NOVEMBER 2018 # 27

the Ophthalmologist™

Women in Vision

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1,386,254.5 Diopters

of astigmatism went unmanaged in U.S. cataract ORs in 2017.*,[1]

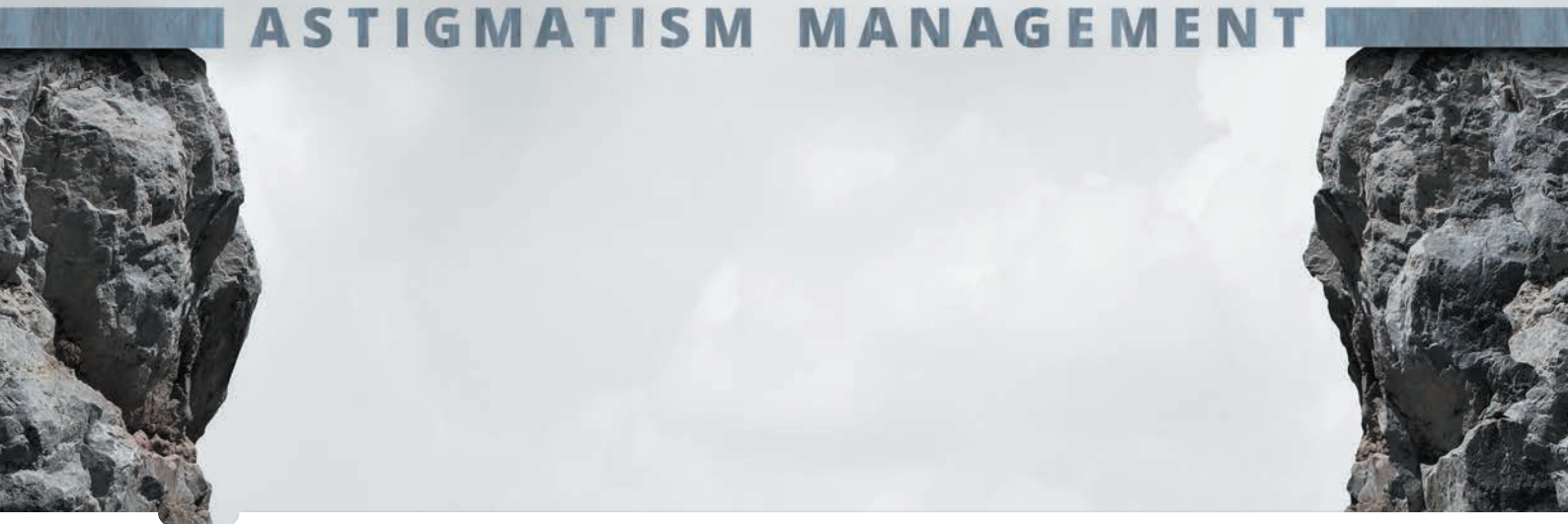

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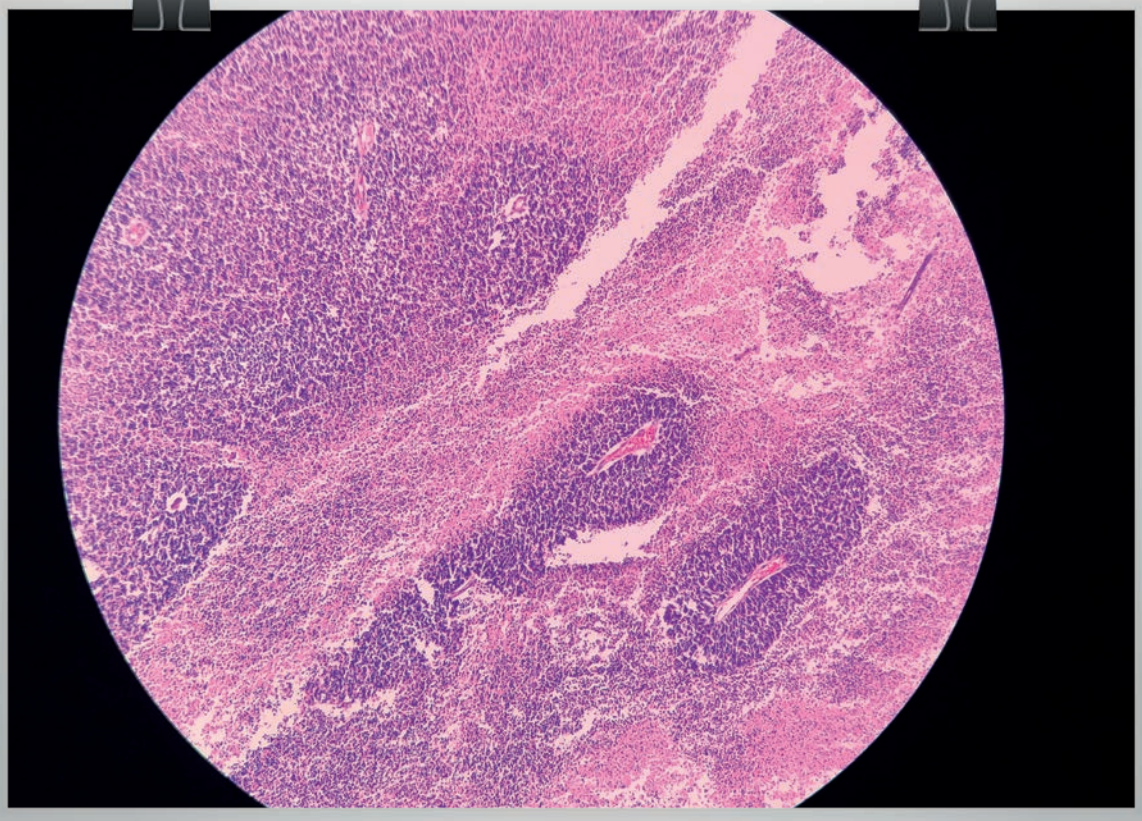
Image of the Month



Beauty from Darkness

The image shows hematoxylin and eosin-stained sections of enucleated eyes from a four-year-old patient with retinoblastoma.

