vajzovic, MD, excels in the virtue of patience. Unfortunately, many of her patients do not. Sitting through an eye examination can prove challenging for anyone. For pediatric patients that Vajzovic sees in the Duke Pediatric Retina and Optic Nerve Center (DPROC), however, it is more than just challenging—it's nearly impossible.

"Retinal diseases are common in kids," says Vajzovic, "but because of the challenge that examining children presents, particularly because of the complexity of performing retinal surgery and the precision required when operating on very small eyes, pediatric retinal specialists are very rare," she explains. Although she treats patients of all ages, Vajzovic is particularly passionate about working with children. In fact, the desire to establish a dedicated pediatric retinal clinic is one of the main reasons why she decided to stay at Duke and join the faculty after completing her vitreoretinal fellowship in 2013.

Vajzovic's passion was shared by the following individuals: Cynthia A. Toth, MD, professor of ophthalmology and biomedical engineering director and pediatric vitreoretinal surgeon, Sharon F. Freedman, MD, professor of ophthalmology and chief of pediatric ophthalmology and the strabismus service, who specializes in pediatric glaucoma and Mays A. El-Dairi, MD, assistant professor of ophthalmology who specializes in neuro-ophthalmology. Together, these four dynamic women founded the DPROC, making Duke Eye Center one of only a handful of medical centers in the U.S. with the resources to treat pediatric patients with retinal and optic nerve diseases.

The DPROC was established in large part because of the kind support from the Andrew Family Charitable Foundation. Its mission is to bring together specialists and resources to advance clinical care, research, and education, and to offer unique diagnostic information on the premature infant eye, brain diseases, and brain development, which will in turn support evaluation and implementation of novel therapeutics. The clinic is held in the pediatric section of Duke Eye Center. Vajzovic,

The Duke Pediatric Retina and Optic Nerve Clinic bring together a team of multi-disciplinary experts.
From left: Cynthia Toth, MD, Lejla Vajzovic, MD, Sharon Freedman, MD and Mays El-Dairi, MD.

Toth, Freedman and El-Dairi work together to diagnose and treat pediatric patients with a variety of conditions including retinopathies, retinal detachments, and retinal dystrophies. "As a junior faculty member, having access to world-class experts to consult with and bounce ideas off of is invaluable and leads to extremely stimulating work environment," says Vajzovic. "By working in close-proximity and sharing resources with one another, we can better manage complex cases and provide the best possible care to our patients," she adds.

Duke Ophthalmology has long been at the forefront of biomedical engineering and utilizing technology to enhance patient care. Advancements made here, such as microscopic-integrated intraoperative and 3D optical coherence tomography (OCT), have revolutionized patient care (learn more on page 10). The standard OCT technology has proven less useful, however, for pediatric patients because of the simple fact that children, particularly toddlers, often cannot hold still long enough for an image of the eye to be captured. Consequently, children often require sedation and taken to the operating room for a full exam, fundus and OCT imaging and surgical treatment if needed.

"There is a huge need for improvement in the way that our specialty diagnoses pediatric patients," says Vajzovic. "One of our main goals is to further develop the technology we use for our adult patients to better meet the needs of children and minimize their exposure to anesthesia and other risks."

Since the DPROC first began accepting patients in 2013, Vajzovic, Toth, Freedman, El-Dairi, and their team have seen over a thousand pediatric patients. Together, they are changing the standard of care for these individuals and leading the way in using technology to improve outcomes. Vajzovic knows that these changes won't happen overnight, but the groundwork has been laid, the key players are in place, and the future promise that the DPROC represents is something well worth working for.

2015 AAO Annual Meeting and Awards

Over 30 faculty and fellows from Duke Eye Center presented more than 70 instructional courses, skills transfer sessions, scientific posters and papers during the American Academy of Ophthalmology (AAO) 2015 annual meeting.

Sanjay Asrani, MD received the AAO Secretariat Award for special contributions and service to the Academy and ophthalmology.

Edward G. Buckley, MD, along with all his fellow Life Achievement Honor recipients, received the AAO Special Recognition Award which is presented for outstanding service in a specific effort or cause that improves the quality of eye care.

