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Foreword

BY BRUCE J. MARKOVITZ, MD

The Thomas Duane Ophthalmology Society (TDOS), founded at Jefferson over 30 years ago, honors the great ophthalmologist Thomas David Duane, MD, PhD. It provides a place for medical students with a mutual interest in ophthalmology to meet, share educational events, and engage in ophthalmology related community service. It has grown from my time as President in 1987, when I had to roam the corridors of Alumni Hall begging friends and strangers to come hear Dr. Jerry Shields speak after he graciously agreed to address our group, into an extraordinarily successful organization attracting 50 to 75 students to each event.

Over the years TDOS has always provided the opportunity for Jefferson medical students to experience ophthalmology as a potential career choice. Now, through inSIGHT, students have a creative outlet to explore ophthalmology by interacting intimately with the great mentors at Wills Eye and to then share their discoveries with others. We thank the world-renowned staff at Wills Eye for sharing their personal reflections and expertise with our students.

This second volume of inSIGHT once again offers up a wonderful selection of articles taking the reader on a captivating tour of ophthalmic topics sampling the diversity of ophthalmology. From the origins of the Wills Eye Manual to cataract surgical techniques in third world countries reversing blindness for millions to the cutting-edge technologies being used to restore and preserve vision at Wills, you are bound to find something that interests you. Whether you are a medical student, a resident, an ophthalmologist, or just a curious lay person, I know you will enjoy the works of these creative student writers as they share their stories with you. Given Dr. Duane's passion for education and literature, it is only fitting that his name be associated with this second edition of the inSIGHT journal.

About

THE JOURNAL

inSIGHT is a student-run, non-peer reviewed journal established by the Thomas Duane Ophthalmology Society to highlight the innovative ophthalmic research, procedures, and faculty at Wills Eye Hospital and Thomas Jefferson University. inSIGHT aims to promote student interest in ophthalmology by supporting peer authors to report on diverse aspects of the field, through editorial and opinion pieces. inSIGHT is proud to present its second issue.

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A New Dimension to Offer

By Ari August, BS | Faculty Reviewer: Allen C. Ho, MD

Technological advancements are crafted, fielded, and sold from the vantage point of benefit: How can this make my life better? The origins of three-dimensional (3D) technology are no different. 3D technology targets the mind's ability to make sense of two different angles of an image, and therefore perceive depth. Earlier models, common in movie theaters and cereal box toys, utilized red and blue lenses to outwit one's perception of a flat image and project it into 3D images, promising deeper immersive experiences and even "x-ray vision." More recently, the capacity of 3D technology has expanded, as seen with the recent virtual reality craze in the entertainment field. The ability to use software to create physical objects within 360-degree experiences allows users to not only observe a high-fidelity experience but also actively manipulate projected surroundings. Beyond the entertainment industry, virtual reality has also been utilized to improve educational outcomes[1] through real-time 3D visualization of 3D structures, showing great potential for positive impact on student, physician, and patient lives.

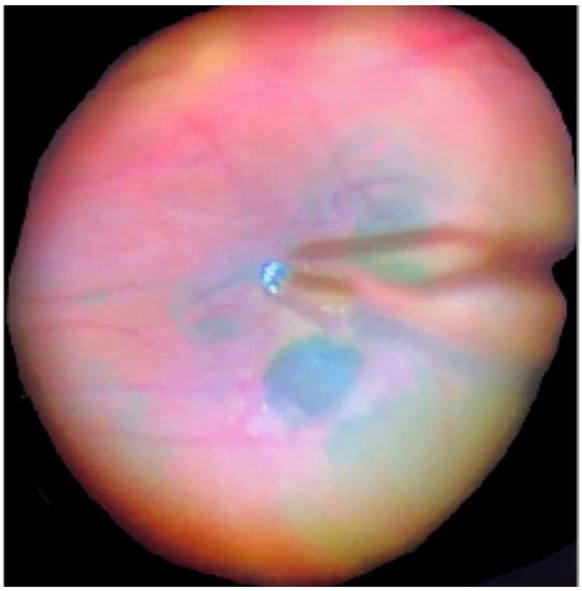

Figure 1. *2D digitized visualization of an indocyanine green dye-assisted macular peel from a standard operating microscope.*

Within the field of ophthalmology, the incorporation of 3D visualization technology aims to improve on limitations with current methods used to visualize structures within the eye during surgery. High-quality visualization of intraocular structures is required for examination, diagnosis, and surgery. According to Wills Eye Hospital vitreoretinal (VR) surgeon Dr. Allen C. Ho, visualization is also "an unmet need" in retinal surgery. The traditional method of visualizing the eye during surgery is a Standard Operating Microscope (SOM),[2] which provides bifocal 2D visuals using classical optics. This microscope has a split ocular, allowing for visualization of the surgical field by two individuals simultaneously, and can digitally project the surgical field onto a screen for recording or observation purposes. However, the digital monitors of the projected images are located away from the surgical field,[3] putting students far from instruction, narration, and the ability to ask questions. Furthermore, this method of traditional microscopic visualization comes with "limitations in field of view, color, contrast

and sharpness."[4] Compared to images seen directly through SOM oculars, the brightness, resolution, and colorization of projected digital images (Figure 1) suffer.[3] Overall, these limitations diminish the potential for learning and visualization.[5] In current 3D visualization systems for ophthalmic surgery, two cameras attached to an operating microscope will send their signals to a central processor that will transmit an image onto a monitor, which can be viewed by surgeons wearing polarized glasses so that they may appreciate the 2D image in 3D (Figure 2). This technology lends to an immersive experience in the operating room for all those present (Figure 3).

3D visualization technology enhances visibility with the real time use of computed filters. Just as a digital photograph may be artificially augmented to emphasize contrast or warmer tones for the sake of consumer experience, the application of a filter allows for increases in image saturation, especially of green tones, which promotes better visualization of stained regions (Figure 4).[6] Furthermore, the ability to adjust gain and brightness on the end of the digitization rather than a light source have led to an improved ability to sufficiently highlight the retina with an extra-globular light source used as a scleral depressor.[3] Finally, while SOMs sacrifice some light to the dual oculars for surgeon/observer viewing, lowering the digital image's quality, 3D technology removes the use of oculars, thereby decreasing the risk of light loss,[3] which enhances the digital image (Figure 4). Thus, the benefits for visualization with 3D digital augmentation can provide unique benefits for both VR surgeons and patients.

3D technology in VR surgeries not only improves visualization but also decreases risk for phototoxicity. Due to its location and requisite viewing through anterior ocular structures, visualization of the posterior segment requires specific posterior segment illumination, which may increase risk for phototoxicity. The retina is typically protected from phototoxicity

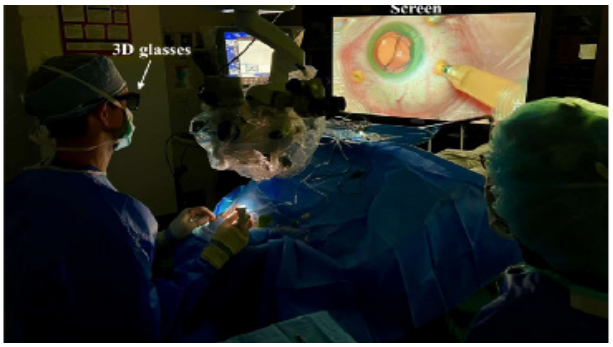

Figure 2. *Dr. John Hinkle (retina fellow at Mid Atlantic Retina) removes silicon oil via vitrectomy using the NGenuity Alcon 3D visualization system. The fellow is wearing polarized glasses to appreciate the 2D image transmitted through a central processor onto a screen in 3D.*

by pigments and antioxidants present in the cornea, lens, uvea, and retina that act to absorb wavelengths of electromagnetic energy to prevent excitation and damage.[7] Upon exceeding a phototoxicity threshold, the retinal epithelium, choroid, and outer segments of the eye are at risk of damage because of non-extensive repair mechanisms, which may result in permanent insult to retinal function.[7] Such phototoxic retinopathy may result from thermal, mechanical, or photochemical damage,[8] including that which is caused by SOM light.[9] It has been found that even with maximal precautions taken with

light sources during SOM VR surgeries, endoillumination can be unsafe with respect to retinal phototoxicity.[10] This is especially of concern during vitrectomy when light from a source does not pass through the lens, and the threshold of safety is surpassed with even just one minute[10] of exposure to most commercial light sources. However, because of the electronic processing functions of 3D visualization, minimum endoillumination during 3D VR surgeries was found to be significantly lower compared to SOM surgeries,[2] lowering the risk of phototoxicity.

VR surgeons also report greater satisfaction with the use of 3D visualization in surgery. Dr. Ho emphasizes the advancement of this technology on functional aspects of "magnification, focus, depth of field, zoom, the ability to focus on something in the macula but also see its effects on the periphery."[5] VR surgeons are also able to overlay ocular computerized tomography intraoperatively to promote surgical decision making.[11] Additionally, 3D technology has been found to provide ergonomic benefit compared to SOM surgical methods.[2,3,12] The wide-angle stereoscopic view of 3D visualization as well as additional freedom of movement and positioning with use of 3D glasses (Figure 2) provides an added benefit of "freeing the surgeon from the physical confines of [SOM] eyepieces"[2] so they can operate with proper ergonomics. This is especially of importance to VR surgeons, who have high rates of spinal pain, possibly due to the frequent adoption of poor body mechanics.[13]

As with any new advancement in a field, enthusiasm for 3D visualization technology is not universal. There is no surprise that shiny new technology comes with a shiny new price tag, but surprisingly, there is a lack of discourse surrounding cost-effective evaluation of 3D surgery. A lack of use, however, is evident. Only half of the training institutions with access to an NGenuity Alcon 3D surgical system, the current 3D technology system used by VR surgeons, have ever used it![14] This discouraged use may be due to the observation of a lag between a user's actions and the feedback shown on the screen. However, one study found the latency of the system to be 70ms, which was detectable by 0% of users during internal limiting membrane peeling and 4% of users during external suturing.[14] For both actions, there were no clinical implications of the 70ms lag.[4,14] The lack of use may also be due to a perceived learning curve, which is often thought to be much more difficult to adapt to than research suggests. Some studies report proficiency after one day's cases.[15] Dr. Ho also expresses, "I think people will become adept and adapt very quickly, faster than they think they will."[5] He adds that fellows under his teaching adapt to the technology after just a couple of cases with it.[5]

Despite some hesitancy, the future of 3D VR surgery still provokes enthusiasm for what may come. VR surgeons who utilize 3D visualization technology openly encourage its expansion, even creating best practice tips and guides to help facilitate an easier transition and more rapid learning curve.[15] Some individuals are excited by findings of improved vitrectomy[16] or the potential of

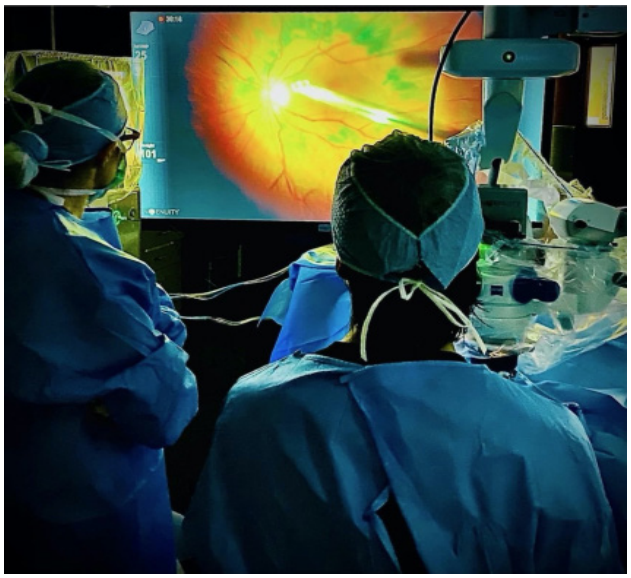

Figure 3. *Dr. Allen C. Ho performing retinal surgery using the NGenuity Alcon 3D visualization system.*

more safe and efficient procedures,[11] and others are hopeful that 3D VR surgery may be a gateway to "telesurgery"[17] in which a surgeon can operate, via joystick, from anywhere in the world. And even in the shadow of science fiction in near reach, some individuals might just be holding onto the possibility of 3D observation experiences helping them perform better on anatomy examinations.[18] Regardless, the future of 3D VR surgeries are sure to remain in sight.