Credit: Alicia Nunez Abreu, Hospital HOMS, Dominican Republic

Do you have an image you'd like to see featured in The Ophthalmologist? Contact edit@theophthalmologist.com

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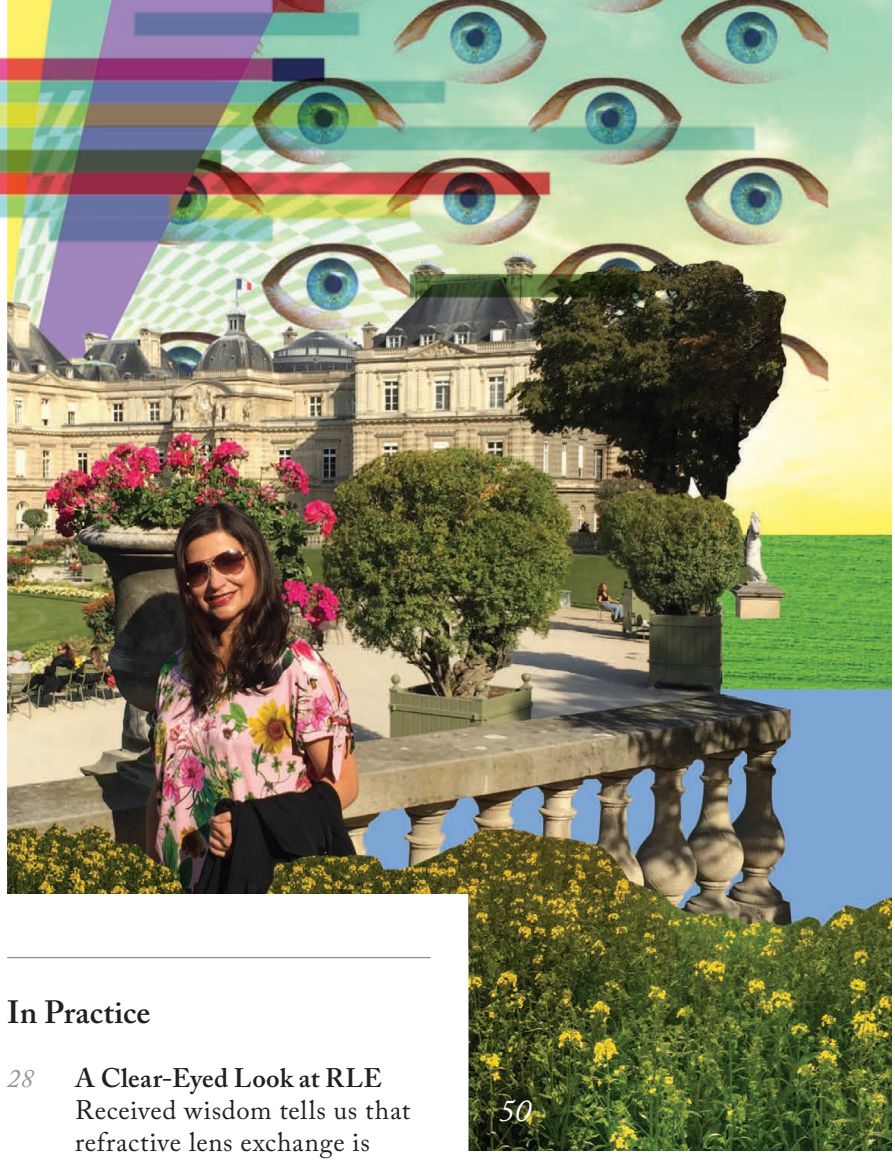
Mariya Moosajee, Lisa Nijm, Georgette Pascale and Cynthia Matossian are four of the women who shared their stories for our 'Women in Vision' feature.