Michael P. Kelly, FOPS received the Achievement Award from the AAO Board of Trustees for his contributions to the Academy, it's scientific and educational programs and to ophthalmology. Mike is the first non-physician from Duke to win the award.

Dilraj Grewal, MD, vitreoretinal program fellow won best poster. Dr. Grewal is also the recipient of the 2015 Ronald G. Michels award that recognizes outstanding second-year vitreoretinal fellows in training.

Goldis Malek, PhD, Gargi Li, PhD, and **Mikael Klingeborn, PhD** received research grant awards for their research from Bright Focus Foundation which funds research worldwide on Alzheimer's disease, glaucoma, and macular degeneration.

Mays El-Dairi, MD, left, received a Knights Templar reseach award.

From left: Allingham, Tseng

R. Rand Allingham, MD and **Henry Tseng, MD, PhD** had a top ten paper at the 2015 American Glaucoma Society. This work describes a discovery made in a new mouse model of normal-pressure glaucoma and results from collaboration between ophthalmology, cell biology and neurobiology departments. The discovery may lead to clues on what causes glaucoma, and possibly a new way to diagnose glaucoma by imaging the retina. Due to this award, Allingham was invited to present this work at the World Glaucoma Congress 2015 in Hong Kong, on behalf of the American Glaucoma Society. In addition, the paper won one of the top ten papers at the World Glaucoma Congress.

Lejla Vajzovic, MD was selected to receive funding from Duke's Private Diagnostic Clinic (PDC) Enhanced Academics in a Basic Laboratory Environment (ENABLE) career development program. The ENABLE program provides 25% effort for up to two years to support your commitment as part of an effective and dynamic research team. Vajzovic's Knights Templar research award was renewed for 2016.

2016 ARVO Annual Meeting and Awards

Duke Eye Center researchers, fellows and residents presented moderated or led almost 60 sessions and were contributing authors for 45 sessions during the annual meeting of the Association for Research in Vision and Ophthalmology (ARVO).

Vasantha Rao, PhD received the 2016 Dr. Roger Vogel Award for Pharmaceutical Research. The award was presented at the 2016 ARVO annual meeting.

Daniel Stamer, PhD was elected to the ARVO board of trustees as the physicology/ pharmacology trustee. His term will last until 2020.

ARVO has established the **Dr. David L. Epstein Award.** The award was created by Dr. Eptsein's family in his honor. The award will be given annually to a well-established, internationally-recognized, senior level investigator with documented history of conducting eye and vision research in glaucoma. The first award of $100,000 was presented at the 2016 annual meeting.

Eleonora Lad, MD, PhD received the ARVO/Alcon Early Career Clinician-Scientist Research Award.

Mays El-Dairi, MD received a Knights Templar research award for her grant proposal "Using Optical Cherence Tomogrpahy to Eluidate Optic Nerve Development in Healthy Infants and Children."

Second year ophthalmology resident **Wenlan (Wendy) Zhang, MD,** whose research proposal titled "The Effect of Corneal Horizontal Diameter on Surgically-induced Astigmatism in Cataract Surgery," was selected to receive the 15th Annual Robert Machemer Resident Research Award. The award, established in 1999, recognizes a resident whose clinical or basic science research proposal demonstrates high intellectual curiosity and outstanding scientific originality, and has a significant impact on the clinical management of persons with ophthalmic disease. The award honors Robert Machemer, MD, a past chair of the Duke Department of Ophthalmology.

Leon Herndon, MD was selected to receive the Distinguished Medical Alumnus Award from the UNC School of Medicine. The award was presented during the 2016 Spring Alumni Weekend.

Sharon Freedman, MD, Xi Chen, MD Shwetha Mangalesh, Du Tran Viet, Alexandra Dandridge, Christian Viehland and Joseph Izatt, PhD, Cynthia Toth, MD won best poster for "Spectral Domain Optical Coherence Tomography (SDOCT) Imaging of the Vascular-Avascular Junction in the Nursery in Infants with Retinopathy of Prematurity" at the 2016 American Association for Pediatric Ophthalmology and Strabismus (AAPOS) meeting.

Scott Cousins, MD, Robert Machemer, MD Professor of Ophthalmology, received the Research Mentoring Award for Translational Research during the Duke School of Medicine 2016 Spring Faculty meeting. The award was presented by **Nancy C. Andrews, MD, PhD,** Dean of the School of Medicine and Vice Chancellor for Academic Affairs.