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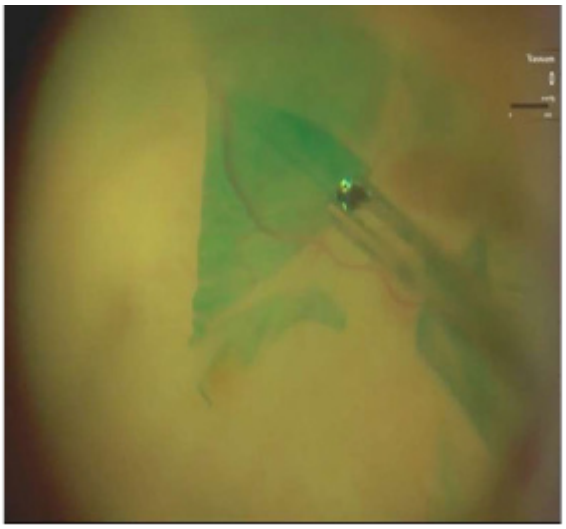

Figure 4. *3D digitized visualization of an indocyanine green dye-assisted epiretinal membrane and internal limiting membrane peel from an Ngenuity Alcon 3D visualization system.*

Neuro-Ophthalmology Subspecialty Highlight: With Dr. Sarah Thornton, Wills Eye Hospital

By Joseph D. DeSimone, BS | Faculty Mentor: Sarah Thornton, MD

Introduction

Neuro-Ophthalmology is a subspecialty within ophthalmology that combines the complexities of nervous system disease with the intricacies of the ocular manifestations of those diseases. Neuro-ophthalmologists work closely with neurologists, neurosurgeons, rheumatologists, and other ophthalmologists in different subspecialties, such as retina and glaucoma, to get to the source of their patients' problems. Neuro-ophthalmology is typically a 1-year fellowship undertaken after residency training is completed, where physicians will learn the complex ways different diseases can manifest in the eye.

A typical day in the Neuro-Ophthalmology clinic varies, but usually involves managing patients with various diseases such as Myasthenia Gravis, Multiple Sclerosis, Optic Neuritis, Giant Cell Arteritis, Thyroid Eye Disease, and many others. A thorough history is essential for diagnosing these patients, as subtle details can give hints into the etiology of a patient's disease. Some common symptoms of neurologic disease include diplopia, sudden or transient vision loss, blurry vision, ptosis, headaches, or cranial neuropathies. A rigorous physical exam requires measuring visual acuity, visual fields, eye pressure, proptosis, extra-ocular

Dr. Sarah Thornton is an attending in the Neuro-Ophthalmology service at Wills Eye Hospital. She attended Sidney Kimmel Medical College, where she decided to pursue ophthalmology after rotating through the Wills Emergency Room as a third-year student: "I found the pathology so fascinating and the patients so grateful for an explanation and treatment of their eye condition. I also wanted to learn how to use this mysterious slit lamp device, which provided a direct view of the pathology in real time." After graduating from SKMC, Dr. Thornton pursued a residency in ophthalmology at Tufts Medical Center. She recalls being exposed to the "bread-and-butter" of ophthalmology, as well as interesting subspecialty clinics and time in the operating room. She enjoyed living in Boston, and discussed that Tufts has a dynamic balance of faculty supervision and autonomy that fostered her independent learning. A word of advice from Dr. Thornton: "When choosing a residency, I think it's helpful to think about your own values and prioritize the most important things for you, whether that be location, surgical volume, etc., and try to find a good fit." After graduating residency, she returned to Philadelphia for a Neuro-Ophthalmology fellowship under the guidance of Drs. Robert Sergott, Mark Moster, and Adam Debusk. She chose to pursue Neuro-Ophthalmology because she "always found those cases most interesting during residency and appreciated the analytical reasoning required to diagnose these challenging cases", and she "continues to be amazed by the diversity of pathology in the field." (Figure 1).

"When choosing a residency, I think it's helpful to think about your own values and prioritize the most important things for you."

Dr. Sarah Thornton
Figure 1

muscle ranges of motion, color vision, pupil responses to light and accommodation, as well as performing a slit lamp examination or using direct or indirect ophthalmoscopy. Diagnostic testing can involve a variety of imaging and lab tests depending on the patient. Imaging typically includes optical coherence tomography (OCT), visual field testing, computed tomographic (CT) or magnetic resonance imaging (MRI) scanning of the brain and orbits, and sometimes fluorescein angiography, electroretinography, and ocular ultrasound. Lab orders can also aid in diagnosing specific diseases, and some common tests used by neuro-ophthalmologists include inflammatory markers C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR), disease-specific antibodies in the serum, or genetic testing for rare hereditary diseases affecting vision, such as Leber's Hereditary Optic Neuropathy.

Clinical Pearls

Dr. Thornton shared some clinical pearls that medical students can use in clinical rotations in neurology and ophthalmology and beyond in clinical practice.

1. Pupillary Light Reflex: The pupillary response to light is a complex process but can give you great detail when evaluating a challenging neurological patient. Physicians test to see if the pupils are responding to light appropriately, and if the pupils appear symmetric or asymmetric. Normally, when light is shone into one eye, the retina will send a signal via the optic nerve (cranial nerve II) to both pretectal nuclei in the midbrain, which activate bilateral Edinger-Westphal nuclei, sending signals via both oculomotor nerves (cranial nerve III) to the sphincter pupillae muscles, resulting in bilateral pupillary constriction. If there is an asymmetric issue along the pathway, you will see a relative afferent pupillary defect, or RAPD, which occurs when the eyes dilate in response to light. RAPDs can be seen in a variety of diseases and lesions along the pathway to the brain, and some common etiologies include optic neuritis, ischemic optic neuropathy or compressive optic neuropathy, although

RAPD can sometimes be seen with severe asymmetric retinal disease.

The Swinging Flashlight test is used to look for a RAPD. To perform this test, the examiner will shine light into one eye to attain maximum constriction, then quickly switch the light source to the other eye and back again. Normally, the second eye should respond with the same pupillary constriction as the first eye as a result of the consensual response. If the eye does not respond at all to the light source and remains dilated, then there should be concern for optic nerve damage. Light shone in the unaffected eye will cause both eyes to constrict. Conversely, light shone in the affected eye will cause both eyes to dilate (Figure 2).1 This is also termed a Marcus Gunn Pupil.

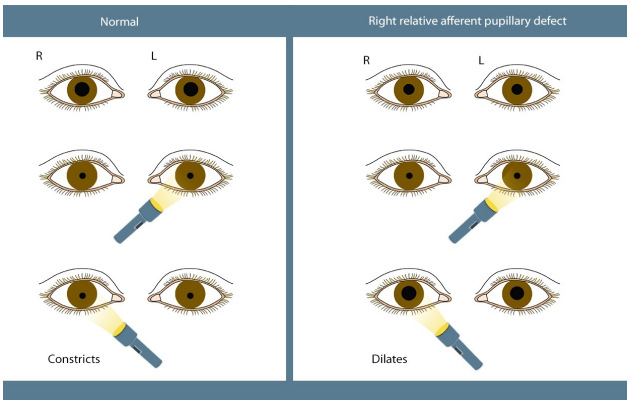

Figure 2

2. Bell's Palsy Examination: Bell's palsy is idiopathic inflammation and dysfunction of the peripheral facial nerve (cranial nerve VII) that results in facial weakness or paralysis that typically affects one side of the face.[2] Patients with Bell's Palsy will have unilateral facial drooping, drooling, difficulty closing the eye on the affected side, and difficulty smiling. Bell's palsy can limit the ability to blink, which can lead to painful corneal irritation and dryness leading to damage and vision problems. Evaluation of Bell's Palsy involves asking the patient to perform the following movements to test cranial nerve VII function and to differentiate an upper and lower facial nerve lesion:

- "raise your eyebrows" → affected side will not show forehead wrinkling and brow furrowing
- "smile" → affected side will have a flat facial contour
- "puff out your cheeks" → affected side will not be able to expand relative to the unaffected side
- "forcefully close your eyes" → affected side will not be able to fully close their eyes due to weakness of the frontalis muscle
- "stick out your tongue" → to check for lesions to the hypoglossal nerve (cranial nerve XII), will deviate toward affected side of nerve injury
- stroke forehead, upper face, and lower face bilaterally → to check for lesions to the ophthalmic (V1), maxillary (V2), and mandibular (V3) divisions of trigeminal nerve (cranial nerve V) sensations, respectively

Clinical Challenge

A 28-year-old woman with a past medical history of obesity, type 2 diabetes mellitus, obstructive sleep apnea, and migraines since childhood presented to the Wills Eye Hospital Emergency Department with one month of positional headaches, transient visual obscurations, and blurry vision in her right eye (OD). The best corrected visual acuity was 20/200 OD and 20/60 in her left eye (OS) with a 2+ APD OD. She had full color plates but was

slower OD. Fundoscopic exam revealed bilateral disc edema. Magnetic resonance imaging of the brain and orbits revealed slight protrusion of both optic nerves and a partially empty sella. MRV showed short segment stenoses at the bilateral transverse sigmoid sinuses. She was unable to undergo bedside lumbar puncture (LP) and was admitted for IV acetazolamide (Diamox) and a fluoroscopy-guided LP. The LP had an opening pressure of 46 cm H2O. Results of cerebral spinal fluid analysis and serology tests were negative

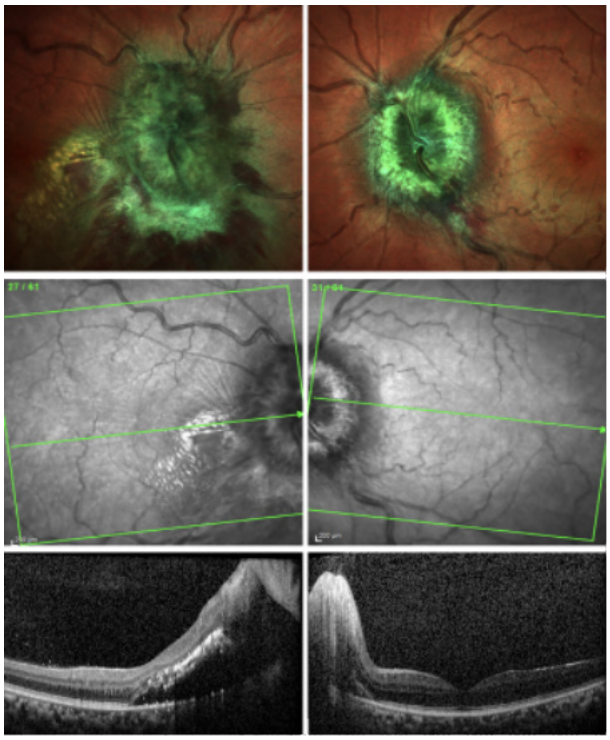

Figure 3

for infectious and inflammatory etiologies, including syphilis, sarcoidosis, Lyme disease, and tuberculosis. Serum studies revealed sickle cell trait and a hemoglobin A1c of 6.8%. She was discharged and was to continue Diamox 1 gram three times per day.

One week later in the Neuro-ophthalmology clinic, she underwent OCT (shown below, Figure 3). OCT showed severe bilateral disc edema, OD worse than OS. There was retinal nerve fiber layer (RNFL) edema extending into the fovea with exudates, chorioretinal folds, and peripapillary hemorrhages OD. Left eye showed RNFL edema with early tracking not extending beyond the prepapillary region, Paton's lines, and peripapillary hemorrhages. Inferior nerve thickness was 445 µm OD and 426 µm OS.

What is the next best step in the management of this patient?