In Practice

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ISSUE 27 - NOVEMBER 2018

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REFERENCES: 1. iStent *inject*® Trabecular Micro-Bypass System: Directions for Use, Part #45-0176. **2.** Hengerer FH. Personal experience with second-generation trabecular micro-bypass stents in combination with cataract surgery in patients with glaucoma: 3-year follow-up. ASCRS 2018 Presentation.

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Let There Be… Lasers

As a Nobel Prize in Physics goes to a woman for the first time in 55 years, we shine a stark light on the issues faced by women in ophthalmology.

It is reasonable to assume that history will view 2018 as a watershed year for the advancement of women in society, not least because Donna Strickland was among the Nobel Prize winners in physics. To date, only three women have ever won the prestigious prize in this category – the first being my fellow countrywoman, Marie Skłodowska Curie.

The many ophthalmologists who perform countless corrective laser eye surgeries every year would struggle to do so without the work of co-winner Gérard Mourou and Strickland, who described "chirped pulse amplification" in 1985. With the ground-breaking technique, it was suddenly possible to pack much more light into a tiny area, dramatically increasing the intensity of the laser pulse. In doing so, lasers were better equipped to revolutionize physics, chemistry, and, of course, medicine.

Comparing herself with the previous female Nobel Prize Physics laureate, Maria Goeppert Mayer (who conducted much of her research in unpaid positions), Strickland felt that she had always been treated as an equal. But that's not necessarily the reality for many women working or starting their careers in STEM fields, as evidenced by numerous studies and direct reports.

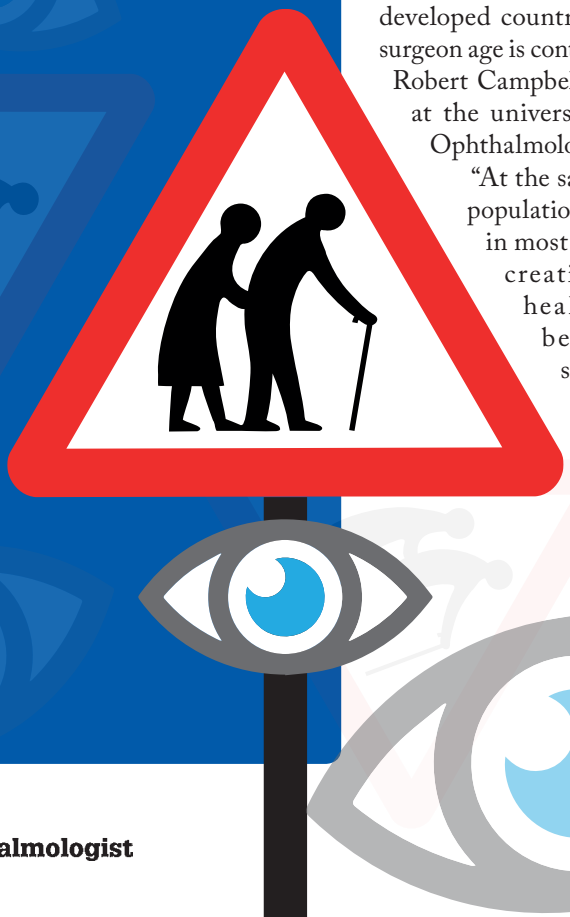
The first step to breaking the barriers that prevent women from progressing in science and medicine is by acknowledging, understanding and then discussing the organizational and institutional challenges that women face every day. In our November issue – my first as Editor – Phoebe Harkin gives voice to influential figures in ophthalmology to uncover what it's really like to be a woman in vision in 2018.