DUKE EYE CENTER CONTINUING MEDICAL EDUCATION

Duke Eye Center offers an extensive continuing education program that supports our community and beyond. Annual events include:

Ophthalmology Grand Rounds

Advanced Vitreous Surgery Course

The Stephen and Frances Foster Lecture

Controversies in Cornea and Cataract Surgery

Gordon Klintworth Distinguished Lecture

Spring Vision Quest

Duke Ophthalmology Trainee Day Scientific Session

Bryan Research Lecture

Duke Eye Center of Winston-Salem – McKinley Conference

Glaucoma Symposium

Medical Alumni Grand Rounds

Dastgheib Pioneer Lecture Award in Ocular Innovation

For dates or more information, please visit dukeeyecenter.duke.edu/cme or contact Renee Wynne, Events Director by email walla023@mc.duke.edu or phone 919-684-3937.

Thomas Devetski, OD

Thomas Devetski, OD joined Duke Eye Center as assistant professor of ophthalmology in November of 2015. Devetski specializes in routine and complex contact lens fittings for those with challenging issues such as irregular corneal conditions, dry eye, and presbyopia.

In addition to his unique skill set, Devetski brings years of experience in both academia and private practice to the Duke Eye Center team. Devetski obtained his undergraduate degree in Chemistry at Indiana University and his Doctor of Optometry at the Illinois College of Optometry. After graduation, he stayed in Chicago and joined a large, multi-specialty ophthalmology practice. A desire to teach led him to the University of North Carolina Medical School, where he served as Assistant Professor of Ophthalmology and Director for the Contact Lens Service for seven years. Prior to coming to Duke, he worked at a large private practice in Alamance County, North Carolina.

Devetski's passion for restoring vision for his patients is inspired by his personal experience. "I have myopia, or nearsighted vision, which hurt my ability to play sports and function in school as a child," he explains. "Seeing an eye doctor changed my life," he adds. "The Duke Eye Center is a world leader in eye care and attracts patients with extremely complex issues, many of whom see Duke as a 'last chance' for successful treatment. It is a distinct privilege to watch elated patients see clearly again for the first time in years thanks to the treatment that our practice provides."

Nicola Maria Kim, MD

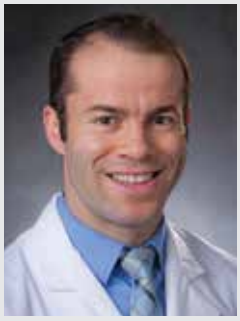
Nicola Maria (née Selig) Kim, MD joined Duke Eye Center as an associate professor of ophthalmology in September of 2015. Kim specializes in routine and complex cataract surgery. She has a talent for providing personalized results for cataract patients that take into account other eye diseases or lifestyle limitations.

Kim's passion for clinical volunteer work, which has led her to both India and Romania, has given her a unique perspective on the enormous impact that basic vision restoration can have on both the individual and the greater community. She hopes to continue to volunteer her time to global health initiatives in the future.

Kim earned a major in theology, a minor in biology, and her Doctor of Medicine at Georgetown University. She completed an internship in general surgery at the University of Texas Southwestern Medical Center, and a postdoctoral fellowship at Lombardi Cancer Center at Georgetown University. She returned to Dallas to complete her residency in ophthalmology at the University of Texas Southwestern Medical Center, and subsequently worked for two years in private practice.

For the past 13 years, Kim has worked as an Associate Professor at The University of Arkansas for Medical Sciences and Practice Director at the Jones Eye Institute. Her unique combination of experience and expertise make her an invaluable new addition to our team. "Joining Duke is a dream come true," says Kim. "The Duke Eye Center is one of the premiere eye-care institutions in the world, and I feel privileged to be part of it."

Ilya Leyngold, MD



The newest member of the Duke Eye Center team, **Ilya Leyngold, MD** began his tenure as assistant professor of opthalmology at Duke in March of 2016. Leyngold, who specializes in orbital and oculofacial plastic and reconstructive surgery, comes to Duke from the University of South Florida Morsani College of Medicine, where he served as Director of Oculofacial Plastic Surgery for four years. During this period, Leyngold performed over five thousand procedures and pioneered new techniques for periorbital reconstruction.