A. continue Diamox and suggest weight loss
B. prescribe Dorzolamide-Timolol eye drops
C. consult Neurosurgery for placement of a ventriculoperitoneal shunt
D. consult Glaucoma for tube shunt placement

Answer: C

Discussion

The differential diagnosis for papilledema includes idiopathic intracranial hypertension, intracranial mass, obstructive hydrocephalus, meningitis, or cerebral venous sinus thrombosis.[3] This patient was diagnosed with pseudotumor cerebri (PTC), also known as idiopathic intracranial hypertension, a syndrome consisting of increased intracranial pressure, headaches, and visual loss not attributable to a mass lesion or underlying infection or malignancy.[4] PTC is normally a more insidious condition, allowing time to

treat medically and with weight loss. More rarely, PTC has a fulminant presentation, and consideration for surgical intervention is warranted. This patient's intracranial pressure was not responding appropriately to medical therapy with acetazolamide alone, so surgical intervention was recommended (eliminating choice A). This patient has increased intracranial pressure, so methods to lower intraocular pressure would be ineffective in treating PTC (choices B and D). The patient was referred to Neurosurgery for ventriculoperitoneal (VP) shunt placement (choice C). When considering surgery for PTC, options include optic nerve sheath fenestration, VP shunting, or venous sinus stenting. The overall rate of visual improvement seems to be equivalent across surgical interventions, and there is insufficient evidence to recommend or reject any one surgical intervention over another at this time.[5,6]

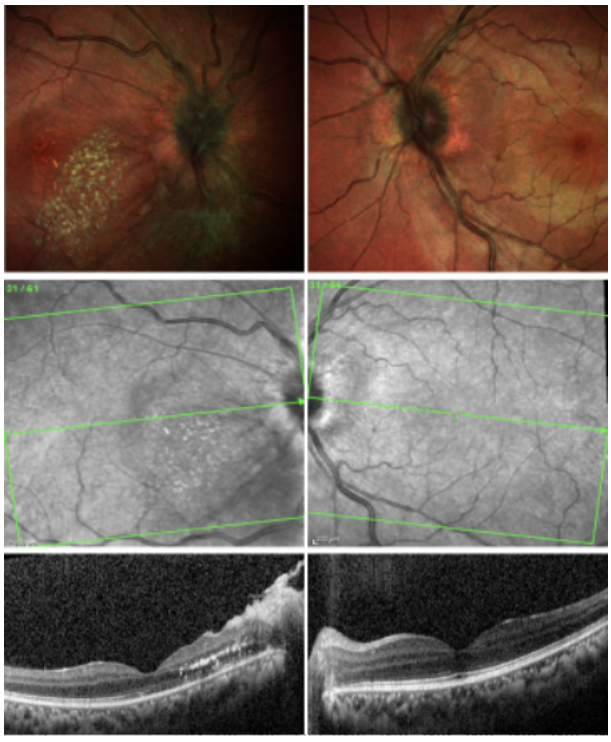

Figure 4

Two months after shunt placement, the patient was evaluated again by Neuro-Ophthalmology. Visual acuity was 20/40 OD and 20/20 OS and color plates were full in both eyes. OCT showed significant improvement in papilledema, now measurable with inferior thickness 124 µm OD and 109 µm OS (Figure 4).

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A Day in the Life in the Wills ER

By Samara Hamou, MS1 | Faculty Reviewer: Christine Chung, MD

Entry to the emergency room; located on the first floor of the Jefferson Hospital for Neuroscience.

The Wills Eye Hospital — among the greatest eye hospitals in the country — is a force to be reckoned with. Located in Center City Philadelphia, the eight-story tall brick facility will capture your attention as you stroll down Walnut Street. The entrance to the Wills Eye Emergency Room (ER), however, is less apparent to the average city-goer. Located directly across from the Hospital, the red and blue entrance sign may go unnoticed to the unsuspecting by passer. However, for those who require expert eye care in a timely fashion, the Eye Emergency Room is a signal for the invaluable services provided by the doctors and trainees inside.

The Wills Eye ER is one of only three emergency rooms in the country dedicated exclusively to emergency eye care. It is available 24 hours a day, 365 days a year, and serves over 1600 patients each month. The hospital's world-renowned reputation uniquely attracts patients throughout the Eastern Seaboard who seek access to the world-class expertise and emergent eye care available at Wills.

As a first-year medical student at SKMC, I was fortunate to catch a glimpse of what goes on behind the scenes during a typical day in the Wills ER. There are five exam rooms and one triage room. Acute eye emergencies account for about 60% of the visits, with the rest comprising of non-emergent visits. Patients come in on their own volition, or are referred from local urgent care, primary care services, their ophthalmologist or ER's as far away as Lehigh Valley. All patients are triaged by a registered nurse upon presentation, a process that starts with visual acuity and vital signs. On my particular visit, the attending physician, Dr. Christine A. Chung, then performed a pupil exam to clear the patient for dilation in preparation for a full eye exam. If cleared, a first- or second-year ophthalmology resident will gather a history and conduct a full ocular exam consisting of color testing, confrontational visual field testing, motility, applanation tonometry, slit lamp, and dilated fundus exam. The patient is then seen a second time by the attending ophthalmologist for final review. After completing the patient work up, the resident and attending team discuss the findings, and together create a diagnostic assessment and treatment plan. Depending on the diagnosis and nature of the case, the patient is either discharged, sent for further imaging, or admitted.

I was amazed at the myriad of patients I witnessed throughout the several hours I spent observing in the Wills ER. Encounters ranged from something as straight-forward as a superficial foreign body requiring removal and treatment with topical drops, to complex ocular pathology such as cavernous sinus hemangioma requiring an intense work-up and further testing. I

A typical exam room in the Wills Eye ER.

distinctly recall three patients that came through which left quite an impression on me.

Case 1: A 70-year-old man presented after falling the prior day while carrying bags of gardening soil. Since he was holding the bags of soil, he was unable to stop his fall and fell directly on his face. Upon arrival, his blood pressure (BP) was elevated to 200/120. He reported good BP control on his home anti-hypertensive medications, but admitted to forgetting his regular dose that morning. Ocular examination quickly revealed that he had a full thickness corneal laceration requiring urgent repair (Figure 1). After starting IV antibiotics, the Wills ER was able to admit him to the Jefferson Hospital for Neuroscience for stabilization of his BP prior to surgery. The patient was then scheduled for open-globe repair at Wills Eye the following day.

Case 2: A 75-year-old man recovering from COVID-19, diagnosed three weeks earlier, presented with debilitating headaches, elevated BP and tunnel vision. These symptoms led the patient to see an optometrist, who found a "poor visual field" and promptly referred him to the Wills Eye ER. A confrontational visual field performed by the ophthalmology resident on initial evaluation revealed a right upper quadrant homogenous field defect. The slit lamp exam and fundus exam were unrevealing, and the patient was scheduled for a brain MRI to confirm the working diagnosis of a subacute stroke. Unfortunately, an MRI workup takes several hours to complete, and the nature of the emergency room does not always allow you to follow a patient to completion.

Case 3: A 54-year-old man with a history of recent shingles presented with a chief complaint of double vision (diplopia) for the past month. His medical history was significant for uncontrolled diabetes, well-controlled hypertension, and hypercholesterolemia. A Three-Step Test was performed (Figure 2), and the etiology of his diplopia was determined to likely be a unilateral cranial nerve IV palsy. The residents presumed that this palsy could be due to microvascular ischemia from uncontrolled diabetes or from his recent shingles infection. He was sent for an MRI which showed no intracranial mass, hemorrhage, or acute infarct, and was consistent with microangiopathy. The patient was advised to follow up

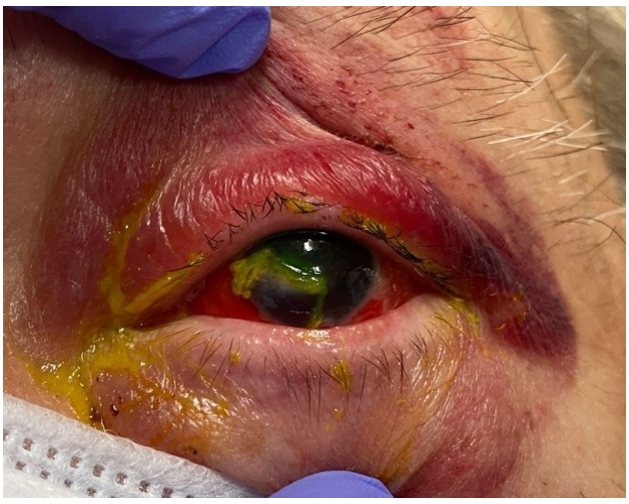

Figure 1. *Anterior ruptured globe enhanced with yellow fluorescein dye, subconjunctival hemorrhage, and surrounding ecchymoses.*

with a neuro-ophthalmologist for his diplopia, and with a comprehensive ophthalmologist to monitor the incidental diabetic retinopathy found on dilated fundus exam.

It became evident to me that the Wills Eye residents are essential for running the ER. The residency program itself is one of the most competitive and largest in the country, and accepts a total of 8 residents each year. Residents complete various 6-week rotations in comprehensive and subspecialty clinics, the emergency room, consult service at Jefferson, and the operating room at Wills Eye Hospital. An ophthalmology attending supervises the residents during the week, and an ER attending covers overnight and during the weekend. I had the privilege of working with Dr. Kaylene Carter (PGY-2) who shared that the most rewarding part of her Wills Eye experience so far has been working with amazing co-residents from around the country. When asked about the most challenging part of residency so far, she reflected upon the "steep learning curve with a high volume of patients in the ER that definitely takes some adjusting to."

Across the many patient encounters that day, I was able to appreciate how ocular symptoms can serve as presenting signs of systemic diseases that often involve multiple organ systems, especially the brain. I witnessed first-hand the meaning behind the cliché expression "the eye is the window to the soul", which could not be more evident throughout the various diagnoses made during my time shadowing Dr. Chung and the talented Wills Eye residents.

Figure 2. *Dr. Bonnie Sklar (PGY-3) using various sets of prisms to quantify diplopia severity after performing the Parks Three-Step Test, a diagnostic test used to identify which muscle is paretic in the case of an acquired hypertropia.*

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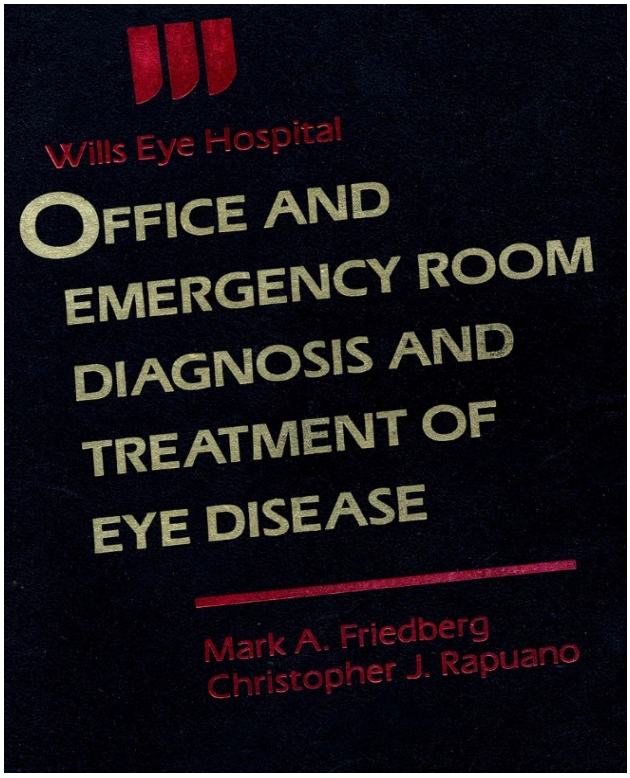
Origins of the Wills Eye Manual: Surviving the Test of Time