Aleksandra Jones
Editor

Upfront

Reporting on the innovations in medicine and surgery, the research policies and personalities that shape the practice of ophthalmology.

We welcome suggestions on anything that's impactful on ophthalmology; please email edit@theophthalmologist.com



Too Old to Operate?

A Canadian study asks: are older physicians an increased risk to patients during surgery?

The old adage, "with age comes wisdom," has been put to the test by a team at Queen's University, Ontario, Canada. In an attempt to establish whether age increases the risk of adverse surgical outcomes, researchers studied almost half a million cataract operations between 2009 and 2013 (1). Of the 416,502 participants in the study, 29.7 percent of surgeons were 81 years or older.

"Late-career surgeons play a large role now in many areas of healthcare, including cataract surgery, which is the most common operation in most developed countries, and the average surgeon age is continuing to climb," says Robert Campbell, Research Director at the university's Department of Ophthalmology.

"At the same time, the overall population is continuing to age in most developed countries, creating a demand for healthcare that can't be met by younger surgeons alone. As a result, we're reliant on late career surgeons to provide a large portion of surgical care, and understanding how that affects quality of care is very important."

So how did they fare? Well – really well. "Our study suggests that surgeons operating at later career stages provide high-quality, low-complication cataract surgery," says Campbell. Later-career surgeons performed a substantial proportion of cataract operations – one third of the overall patient sample – with surgical complication rates similar to those of midcareer surgeons. "This likely stems from a few factors including that surgeons are staying up to date with technical innovations in the field and also that older surgeons are retiring at appropriate stages, before issues arise."

Of the four individual complications, the only increase in risk concerned dropped lens fragment (0.11 percent) and suspected endophthalmitis (0.045 percent). "It's important to note that overall complication rates were not higher among late-career surgeons," says Campbell. "Additionally, the absolute risks of these two specific complications were very low among both groups of surgeons, and, as a result, the difference in risk between older and younger surgeons was actually very small."

Campbell notes that, with all studies, there is a risk that associations occur just by chance – however… "Alternatively, the findings cannot rule out the possibility that some late-career surgeons may be less equipped to deal with some of the surgical challenges that lead to these specific outcomes. We'll have to await follow up studies to understand why this association exists."

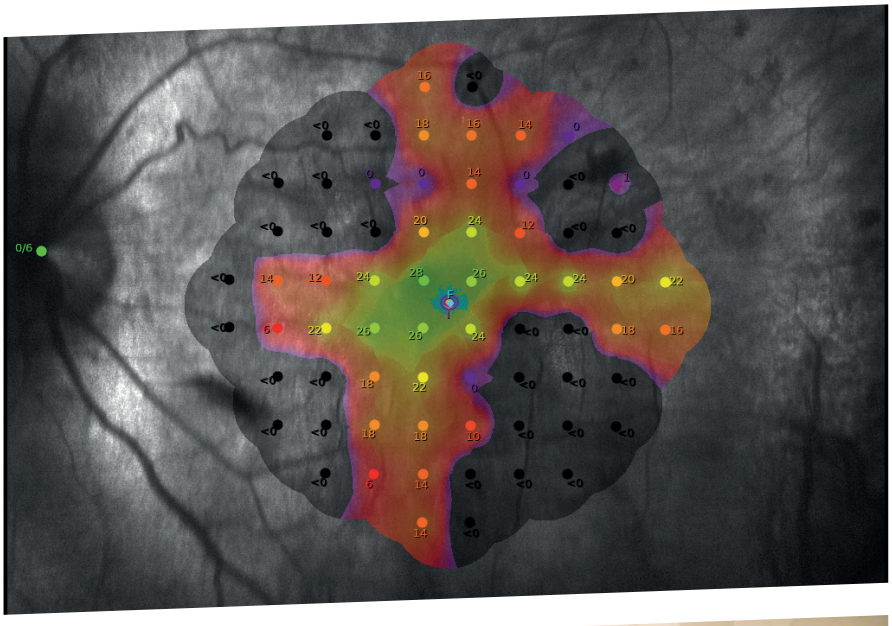
Reference

1. *1. RJ Campbell et al., "Cataract surgical outcomes among late-career surgeons: A population-based cohort study", JAMA Ophthalmology (2018). ePub ahead of print.*