Leyngold obtained his medical degree from Johns Hopkins University School of Medicine, and completed his ophthalmology residency at The Wilmer Eye Institute at Johns Hopkins Hospital. Subsequently, he completed a two-year fellowship program in oculofacial plastic and reconstructive surgery in Salt Lake City, Utah through the American Society of Ophthalmic Plastic & Reconstructive Surgery (ASOPRS).

Leyngold has a great deal of experience in treating patients with orbital tumors, eyelid and facial skin cancer, thyroid eye disease and facial aging. "I am particularly passionate about eyelid and facial reconstructive and cosmetic surgery," says Leyngold. "I enjoy the variety that it offers, and it allows me to use my creativity to achieve the best functional and aesthetic results." He hopes to one day to found a national center for orbital disease, adnexal oncology, and complex periorbital reconstruction. Leyngold is excited to be part of such a collegial team of professionals and looks forward to growing his practice and furthering his research at Duke.

Gargi K. Vora, MD

Gargi K. Vora, MD, a Duke Corneal Fellowship trained ophthalmologist specializing in the medical and surgical treatment of the cornea, lens, and anterior segment diseases. She performs advanced corneal transplantation procedures, and is well versed in the newest refractive vision correction and cataract surgery techniques.

Vora completed her fellowship in Cornea, External Disease & Refractive Surgery at Duke in 2015, and was hired to stay on as assistant professor of ophthalmology. "I chose Duke for my fellowship because of its reputation for providing world class academic ophthalmology and in-depth comprehensive surgical teaching," says Vora. "I stayed on because of the people," she continues. "The faculty, staff, and technicians are wonderful colleagues, and it is a pleasure to work with them every day."

Prior to coming to Duke, Vora pursued her ophthalmology residency at Harvard University, and earned her medical degree at Johns Hopkins University School of Medicine. She completed her Bachelor of Science in Brain & Cognitive Sciences at the Massachusetts Institute of Technology.

Vora has a special clinical and research interest in ocular surface growths and tumors. Her research focuses on novel ways to image and diagnose these tumors, as well as to understand the risk factors that contribute to the disease process. As a new faculty member at Duke Eye Center, she aims to improve prevention, early diagnosis, and find new and better ways to treat these diseases.

2015–2016 RESIDENTS

Chief Resident:
Varsha Manjunath, MD

Third-Year Residents

Jaya Badhwar, MD
Ramiro Maldonado, MD
Patrick Oellers, MD
Brad Wainright, MD
Wendy Zhang, MD

Second-Year Residents

Duncan Berry, MD
Michelle Kim, MD
Andrew Lee, MD
Landon Meekins, MD
Nambi Nallasamy, MD
Sally Ong, MD

First-Year Residents

Amy Tong, MD
Atalie Thompson, MD MPH
Kay Liu, MD, PhD
Morgan Godin, MD
Ryan Constantine, MD PhD
Tanya Glaser, MD

2015–2016 FELLOWS

Derek Bitner, MD
Xi Chen, MD, PhD
Garrett Frank, MD
Dilraj Grewal, MD
Divakar Gupta, MD
Kim Jiramongkolchai, MD
Tanya Khan, MD
Debbie Kuo, MD
Erin Lally, MD
Nicole Langelier, MD
Maria Lim, MD
Milica Margeta, MD PhD
Ashiyana Nariani, MD MPH
Peter Nicholas, MD
Veena Rao, MD
Michael Seider, MD
Christine Shieh, MD, MD
Scott Walter, MD
James Weightman, MD