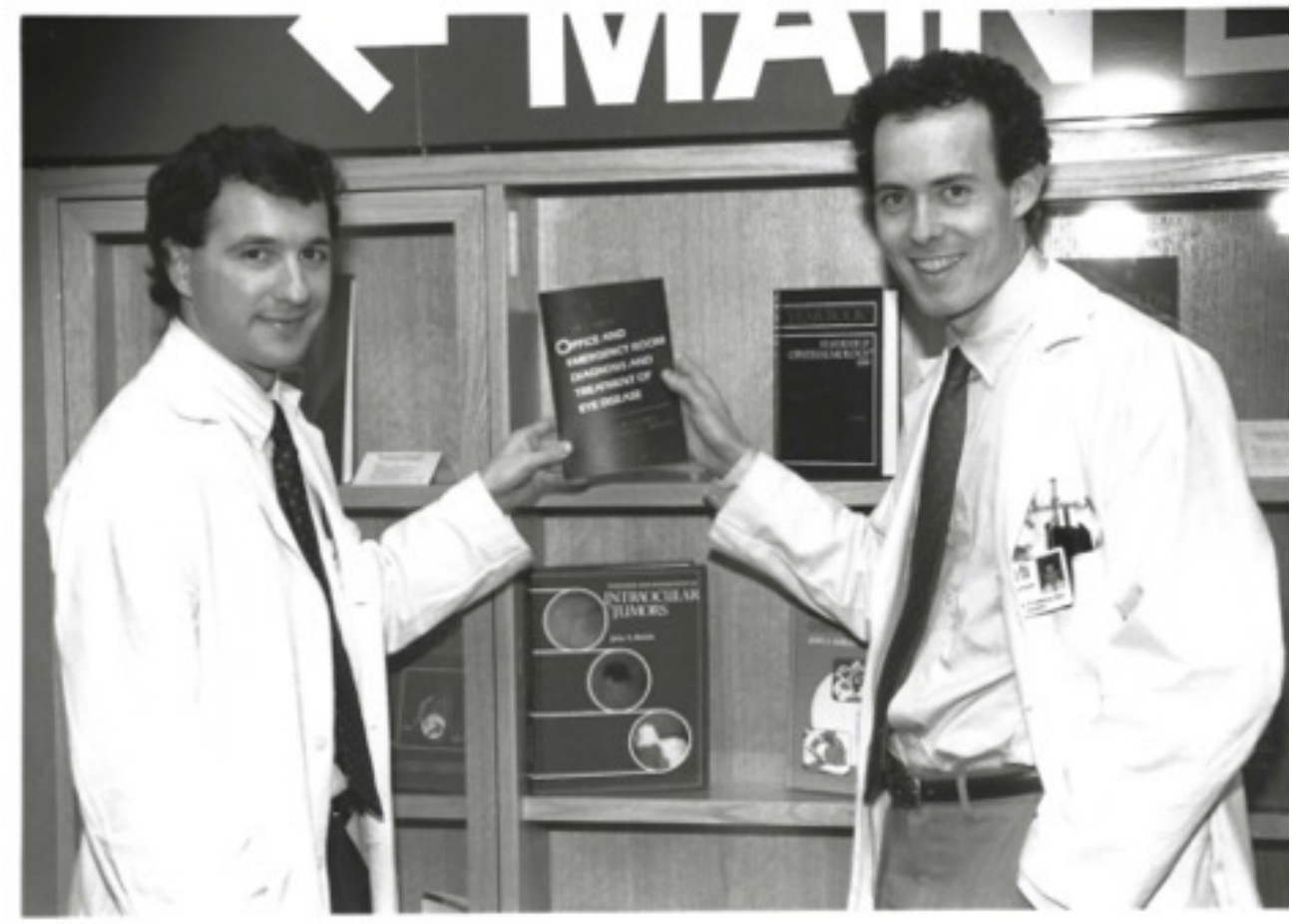
By Jordan Safran, BS | Faculty Mentor: Christopher Rapuano, MD



The first copy of the Wills Eye Manual hit the press in late 1989; it featured a black cover page with bold gold lettering and the Wills Eye logo proudly displayed on top. Published in a time before the invention of the world wide web or the advent of digital printing, this 450-page expertly sourced ocular disease reference guide took the ophthalmology world by storm. Since its debut, the manual has served as the go-to guide for trainees and seasoned physicians alike in diagnosing and treating more than 200 ocular diseases. To date, the Wills Eye Manual has published eight editions, with over 200,000 copies in circulation within ophthalmology clinics, emergency departments, and hospitals around the world.

Humble Beginnings

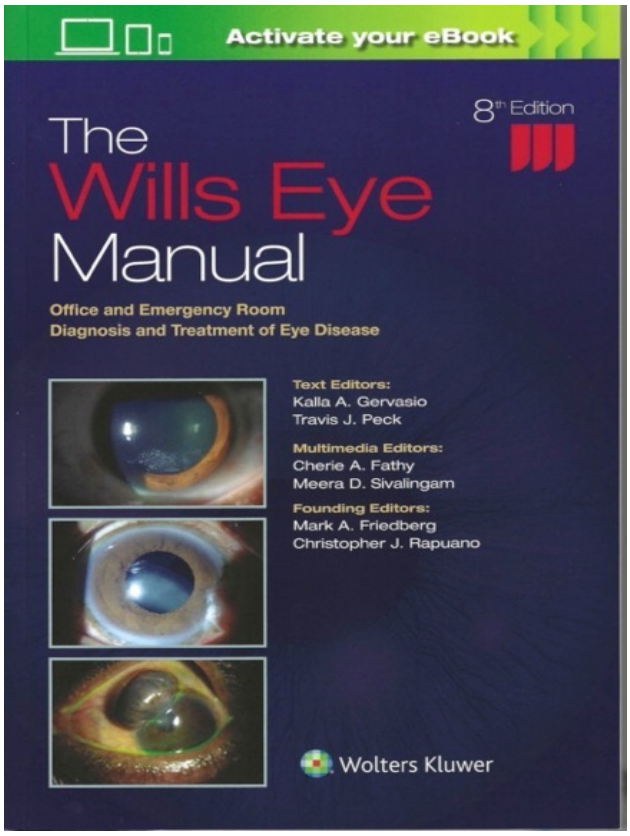
Considering how impactful the Wills Eye Manual is today, it is remarkable that this cornerstone publication started as a small project for two ambitious Wills Eye ophthalmology residents. Dr. Christopher Rapuano, Chief of the Cornea Service at Wills Eye and one of the two founding editors of the Wills Eye Manual, explains that the story of the Wills Eye Manual began in June of 1988 at the tail-end of his first year of residency. At the time, ophthalmology trainees spent their first year learning the ins and outs of the field by interviewing and examining patients with guidance from second-year residents. Dr. Rapuano shared how this pivotal point in his education contributed to the early beginnings of the Wills Eye Manual: "I realized that I would soon become a mentor to the first years and wanted to be prepared for the role. I started to work on a framework to organize my knowledge with a simple goal in mind, to create a rudimentary guide to the top 10-20 diagnoses encountered in the Wills Eye ophthalmology emergency department." Shortly thereafter, this undertaking led Dr. Rapuano to his classmate, Dr. Mark Friedberg, who shared a passion for making ophthalmology knowledge accessible. Discussions between them centered around two ideas: creating a booklet for ophthalmology residents in the Wills Eye ER and drafting a book about conditions



of the eye for non-ophthalmologists. Over the next few weeks, the synergy of these ideas culminated into a four-chapter-long sampler of an eye disease diagnosis and treatment guide bound for the desks of several major publishing companies.

Founding Principles

Dr. Rapuano described the vivid memory of his first encounter with a publishing company. He and Dr. Friedberg, donned in their white coats, entered an office sporting ornate wooden architecture and bookshelves lined with countless medical texts. As they took their seats, they were joined by about ten senior editors and publishers at Lea & Febiger to discuss the fate of their brainchild. For most this would be a daunting scenario, but Dr. Rapuano and Dr. Friedberg had come prepared with an elegant proposition. "We presented our vision for the manual to the publishers" remarked Dr. Rapuano, "to create a guide that would give ophthalmologists information right at their fingertips – no pathophysiology, histology, or surgery, just the essentials to treat a patient with ocular disease. It would be soft cover, small enough to fit into a lab coat pocket and affordable." This manual would be completed with the assistance of their entire residency class and reviewed by Wills Eye attendings. Further, they had arranged that future Wills Eye resident classes would be the successors for revising and publishing new editions of the manual. This proposal was pitched to three more publishers in Philadelphia's Washington Square area – the epicenter for medical publication at



the time. Astonishingly, all four companies were enthralled with this revolutionary idea and offered them contracts; the to-be ophthalmologists ultimately signed a deal with J. B. Lippincott Company and the writing began.

Writing the Wills Eye Manual

Over the subsequent nine months, the Wills Eye residents worked together on the first edition of the manual. Dr. Rapuano and Dr. Friedberg served as editors and assigned sections to each of the residents in their class. Residents refined their additions to the manual by consulting with attendings at Wills Eye. Dr. Rapuano recalled these meetings fondly: "one-on-one discussions with some of the world's leading experts for the manual enriched our understanding of ophthalmology and was the most rewarding part of the project." The Wills Eye Manual would provide everything from pearls in ocular oncology directly from Drs. Carol and Jerry Shields to the newest developments in glaucoma from Dr. George Spaeth. The team worked diligently to summarize the essentials, sometimes opting to include multiple perspectives in the management of certain conditions to account for discrepant expert opinions. While the original plan was to include 100 diagnoses, the final product morphed into a reference guide of over 200 conditions. The manual was submitted for publication by April and Drs. Rapuano and Friedberg were told that it was the fastest book authors had delivered to Lippincott in its history. The residents had worked tirelessly to bring their idea to fruition; however, there was still uncertainty whether the project would catch on. Impressively, the first edition sold 15,000 copies, about triple what the publishing company had hoped for.

Surviving the Test of Time

When the Wills Eye Manual was published, it was the first of its kind. While ophthalmology atlases and textbooks existed, this was the first reference guide that allowed for any physician to rapidly access reliable, practical, up-to-date information to recognize and treat a vast array of eye conditions. This was particularly groundbreaking in a time when there were no search engines or internet medical databases. Despite developments over the past 30 years such as EyeWiki and UpToDate, the Wills Eye Manual holds its ground as one of the best-selling books in ophthalmology. The manual's continued popularity in the age of unprecedented information access may be credited to the preservation of its founding principles.

According to Dr. Rapuano, "when the contract was created for the manual, it was decided that all funds raised from sales would be directed towards the Wills Eye Residency program." This has encouraged continued support from residents and faculty, allowing for the manual to adapt with the times without compromising its beloved simplicity and authoritative voice. Over the years, the manual incorporated color photos, and more recently has added online accessibility and video addendums. Sections within the guide have also been added to reflect the newest developments in ophthalmology such as imaging modalities.

Regarding the progress of the manual, Dr. Rapuano shares, "I am proud of the hard work residents have dedicated over the years to uphold the tradition of the Wills Eye Manual." Dr. Rapuano has remained an integral part of the manual's success over the years acting as the primary faculty supervisor for all subsequent editions and has continued to advance the field of ophthalmology. Since completing his cornea fellowship at the University of Iowa, his contributions to the field of ophthalmology have been numerous as one of the world's leading experts in corneal disease, refractive surgery, and excimer laser phototherapeutic keratectomy surgery. In addition to the Wills Eye Manual, he has authored numerous works including a cornea textbook, being the series editor for the Wills Eye Color Atlas Series and over 250 peer-reviewed articles. His vision for the future of the manual is to continue including the most cutting-edge information, while never compromising

on the philosophy of practicality that lives at its core. The Wills Eye Manual will continue to be the north star for physicians navigating the complexities of ocular diagnosis and treatment, even as new discoveries abound.

GATT: A Micro-invasive Glaucoma Surgery and a Big Step for Glaucoma Treatment

By Moses Im, BS | Faculty Mentor: Lauren Hock, MD & Marlene Moster, MD

Glaucoma is a group of ocular diseases characterized by damage to the optic nerve that may lead to permanent vision loss. Currently, 76 million people (aged 40-80 years) suffer from glaucoma, and the prevalence is projected to increase to 111.8 million by 2040.[1] The diagnosis of glaucoma can be frightening, particularly because there is no known cure. Fortunately, recent advancements in glaucoma surgery have made more options available for patients presenting with new-onset glaucoma. In particular, patients with mild to moderate glaucoma may be eligible for newer minimally invasive glaucoma surgeries (MIGS). This review is both an overview of MIGS, a new class of glaucoma surgeries, and a case study on how one of these novel procedures saved a 47-year-old woman's vision.