Tackling the Root Cause of Genetic Blindness

Positive results spur a pivotal phase III trial for choroideremia gene therapy

Figure 1. Retinal sensitivity map in a patient with choroideremia.



Two decades ago, Robert MacLaren began working on gene therapies. And the work is paying off, according to a recent publication describing vision improvement in patients who were given retinal gene therapy for choroideremia (1). Choroideremia is a rare (1 in 50,000–100,000) X-linked retinal degenerative disease. It manifests in childhood as an impairment of night vision, and is followed by peripheral vision loss, and then central vision loss later in life.

MacLaren led a 2011 clinical trial at the Oxford Eye Hospital, UK, which assessed subretinal injection of an adeno-associated viral vector that expresses Rab-escort protein 1 (REP1, the deficient protein in choroideremia). The paper in Nature Medicine notes that visual acuity improved in the 14 treated eyes over controls (median 4.5 letter gain, versus 1.5 letter loss, P = 0.04), with six treated eyes gaining more than one line of vision (>5 letters) – despite complications in two patients.

In a related press release (2), MacLaren said, "The early results of vision improvement we saw have been sustained for as long as we have been following up these patients and in several the gene therapy injection was over five years ago. The trial has made a big difference to their lives."

Now, following the success of the Oxford trial, a pivotal Phase 3 trial in 100 patients is being conducted in nine countries across Europe and North America. The company leading it? Nightstar Therapeutics – a gene therapy spin-out founded by MacLaren and established by the University of Oxford and Syncona.

What chance of success? Well, the experimental gene therapy OTL-300 was given PRIME designation by the European Medicines Agency at the beginning of October, so the regulatory landscape for gene therapies is looking rosier than ever.

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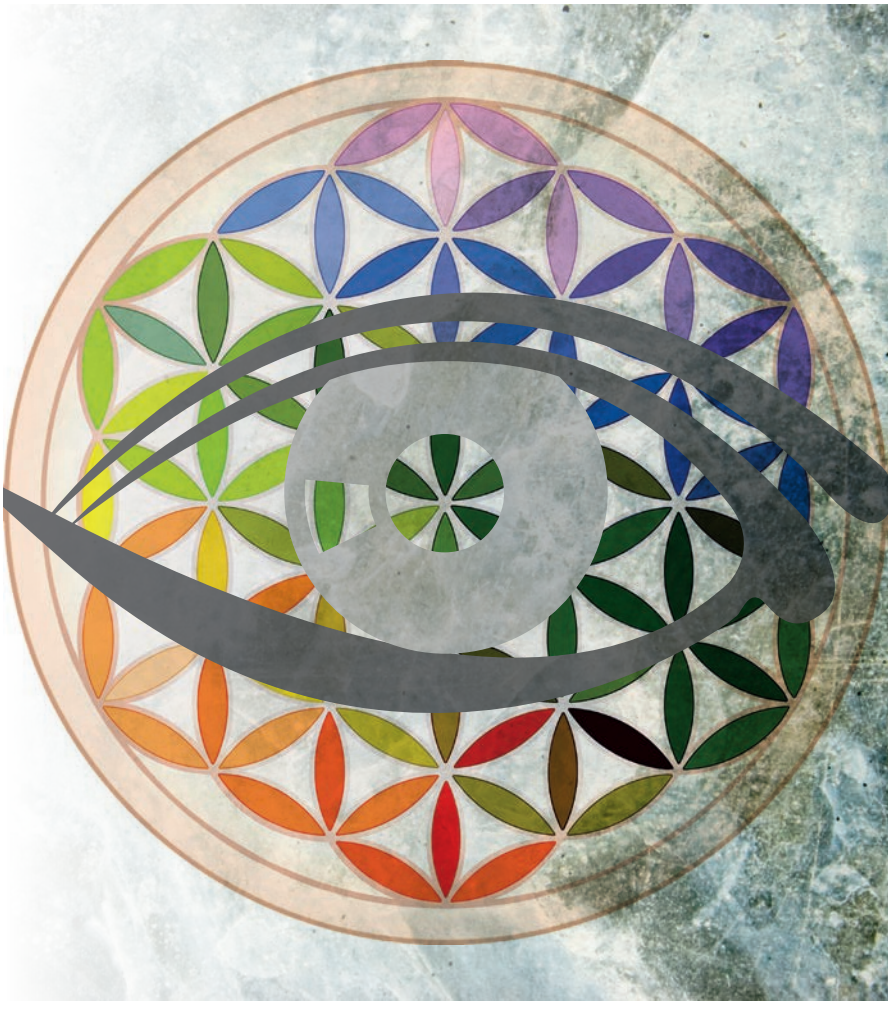
1. *K Xue et al., "Beneficial effects on vision in patients undergoing retinal gene therapy for choroideremia", Nat Med, 24, 1507–1512 (2018). PMID: 30297895*
2. *University of Oxford, "Gene therapy breakthrough in treating rare form of blindness" (2018). Available at: http://www.ox.ac.uk/news/2018-10-09-gene-therapy-breakthrough-treating-rare-form-blindness Accessed October 19, 2018.*