Duke Eye Center Administration, Faculty and Staff

FACULTY LEADERSHIP

Edward G. Buckley, MD	Chair, Department of Ophthalmology Vice Dean of Medical Education, Duke University School of Medicine
Alan N. Carlson, MD	Vice Chair, Development
Scott W. Cousins, MD	Vice Chair of Research Director, Translational Research Program Director, Center for Macular Diseases Director, Ophthalmic Imaging
Eric A. Postel, MD	Vice Chair, Clinical Affairs and Chief, Ambulatory Eye Surgery
David K. Wallace, MD, MPH	Vice Chair, Clinical Strategic Planning, Director, Clinical Research Unit
Vadim Arshavsky, PhD	Scientific Director of Research
Sanjay Asrani, MD	Medical Director, Duke Eye Center of Cary
Pratap Challa, MD	Director, Residency Program
Sharon Fekrat, MD, FACS	Associate Chief of Staff Durham VA Medical Center
Preeya Gupta, MD	Medical Director, Duke Eye Center at Page Road
Glenn J. Jaffe, MD	Director, Duke Reading Center
Kelly Muir, MD, MHSc	Director, Fellowship Program Chief, Division of Ophthalmology, Durham VA Medical Center
Diane B. Whitaker, OD	Director, Optometry Education
Catherine Bowes Rickman, PhD	Director, Third-Year Medical Student Program
Jullia A. Rosdahl, MD, PhD	Director, Patient Education
Tina Singh, MD	Director, Second- and Fourth-Year Medical Student Program
Cynthia A. Toth, MD	Chair, Department APT Committee
Robin R. Vann, MD	Medical Director, Perioperative Services
Julie A. Woodward, MD	Director, Public Education Program Faculty Liaison Director, Ophthalmic Technician Program

ADMINISTRATION

Adrienne Lloyd, MHA, FACHE	Chief Administrator
Elizabeth Hunter, MHA, CFM	Director of Finance
Heidi Campbell, COT	Health Center Administrator, Satellites
Evelyn Kelly, COA	Health Center Administrator, Main Campus
Martha Wilson, MHA	Health Center Administrator, Winston-Salem
Tori Hall	Director, Marketing and Communications
Robert Hayford, MBA	Administrative Manager
Jillian Ream	Director, Development
Brooke Marchetti, CRA	Senior Grants and Contracts Manager
Michael Flintosh, MBA	HR Manager
Renee Wynne	Program Director, Continuing Medical Education Program Director, Special Events

COMPREHENSIVE OPHTHALMOLOGY

Anna Bordelon, MD	Assistant Professor of Ophthalmology
Thomas Devetski, MD	Assistant Professor of Ophthalmology
Anupama Horne, MD	Assistant Professor of Ophthalmology
Thomas Hunter, MD	Assistant Professor of Ophthalmology
Nicola Kim, MD	Associate Professor of Ophthalmology
John T. Petrowski III, OD, FAAO	Assistant Professor of Ophthalmology
Laurie K. Pollock, MD	Assistant Professor of Ophthalmology
Dianna Seldomridge, MD	Assistant Professor of Ophthalmology
Tina Singh, MD	Assistant Professor of Ophthalmology
Robin R. Vann, MD	Assistant Professor of Ophthalmology Division Chief

CORNEA AND REFRACTIVE SURGERY

Christopher S. Boehlke, MD	Assistant Professor of Ophthalmology
Alan N. Carlson, MD	Professor of Ophthalmology
Melissa Daluvoy, MD	Assistant Professor of Ophthalmology
Preeya Gupta, MD	Assistant Professor of Ophthalmology
Terry Kim, MD	Professor of Ophthalmology Division Chief
Anthony Kuo, MD	Assistant Professor of Ophthalmology
William Rafferty, OD	Assistant Professor of Ophthalmology
Terry Semchyshyn, MD	Assistant Professor of Ophthalmology
Gargi Vora, MD	Assistant Professor of Ophthalmology

GLAUCOMA

R. Rand Allingham, MD	Richard and Kit Barkhouser Professor of Ophthalmology
Sanjay Asrani, MD	Professor of Ophthalmology
Pratap Challa, MD	Associate Professor of Ophthalmology
Sharon F. Freedman, MD	Professor of Ophthalmology Professor in Pediatrics ++
Leon W. Herndon, MD	Professor of Ophthalmology Division Chief

Jill B. Koury, MD	Assistant Professor of Ophthalmology
Stuart J. McKinnon, MD, PhD	Associate Professor of Ophthalmology Associate Professor in Neurobiology ++
Frank J. Moya, MD	Assistant Professor of Ophthalmology
Kelly W. Muir, MD	Associate Professor of Ophthalmology
Jullia A. Rosdahl, MD, PhD	Assistant Professor of Ophthalmology
Henry Tseng, MD, PhD	Assistant Professor of Ophthalmology
Molly M. Walsh, MD, MPH	Assistant Professor of Ophthalmology
Carol Ziel, MD	Assistant Professor of Ophthalmology