Glaucoma is an optic neuropathy characterized by progressive deterioration of the retinal neural ganglion and nerve fiber layer.[2] The exact mechanism of nerve damage is unknown, but high intraocular pressure (IOP) is commonly correlated. Under normal conditions, IOP is maintained through a constant flux of aqueous fluid from the posterior chamber through the pupil into the anterior chamber of the eye.[3] The aqueous humor nourishes the anterior chamber and then leaves via the trabecular meshwork and Schlemm's canal into the venous drainage system deep within the sclera. In open-angle glaucoma, elevated IOP may be due to progressive microscopic clogging of the trabecular meshwork, the primary source of aqueous outflow (Figure 1).[3] Secondary open-angle glaucoma can commonly occur with chronic corticosteroid use, where there is a similar microscopic clogging of the trabecular meshwork. The exact process of aqueous outflow impediment is uncertain, but it is hypothesized that

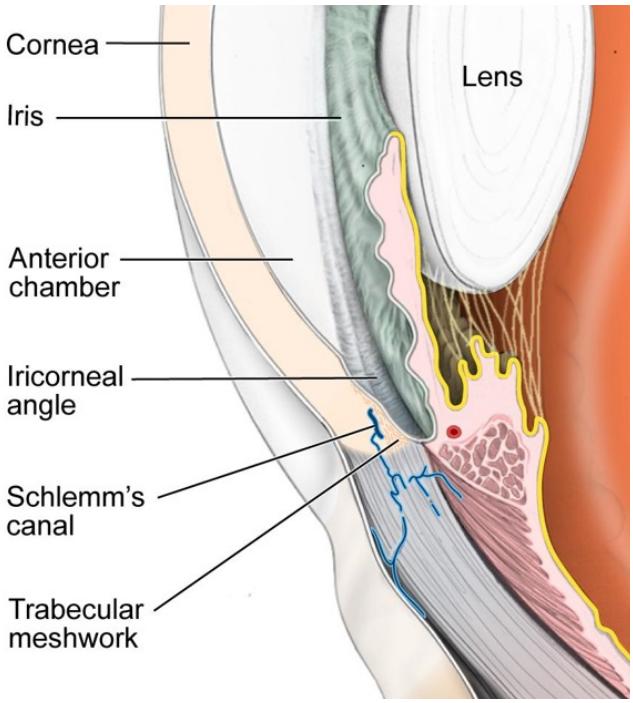


Figure 1. *Anatomy of the eye demonstrating the aqueous fluid movement from the anterior chamber into Schlemm's canal through the trabecular meshwork. Blockage of the trabecular meshwork seen in primary open-angle glaucoma. Figure adapted from National Eye Institute, National Institutes of Health Media Library.*[13]

glycosaminoglycan accumulation in the trabecular meshwork causes elevated IOP.[4] Early-onset of glaucoma is typically asymptomatic, but glaucoma progression leads to characteristic visual field loss.

The treatment options for glaucoma include medications, laser, and surgical intervention. Importantly, these treatments help prevent disease progression but do not reverse visual field loss. Therefore, early treatment is critical for the maintenance of vision and maximizing quality of life.[5]

Of the surgical interventions, the most performed traditional procedure is a trabeculectomy. This procedure lowers the IOP by creating an alternative drainage pathway, or a "bleb", for the aqueous fluid. A small incision is made through the superior limbus, the border between the cornea and the sclera, so that excess fluid drains under the conjunctiva (Figure 2). While trabeculectomy is effective, it requires a lengthy 6-week recovery period. Serious risks include hypotony (very low IOP), choroidal effusion, hemorrhage, bleb leaks, and infections like blebitis and endophthalmitis.[5-7] Importantly, these complications may result in blindness. While trabeculectomy is often indicated for patients with severe glaucoma, its risks are often considered too great to treat mild to moderate disease. As a result, novel surgery alternatives have been explored in the past decade to treat patients with mild to moderate glaucoma.

In the past few decades, MIGS (Minimally Invasive Glaucoma Surgery) has emerged as a novel class of surgery to reduce IOP with the aim of creating minimal damage to the sclera or conjunctiva, reducing the duration of recovery, and producing more standardized outcomes.[5] Several forms of MIGS increase aqueous outflow by bypassing the trabecular meshwork, whereas other forms reduce fluid production by ablating the ciliary body. A common technique used in MIGS is the "ab interno" approach. In this technique, a corneal or limbal microincision is performed to preserve ocular tissue rather

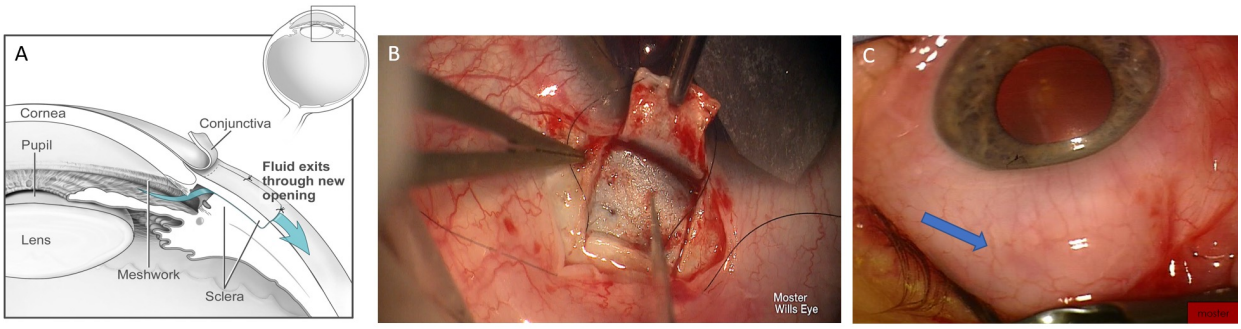


Figure 2. *Intraoperative and Postoperative Images of Trabeculectomy A) Anatomy of the eye demonstrating the new opening made in trabeculectomy. B) Real image of the incision through the superior limbus. C) The arrow indicates the bleb that forms from the elevation of the conjunctiva. Image A adapted from National Eye Institute, National Institutes of Health Media Library. Images B and C provided by Marlene Moster, MD, Wills Eye Hospital.*

than the classic scleral incision used in trabeculectomy. The iStent is a MIGS procedure, where a 1mm stent is inserted through the trabecular meshwork into Schlemm's Canal, allowing for increased outflow of aqueous fluid.[8] The Kahook dual blade is another MIGS device that is inserted into Schlemm's Canal through the trabecular meshwork. The ramp of the blade subsequently excises a strip of the trabecular meshwork, exposing a direct opening to the outer wall of the Schlemm's Canal.[9] Another MIGS stent is XEN, a gel stent that is inserted from the anterior chamber to the subconjunctival space, creating a small outflow tunnel that functions similarly to the bleb formed with a trabeculectomy.[10] While many studies show that standard glaucoma surgeries reduce IOP to a greater degree than MIGS, MIGS has demonstrated good efficacy in decreasing IOP in select mild to moderate cases while also displaying reduced rates of complications.[8,9,10]

The gonioscopy-assisted transluminal trabeculotomy (GATT), another MIGS subtype, was first introduced by Grover et al., from Glaucoma Associates of Texas. GATT is a MIGS procedure that involves threading a catheter or suture through Schlemm's canal within the anterior chamber in a 360-degree manner. The distal tip of the catheter or suture is then removed, causing a circumferential tearing of the roof of Schlemm's canal (Figure 3).[11] Grover, et. al. described GATT as a safe and effective procedure in 2014. The authors divided 85 patients into primary open-angle glaucoma and secondary glaucoma cohorts. In the primary glaucoma group, there was a 30% ± 22.7% mean reduction in IOP, while in the secondary glaucoma group, there was a 52.7% ± 15.8% reduction. The most common complication was transient hyphema, occurring in 30% of patients within 1 week of surgery. Finally, there was a 9% failure rate, where 8 patients required additional glaucoma surgery. The GATT procedure was further analyzed by Rahmatnejad and Moster et al. at Wills Eye Hospital in 2017.[12] In their retrospective chart review of 66 patients, they had a 63% success rate, where surgical success was defined as not needing further glaucoma surgery upon follow-up evaluation. They reported a 44% mean reduction in IOP and a 38% rate of hyphema at postoperative week one, which decreased to 6% at one month. Their results suggested that GATT was effective and had lower rates of serious complications. Furthermore, this operation requires no sutures and preserves conjunctival tissue by avoiding the creation of a bleb, allowing for future glaucoma surgeries if needed. In summary, GATT is a promising procedure with a lower risk of serious complications for the future of glaucoma surgery.

To highlight the promise of MIGS, we will describe the case of a 47-year-old Jefferson Internist whose vision was preserved through the GATT operation. This healthy physician, with no family history of uveitis, glaucoma, or blindness, developed abrupt uveitis in both eyes and an epiretinal membrane in her left eye. She was prescribed topical and oral steroids for months to control the uveitis and developed steroid-induced

glaucoma. After which, she was prescribed oral Diamox (acetazolamide), for maximum IOP control. However, when she presented to Dr. Marlene Moster, her IOP remained elevated (OD 48 mmHg, OS 50 mmHg; normal 10-21 mmHg). Her vision was 20/20 in the right eye and 20/40 in the left eye. On exam, she was noted to have mild bilateral posterior subcapsular cataracts, with more advanced cataracts in the right eye. She had a disc damage likelihood score (DDLS) of 3/10 bilaterally which indicated mild optic nerve damage without visual field loss. The optical coherence tomography (OCT) displayed the preservation of nerve fibers (over 100 microns).

While this patient presented with steroid induced elevated IOP, she did not yet have significant optic nerve damage and as a result, was a good candidate for the GATT procedure. GATT was performed on her left eye followed by the right eye. Since surgery, the patient demonstrates stable IOPs (11mmHg) and only takes one drop of aqueous suppressant daily. At her 5-year follow-up, the uveitis is controlled, her visual fields and OCT were normal, her optic nerve appearance was unchanged, and her vision was 20/20 bilaterally. This case demonstrates how a busy physician was able to maintain her vision and excellent quality of life. GATT surgery can oftentimes be an effective treatment option for patients with mild to moderate glaucoma, particularly in steroid-induced glaucoma.

In summary, while traditional glaucoma surgeries, such as trabeculectomy, are effective at lowering IOP, the rise of MIGS operations provides safer options for patients meeting certain criteria. Further

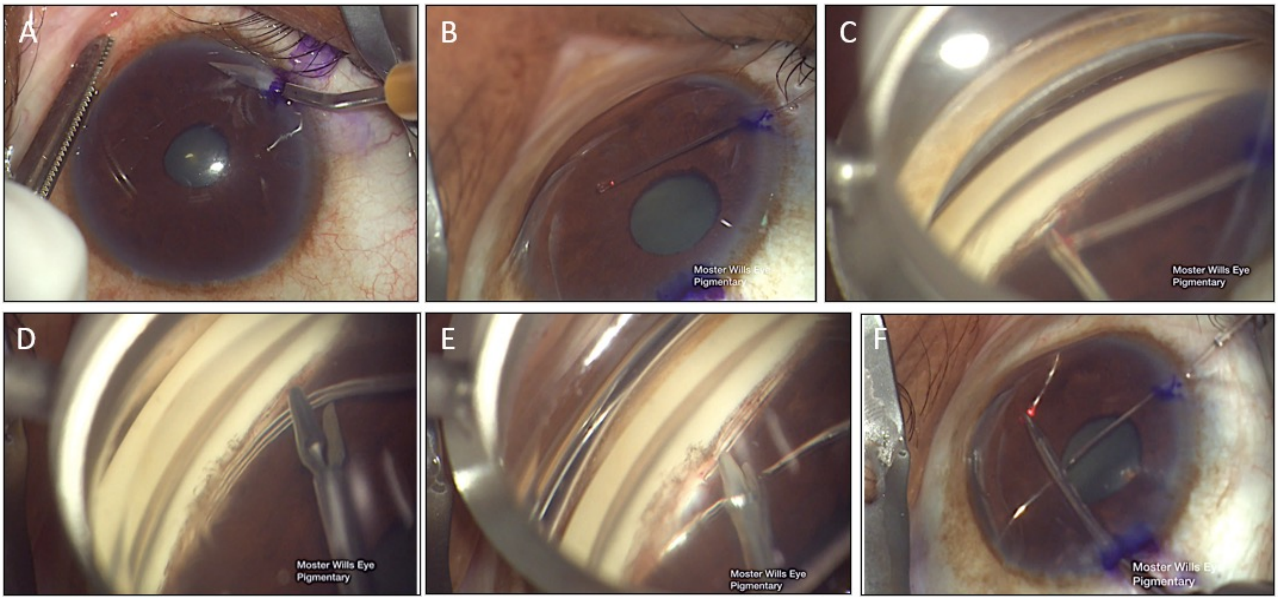


Figure 3. *Demonstration of the steps of the GATT procedure. A) Initial corneal incision is made. B) The catheter is inserted into the anterior chamber. C) An incision in the trabecular meshwork is made to gain access to Schlemm's canal. D) The distal tip of the catheter canulates Schlemm's Canal. E) The catheter is passed through the canal in a 360-degree manner. F) The distal tip of the catheter is retrieved and removed to create the circumferential tear of Schlemm's Canal. Images provided by Marlene Moster, MD, Wills Eye Hospital.*

research is needed to identify the best candidates for GATT, while also clarifying the long-term efficacy of this operation. Overall, MIGS, particularly GATT, is an exciting and promising development for the field of glaucoma.

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Manual Small-Incision Cataract Surgery

By Ankur Nahar BS | Mentor: Brenton D. Finklea MD

Of the 49 million people living with blindness worldwide, 15.2 million are blind due to cataracts, making it the leading cause of preventable blindness.[1,2] Furthermore, 65.2 million people experience moderate to severe vision impairment from cataracts, according to the World Report on Vision published by the World Health Organization (WHO).[3] While global cataract surgery efforts have been a major success over the past three decades, an aging population has resulted in a rapid rise in cataracts, primarily in low- and middle-income countries (LMICs).[2,4] To address the increasing demand for cataract treatment, countries must perform an equal or greater amount of surgeries than the incidence of cataracts.

LMICs experience a unique set of obstacles to overcome in addressing the cataract surgical need. Methods of cataract surgery via phacoemulsification, as performed in affluent countries, are not suitable due to the unfavorable cost, speed, and availability of this surgical technique. Manual small-incision cataract surgery (MSICS) has, therefore, become the gold-standard in LMICs as a result of its low cost, short case time, and excellent outcomes when compared to phacoemulsification.[5]

Modern MSICS is a technique that cannot be attributed to a single individual but rather has been developed over the past three decades by a cohort of highly skilled surgeons. One of the first major steps towards modern MSICS was described by Dr. Michael Blumenthal and colleagues in 1992 as a modification to extracapsular cataract extraction (ECCE), where the entire natural lens is removed through a large limbal incision in the eye.[6] MSICS using the Blumenthal technique requires a 5-7 mm superior scleral incision to extract the cataractous lens. The sclero-corneal tunnel architecture was designed such that when the eye is pressurized, the wound is watertight and requires no sutures for closure. The technique was further modified by Dr. Sanduk Ruit and colleagues in 1999, whose surgical steps have formed the backbone of most current MSICS styles.[7,8] In Dr. Ruit's technique, the cataract is removed from the eye using an irrigating Vectis, as opposed to the prior Blumenthal technique which utilized an anterior chamber maintainer and hydrostatic force to push the lens out of the eye. Both techniques allow the surgeon to remove the cataract lens en-bloc and without the need to disassemble the cataract into smaller parts. In contrast, standard phacoemulsification surgery uses ultrasonic waves to emulsify and fragment the lens nucleus, which is then removed by suction through a small clear corneal incision.[9] While phacoemulsification produces excellent results with low complication rates and minimal induced astigmatism, MSICS produces similar visual outcomes with shorter average surgical

times and at a significantly reduced cost.

Speed and outcomes alone were not enough to address the burgeoning cataract rate in third-world countries; an infrastructure that would allow for high-volume and low-cost cataract surgeries was needed. In 1994, Dr. Sanduk Ruit and Dr. Geoffery Tabin created the Himalayan Cataract Project (HCP) to establish an eye care infrastructure in Nepal. By 1999, the team had reduced the cost of MSICS to less than $20 per surgery and now has programs in underserved areas of the world including Nepal, Ghana, Ethiopia, Bhutan, and India.

A primary reason for the success of HCP was its unique cost-saving measures. For example, HCP adopted a cross-subsidization model where wealthy patients pay a higher fee for the services rendered to support patients who have severely limited means.[10] One critical factor that enabled MSICS to become an inexpensive procedure was the development of low-cost intraocular lenses implanted at the time of surgery. Key to this was the creation of the non-profit Aurolab by the Aravind Eye Hospital in Tamil Nadu, India. Aurolab reduced manufacturing costs by utilizing a workforce predominantly of young women from rural areas who used this internship as a stepping-stone for further career opportunities.[11] By maximizing India's labor cost advantage, Aurolab introduced its first intraocular lenses (IOLs) at $10 compared to about $105 in the United States.[12] Today, Aurolab produces 19% of the world's IOLs and sells them for as low as $2.13.

Despite the lower cost and greater efficiency, visual outcomes from MSICS do not significantly differ from phacoemulsification. A landmark prospective randomized control trial by Ruit et al. compared phacoemulsification to MSICS and found comparable best-corrected visual acuities and complication rates with shorter operative time for MSICS.[5] Furthermore, some academic centers have found a more rapid acclimation to MSICS than to phacoemulsification in those surgeons who have previously trained in ECCE due to the similarities between procedures.[14] Phacoemulsification, on the other hand, does have its benefits. It requires a smaller incision than MSICS (2.2-2.75 mm vs 6-8 mm respectively), which results in improved intraocular pressure control, minor to no astigmatism, and quicker rehabilitation.[15] For these reasons, phacoemulsification continues to be the gold standard in affluent nations. Nevertheless, MSICS will still play a role in treating the most advanced and dense cataracts in all countries regardless of their GDP. When phacoemulsification is used for severely dense cataracts, there is an increased risk for corneal endothelial cell loss and iatrogenic corneal edema.[16] Future efforts in modernizing MSICS will focus on minimizing induced astigmatism while maintaining the endothelial-friendly aspects of the procedure.

The success of high-volume MSICS centers throughout the world is a testament to the individual and combined efforts of the many surgeons and public health professionals who have dedicated their lives to treating avoidable blindness. Several barriers

remain as gender, socioeconomic status, poor health literacy, and the perceived cost of eye care continue to limit patients from accessing these sight-saving surgeries.[3] Women in LMICs are significantly less likely to undergo cataract surgery than men as they may have limited financial decision-making power or barriers preventing access to transportation.[17] Others may perceive vision loss as a normal part of aging and are thus less likely to seek care.[3] Future efforts to combat cataracts worldwide must not only address accessibility of a low-cost cataract surgery infrastructure but also take into account the unique socioeconomic and cultural milieu of each region. A multifaceted approach, which examines the broad spectrum of risk factors for and barriers to cataract surgery, will bring us one step closer to eradicating preventable blindness throughout the world.

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A Look into Oculoplastics: Repairing Lower Eyelid Defects From Carcinomas

By Cameron Haghshenas, BS | Faculty Mentor: Robert Penne, MD

Eyelids are the thinnest, most sensitive skin we have and can easily be damaged by sun exposure. This is evident given that 5 - 10% of all skin cancers occur on the eyelid, and over half of these occur on the lower eyelid[1]. Most of such cases are basal cell carcinomas, which are slow-growing cancers that arise from the basal cell layer, the deepest part of the epidermis. If left untreated or improperly treated, these tumors can extend into adjacent tissues and bone, or recur. Squamous cell carcinomas can also occur on the lower eyelid, although they represent only a minority of cases. These arise from the squamous epithelium, a layer of scale-like cells found in the superficial epidermis and they can also spread and grow into deeper layers of the skin. Cancers of the lower eyelid are usually treated with surgical excision and evaluation of the surgical margins. This can be done with frozen sections or Mohs surgery. With frozen sections, the margins are evaluated by a pathologist at the time of surgery. Mohs surgery is a procedure that has been around for decades and is done by a specialized dermatologist. It involves excising the carcinoma layer by layer until it is fully removed. The non-surgical alternatives are cryotherapy and radiotherapy. They are less invasive, avoid surgery, but have a higher rate of recurrence compared to surgery[2]. When a lot of tissue needs to be removed, the result is the unilateral loss of a portion of

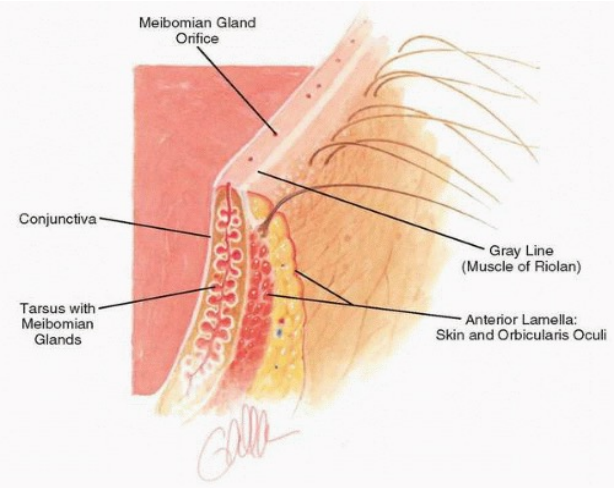

Figure 1. *Anatomy of eyelid*[7]

the lower eyelid full thickness. This is also known as a lower eyelid defect, which can be repaired by an oculoplastic surgeon. The eyelid consists of the anterior lamella, which includes the skin and orbicularis oculi muscle, and a posterior lamella, which includes the conjunctiva and tarsus (Figure 1). This anatomy is important to understand when repairing the lower eyelid defects.

Oculoplastic surgeons have a host of procedures available to treat lower eyelid defects. The choice of procedure depends on the size of the defect after tumor excision and patient-specific factors like eyelid laxity and age.[3] For smaller full-thickness defects (Figure 2a) which only affect around one-fourth of the eyelid width, one can perform primary closure of the eyelid margin, which entails apposing the two free edges to close the gap left after the tumor excision (Figure 2b). The goal with primary closure is to do so

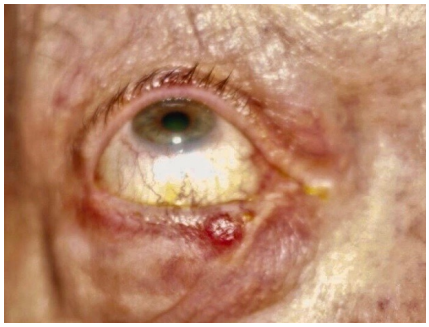

Figure 2a. *Small basal cell carcinoma on lower eyelid*

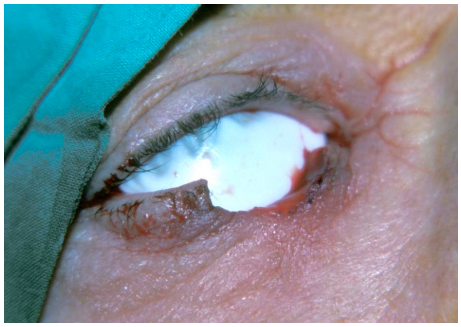

Figure 2b. *Excision of small carcinoma on lower eyelid*

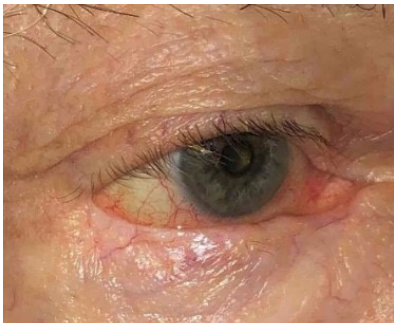

Figure 2c. *Lower eyelid after primary closure*

with the eyelid margin, tarsus and skin layers. The eyelid margin is closed first, the wound edge is everted, and tension is spread to prevent scarring or notching. This is followed by suturing the tarsus with deep sutures and finally closing the skin. A lateral cantholysis can be done at the time to allow closure of a larger defect. Upon healing, patients have a clean, functional eyelid (Figure 2c)[3].

For medium-sized defects, which affect around one-third to two-thirds of the eyelid width (Figure 3a), a technique called Tenzel semicircular flap is performed after cancer excision (Figure 3b). With this technique, a semicircular incision beginning from the lateral canthus, or the lateral edge of the eyelid, extending upward and laterally creates a skin-muscle flap. This flap is then rotated over the excision area. The margin is closed as with a primary defect and the rotated flap is closed with deep and skin sutures (Figure 4)3. This helps avoid healing defects (Figure 3c).

For larger defects nearing the entirety of the lower eyelid (Figure 5a), a Hughes flap, also known as a tarsoconjunctival flap, is performed after cancer excision (Figure 5b). This flap is created from the tarsus and conjunctiva of the upper eyelid and sutured into the gap of the lower eyelid to create its posterior lamella. The anterior lamella can come from any remaining skin on the lower eyelid, or if need be, do a full-thickness skin graft from the upper eyelid, retro-auricular or supra-clavicular areas. It is important to note that due to this connection, the eyelids are sutured shut for a period of 4 to 6 weeks (Figure 6). The eyelid margins are then recreated through a second procedure, resulting in functional eyelids (Figure 5c)[3].