LOW VISION REHABILITATION SERVICE

Diane B. Whitaker, OD	Assistant Professor of Ophthalmology Division Chief

NEURO-OPHTHALMOLOGY

M. Tariq Bhatti, MD	Division Chief Professor of Ophthalmology and Professor in Medicine
Edward G. Buckley, MD	James P. and Heather Gills Professor of Ophthalmology Chair, Department of Ophthalmology
Mays El-Dairi, MD	Assistant Professor of Ophthalmology

OCULOFACIAL SURGERY

Parag D. Gandhi, MD	Assistant Professor of Ophthalmology
Ilya Leyngold, MD	Assistant Professor of Ophthalmology
Jason Liss, MD	Assistant Professor of Ophthalmology
Julie A. Woodward, MD	Associate Professor of Ophthalmology Associate Professor in Dermatology ++ Division Chief

PEDIATRIC OPHTHALMOLOGY AND STRABISMUS

Edward G. Buckley, MD	James P. and Heather Gills Professor of Ophthalmology Professor of Pediatrics Chair, Department of Ophthalmology
Mays El-Dairi, MD	Assistant Professor of Ophthalmology
Laura B. Enyedi, MD	Associate Professor of Ophthalmology Associate Professor in Pediatrics ++
Sharon F. Freedman, MD	Professor of Ophthalmology Professor in Pediatrics ++ Division Chief
S. Grace Prakalapakorn, MD, MPH	Assistant Professor of Ophthalmology
Yos Priestley, OD, FAAO	Assistant Professor of Ophthalmology
David K. Wallace, MD, MPH	Professor of Ophthalmology Professor in Pediatrics ++

VITREORETINAL DISEASES AND SURGERY

Scott W. Cousins, MD	Robert Machemer, MD, Professor of Ophthalmology Professor in Immunology ++
Sharon Fekrat, MD, FACS	Professor of Ophthalmology
Glenn J. Jaffe, MD	Robert Machemer, MD, Professor of Ophthalmology Division Chief
Eleonora Lad, MD, PhD	Assistant Professor of Ophthalmology
Tamer Mahmoud, MD, PhD	Associate Professor of Ophthalmology
Priyatham Mettu, MD	Assistant Professor of Ophthalmology
Eric A. Postel, MD	Professor of Ophthalmology
Stefanie G. Schuman, MD	Assistant Professor of Ophthalmology
Cynthia A. Toth, MD	Professor of Ophthalmology Professor in Biomedical Engineering ++
Lejla Vajzovic, MD	Assistant Professor of Ophthalmology

RESEARCH OPHTHALMOLOGY

Vadim Arshavsky, PhD	Helena Rubinstein Foundation Professor of Ophthalmology Professor in Pharmacology & Cancer Biology ++ Scientific Director
Sina Farsiu, PhD	Associate Professor of Biomedical Engineering Assistant Professor in Ophthalmology++
Paulo Ferreira, PhD	Associate Professor of Ophthalmology Associate Professor in Pathology ++
Pedro Gonzalez, PhD	Associate Professor of Ophthalmology Associate Professor in Pathology ++
Jeremy Kay, PhD	Assistant Professor of Neurobiology Assistant Professor in Ophthalmology
Paloma Liton, PhD	Associate Professor of Ophthalmology Assistant to Associate Professor in Pathology
Goldis Malek, PhD	Associate Professor of Ophthalmology Assistant to Associate Professor in Pathology
P. Vasantha Rao, PhD	Professor in Ophthalmology Professor in Pharmacology & Cancer Biology ++
Catherine Bowes Rickman, PhD	Associate Professor of Ophthalmology Associate Professor in Cell Biology ++
Daniel Saban, PhD	Assistant Professor of Ophthalmology
Nikolai Skiba, PhD	Associate Professor in Ophthalmology
W. Dan Stamer, PhD	Joseph A.C. Wadsworth Research Professor of Ophthalmology
Sandra Stinnett, DrPH	Assistant Professor of Biostatistics & Bioinformatics Assistant Professor in Ophthalmology ++