Eyelid lesions like carcinomas can appear

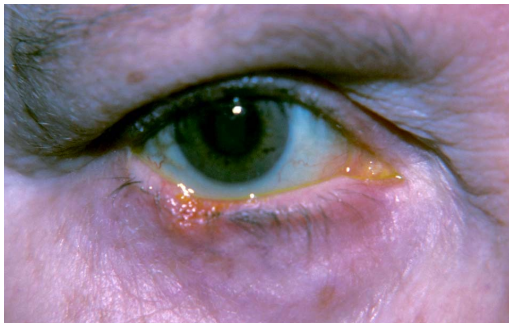

Figure 3a. *Medium-sized carcinoma in lower eyelid*

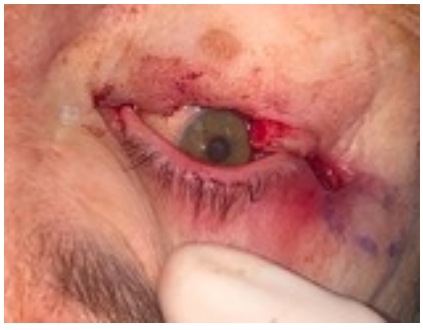

Figure 3b. *Excision of medium-sized squamous carcinoma on lower eyelid*

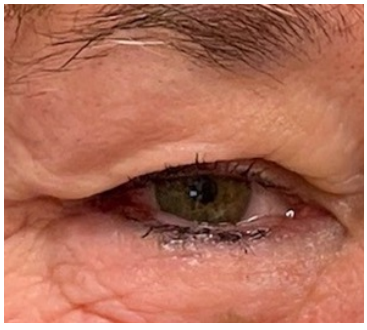

Figure 3c. *Lower eyelid after Tenzel semicircular flap*

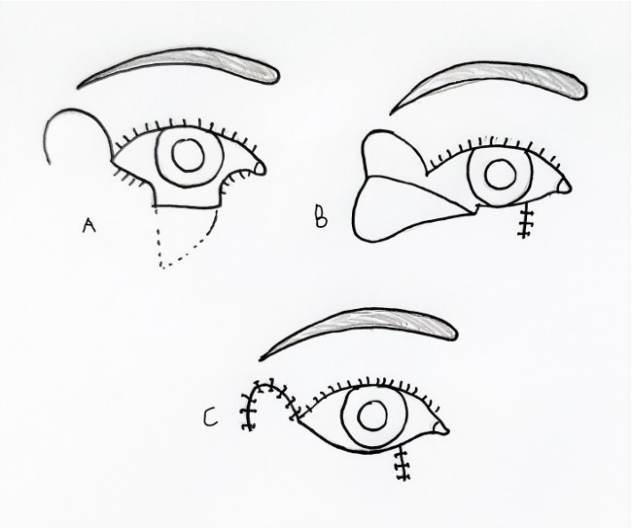

Figure 4. *Outline of Tenzel semicircular flap. The Tenzel flap is marked (A), and a dissection is performed in plane superior to the orbicularis to mobilize the flap medially (B). Then, the lid margin is repaired with flap closure (C)*[8]

even on the smallest parts of our bodies. The procedures mentioned above are only a few of the innovative tools oculoplastic surgeons use to treat and repair lower eyelids afflicted with such carcinomas. These procedures have a favorable prognosis, with the most involved of the procedures, the Hughes flap, having an 87% success rate in achieving satisfactory cosmesis and no further required surgeries.[4] The healing process can take up to 3 months and it is recommended that the patient checks up on any reoccurrence of cancer every 6 months.[5,6] Through these procedures, physicians ensure that patients maintain their health, vision, and facial anatomy.

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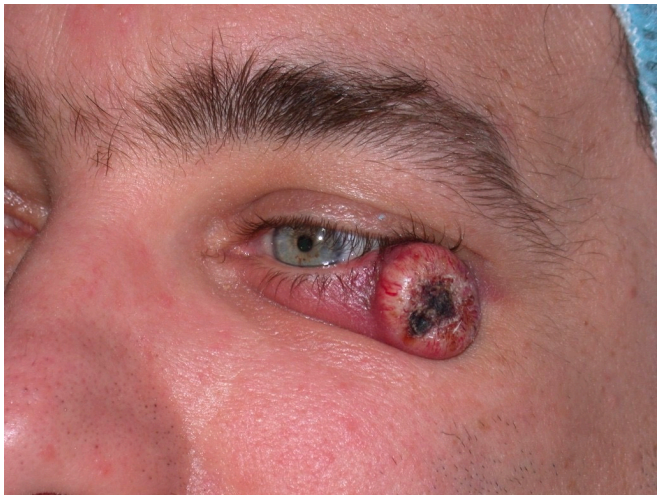

Figure 5a. *Large carcinoma on lower eyelid*

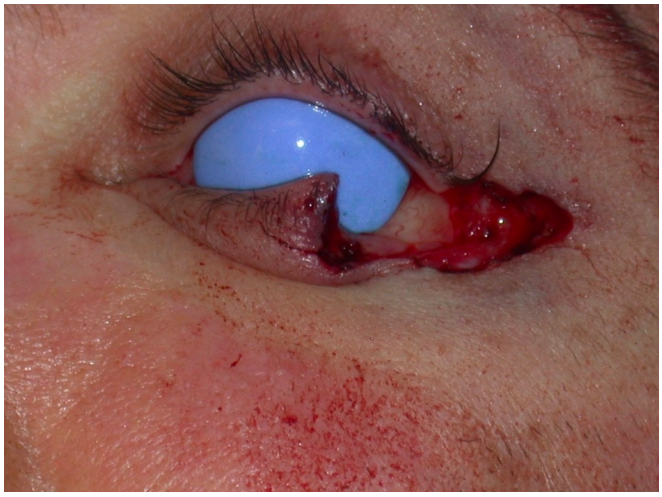

Figure 5a. *Excision of large basal cell carcinoma on lower eyelid*

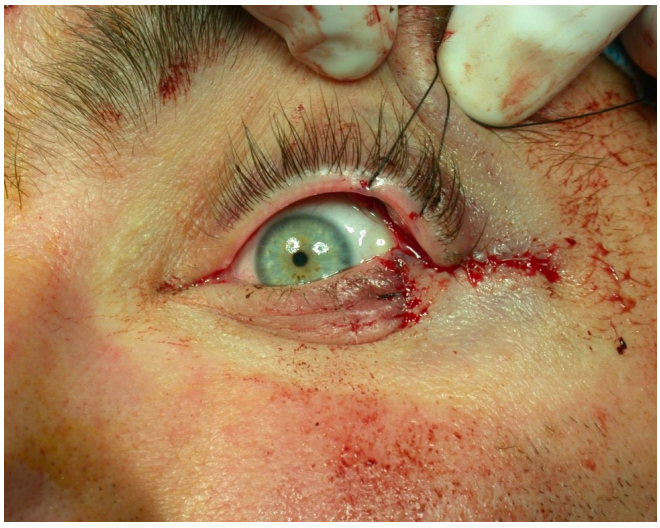

Figure 5a. *Lower eyelid after Hughes/tarsoconjunctival flap, prior to reforming the eyelid margins*

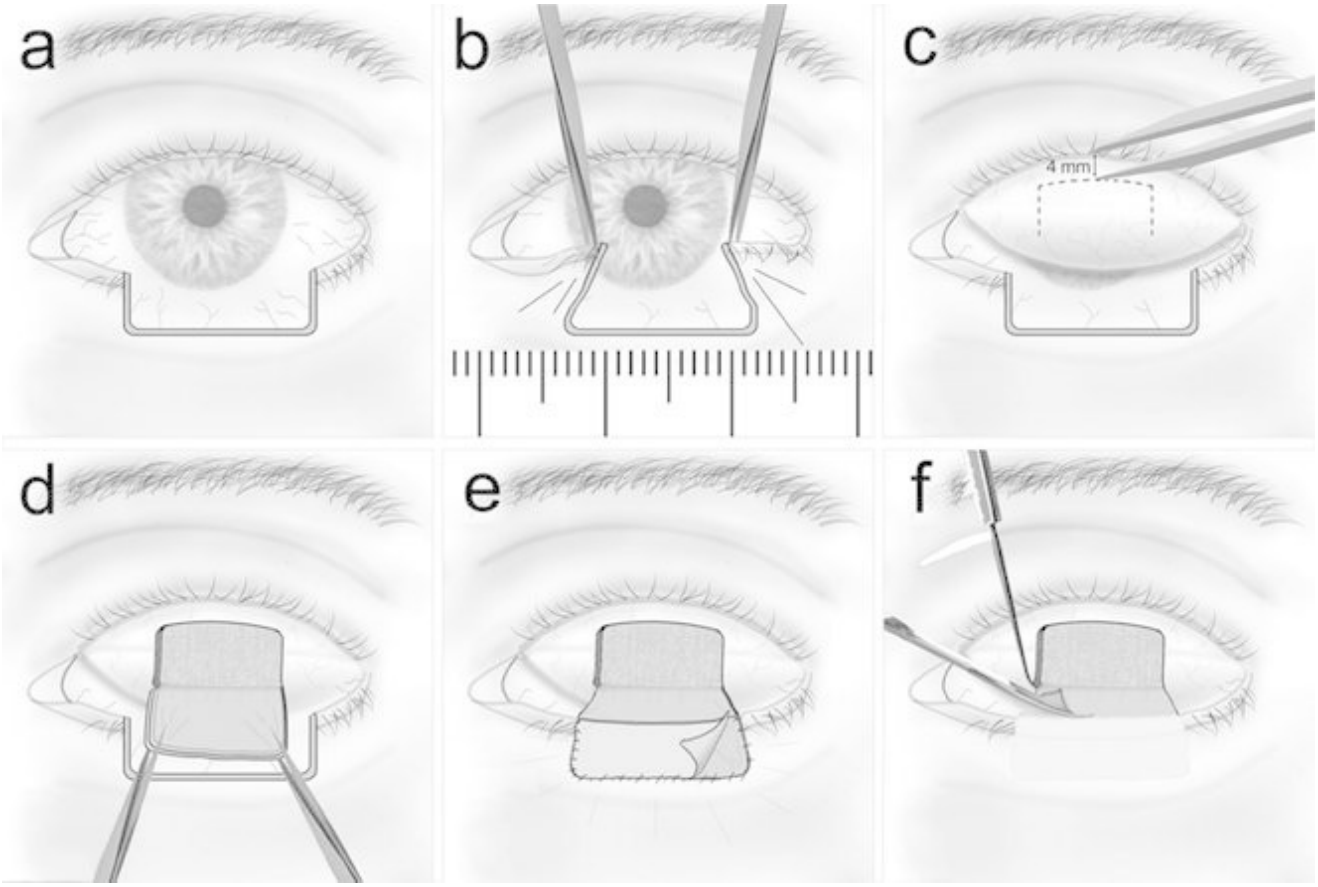

Figure 6. *Outline of Hughes flap. After excision of the carcinoma (A and B), a flap is created from the tarsus and conjunctiva of the upper eyelid (C and D) and sutured onto the gap of the lower eyelid, creating its posterior lamella and eventually anterior lamella (E). The eyelid margins are then recreated (F)[9].*

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Seeing Eye to Eye: An Overview of Strabismus and Approach to Treatment

By Shreya Swaminathan, BS | Faculty Mentor: Barry Wasserman, MD

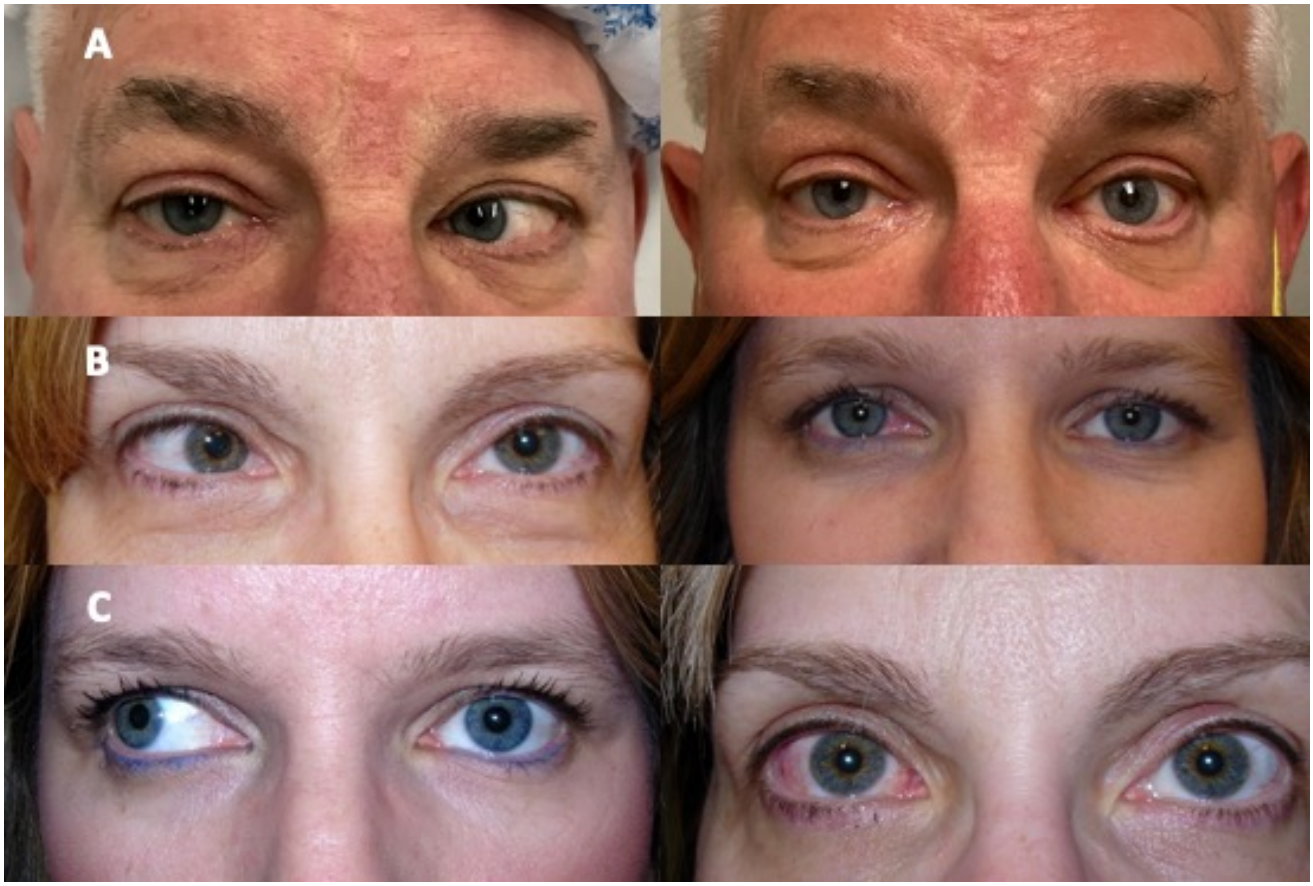

Figure 1. *Strabismus correction surgery can be used to correct esotropia (1A, 1B) and exotropia (1C)*

Strabismus is a heterogenous group of conditions characterized by the misalignment of the eyes. It may manifest as constant or intermittent deviation, meaning the eyes sometimes appear well aligned, or straight, and sometimes appear misaligned. Vision can be normal in some patients, but when associated with amblyopia, may be decreased vision in one eye. There is sometimes diminished binocular vision, with decreased depth perception.

Twin and family studies suggest a possible genetic component to the etiology of strabismus.[1] Strabismus most commonly occurs sporadically and in otherwise healthy patients, but risk factors that increase the likelihood of developing strabismus include exposure to teratogens such as alcohol, retinopathy of prematurity, premature birth, and low birthweight.[2] Secondary causes of strabismus include monocular vision loss from diseases like retinoblastoma or cataract, neurodevelopmental disorders,

craniofacial syndromes. Abnormalities and disorders affecting extra-ocular muscles and/or their innervation may also affect ocular alignment.

Strabismus is sometimes described by the direction of the misaligned eye. In esotropia, the misaligned eye deviates medially toward the nose. In exotropia, the eye deviates laterally toward the ear. Vertical misalignment is called hypertropia when the eye drifts or deviates upwards and hypotropia when the eye deviates downwards. The strabismus is described as comitant when it is the same in all gazes, but incomitant when it changes depending on the direction the patient is looking. For example, a patient with a cranial nerve VI palsy may develop a large angle esotropia when looking toward the side of the palsy but may have relatively good ocular alignment when looking away from the palsy. This can create variable double vision, or diplopia, for some patients. Esotropia, convergent alignment of the eyes, is more common in children than exotropia, or divergent alignment of the eyes.[3] Figure 1 depicts adult patients with esotropia and exotropia before and after strabismus surgery.

Strabismus can be corrected with nonsurgical intervention in many cases. Sometimes correcting the vision with glasses can achieve excellent ocular alignment. In some cases, eye exercises, sometimes referred to as vision therapy or orthoptics, can help align the eyes. In cases when nonsurgical interventions are insufficient, strabismus is often corrected through surgical intervention. The surgery is same day and often requires less than an hour to change a patient's life. The goal of strabismus surgery is to effectively balance the forces of the muscles on the globe. This modification improves ocular alignment and in turn, reduces diplopia. More specifically, strabismus surgery often involves recession or resection. Recession changes the position of muscle attachment to weaken its function. First, a suture is placed through the muscle at the attachment site. Next, the muscle is detached from the scleral surface and reattached more posteriorly, effectively 'loosening' the muscle. Resection, on the other hand, involves removing a portion of the muscle and reattaching the muscle to the original insertion site to effectively 'tighten' the muscle.[4] Figure 2 highlights the differences between recession and resection.

Some strabismus surgeons utilize a technique called adjustable sutures. In these procedures, the muscle position is moved to a desired location, but placed on a suture with a sliding knot. The patient can then be tested after surgery, and if necessary, the position refined with local anesthesia. These procedures require proper patient selection as cooperation and sometimes additions anesthesia is required. Whether adjustable or not, all strabismus surgery carries small risks. While serious risks like infection and loss of vision are extremely rare, a small number of patients do require another surgery later in life, as the eyes may deviate again.

Treating strabismus not only improves ocular alignment, but also ameliorates the

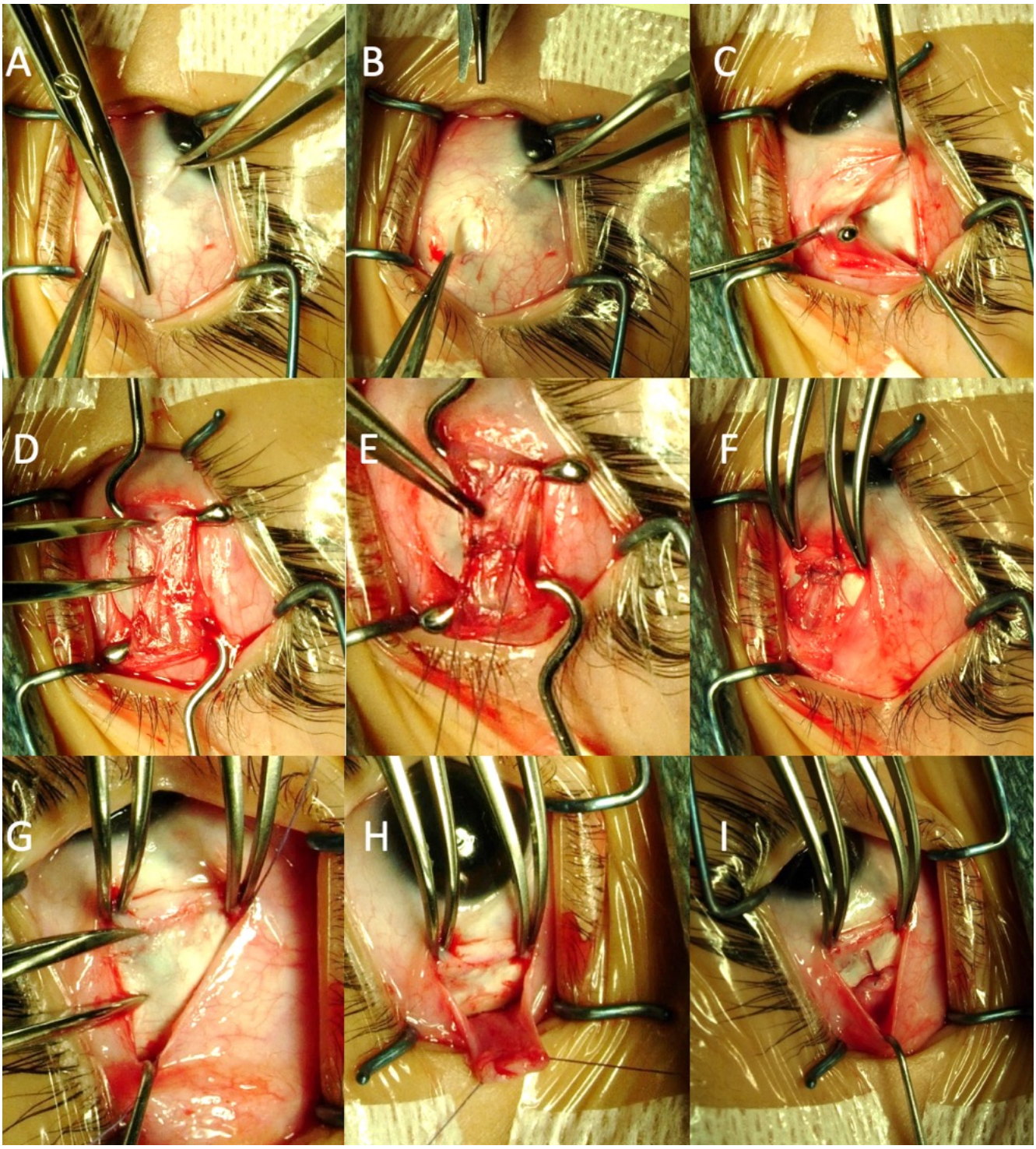

Figure 2. *Strabismus muscle involves cutting through the conjunctiva (2A) and tenon's fascia (2B) to isolate the lateral rectus muscle, as seen resting on the hook (2C). In a resection, the amount to be resected is measured using a caliper (2D) and a suture is placed accordingly (2E). The portion of the muscle located anterior to the suture is resected and the muscle is then reattached to the globe (2F). This serves to strengthen the ocular muscle. In a recession, the caliper measures the position where the new insertion of the muscle will be placed (2G). The initial suture is placed at the insertion (2H) in contrast to the suture placement in a resection. The lateral rectus muscle is reinserted to the superficial sclera posterior to the original position of the insertion (2I) to loosen the muscle and weaken its function.*

negative psychosocial impacts associated with the condition. Many patients, particularly adults with longstanding misalignments, are told their strabismus is 'just cosmetic.' Patients with untreated strabismus report more psychosocial difficulties that tend to intensify in adulthood, contrary to popular belief of dissipation with age. Specifically, strabismus can impact self-image, sports participation, school achievement, and interpersonal relationships. Occasionally, patients report difficulty securing employment or false accusations of cheating due to the inability to make eye contact. For these reasons, strabismus is not considered cosmetic, and surgery is covered by insurance. Strabismus surgery offers the opportunity to make a substantial difference in patients' lives and can be extremely rewarding for both the patient and the surgeon. Future studies are needed to further quantify the benefits of strabismus correction from a psychosocial standpoint.[5]

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Thomas Duane Ophthalmology Society

The Thomas Duane Ophthalmology Society (TDOS) at Sidney Kimmel Medical College (SKMC) at Thomas Jefferson University is dedicated to promoting interest in the medical specialty of ophthalmology through lectures and interactive programming for the Jefferson Community. We are also committed to volunteerism, and connect SKMC students with our community partners through ophthalmology-related volunteer opportunities, including Give Kids Sight Day and vision screenings at JeffHOPE clinics.

A central goal of TDOS is to support student engagement with educational opportunities in ophthalmology. Our annual introductory talk, hosted by Dr. Bruce Markovitz, aims to raise awareness and promote interest in the field and its subspecialties. With the support of Wills Eye Hospital, we also host an annual resident-run slit lamp workshop, bi-monthly wet lab sessions, and organize panel discussions with physicians.

To strengthen the unique connection between Wills Eye Hospital faculty and Thomas Jefferson students, we have included new additions to the TDOS programming, including monthly journal clubs. Finally, inSIGHT has offered students a hands-on opportunity to write about and directly engage with ophthalmology research and developments under the close mentorship of a Wills Eye physician.

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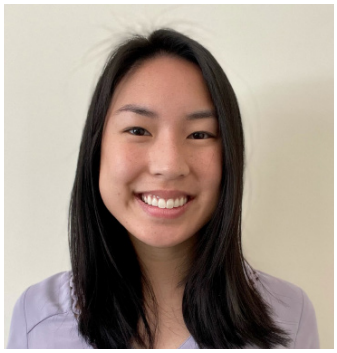

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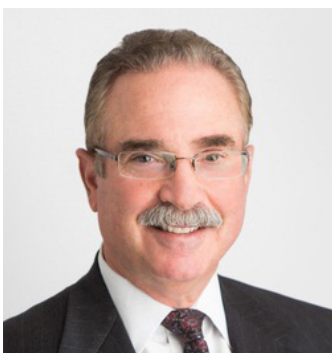

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