Secondary appointment ++

Duke Eye Center

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DUMC 3802 Durham, NC 27710

dukeeye.org

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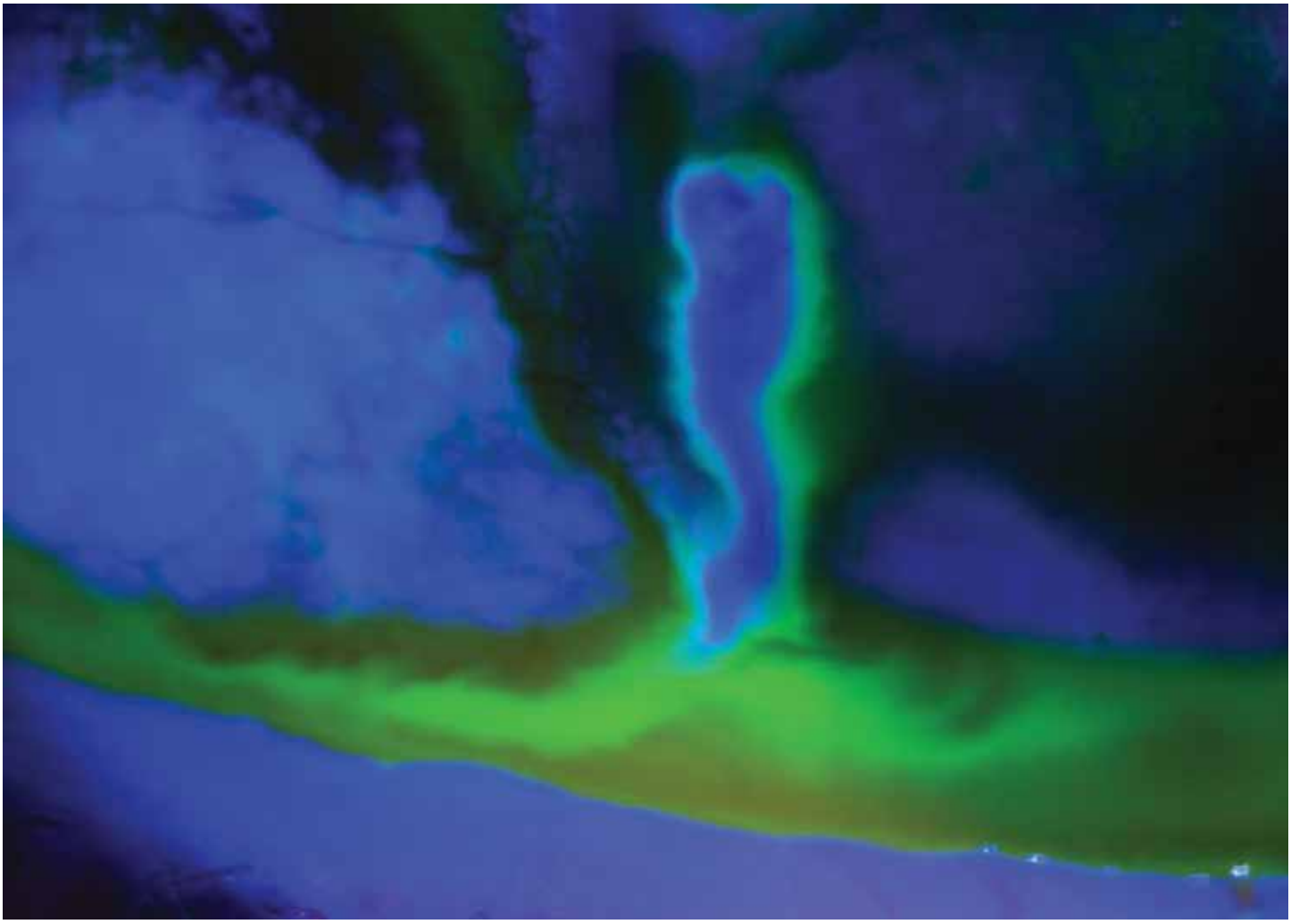

Corneal perforation imaged using the Seidel test technique. Image by Michael P. Kelly, FOPS.