Bitesize Breakthroughs

The latest ophthalmology news – in brief



Color-Contact

- Introducing the (potential) drug delivery system of the future – the self-reporting color-contact lens. Designed by a team at China Pharmaceutical University, Nanjing, it uses molecular imprinting – a technique that creates molecular cavities in a polymer structure – to offer sustained drug release. The lens turns blue when medication is fully released – a shift visible to the naked eye, as well as fiber-optic spectrometers. Researchers hope the lens will provide an effective alternative to eye drops and ointments, which only allow patients to absorb five percent of drugs, with most of the medication going directly into the bloodstream.

Eat Your Greens

- A team at the Westmead Institute for Medical Research claims that adopting a diet rich in vegetable nitrates can significantly reduce the risk of developing early-stage age-related macular degeneration. The study of 2,000 Australian adults found those who ate between 100 and 142 mgs of dietary nitrates had a 35 percent lower risk of developing early AMD than those who ate less than 69 mgs. "If our findings are confirmed, incorporating a range of foods rich in dietary nitrates – like green leafy vegetables and beetroot – could be a simple strategy to reduce the risk of early macular degeneration (1)," said research leader, Bamini Gopinath.

Window to the Mind

- Researchers at the Howard Hughes Medical Institute have found a way to engineer rhodopsins – the light-sensitive proteins used to explore the brain. By flipping proteins in the cell membrane upside down, the team was able to create a diverse palette of tools, potentially doubling the number of proteins available for optogenetics – a technique for manipulating the activity of neurons with light. The engineered rhodopsins are already being used in experiments to study Parkinson's disease (2).

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1. *J Deng et al., "Self-Reporting Colorimetric Analysis of Drug Release by Molecular Imprinted Structural Color Contact Lens", ACS Appl Mater Interfaces (2018)*
2. *Westmead Institute, "Eating leafy greens could help prevent macular degeneration" (2018). Accessed October 10, 2018. Available at: https://tinyurl.com/yb766lqe.*
3. *Howard Hughes Medical Institute, "Expanding the optogenetic toolkit" (2018). Accessed October 8, 2018. Available at: https://tinyurl.com/y7uzfuh6.*

Animal Instincts

A study into the retinal membranes of rodents attempts to shed light on autosomal dominant Stargardt disease and age-related macular degeneration

Stargardt-like macular dystrophy is an inherited disease caused by a mutation in the gene controlling the synthesis of certain polyunsaturated fatty acids (PUFAs). The disease (caused by a mutations of the elongation of very-long-chain fatty acids-4 –or ELOVL4 gene) mainly affects the cone-photoreceptor-rich macula of the eye and results in a loss of central vision – but a question remains: why are rod cells in the peripheral retina – which also require PUFAs for normal signaling – not affected? With the help of a few furry friends, a team from the University of Oklahoma Health Sciences Center tried to find (part of) the answer.

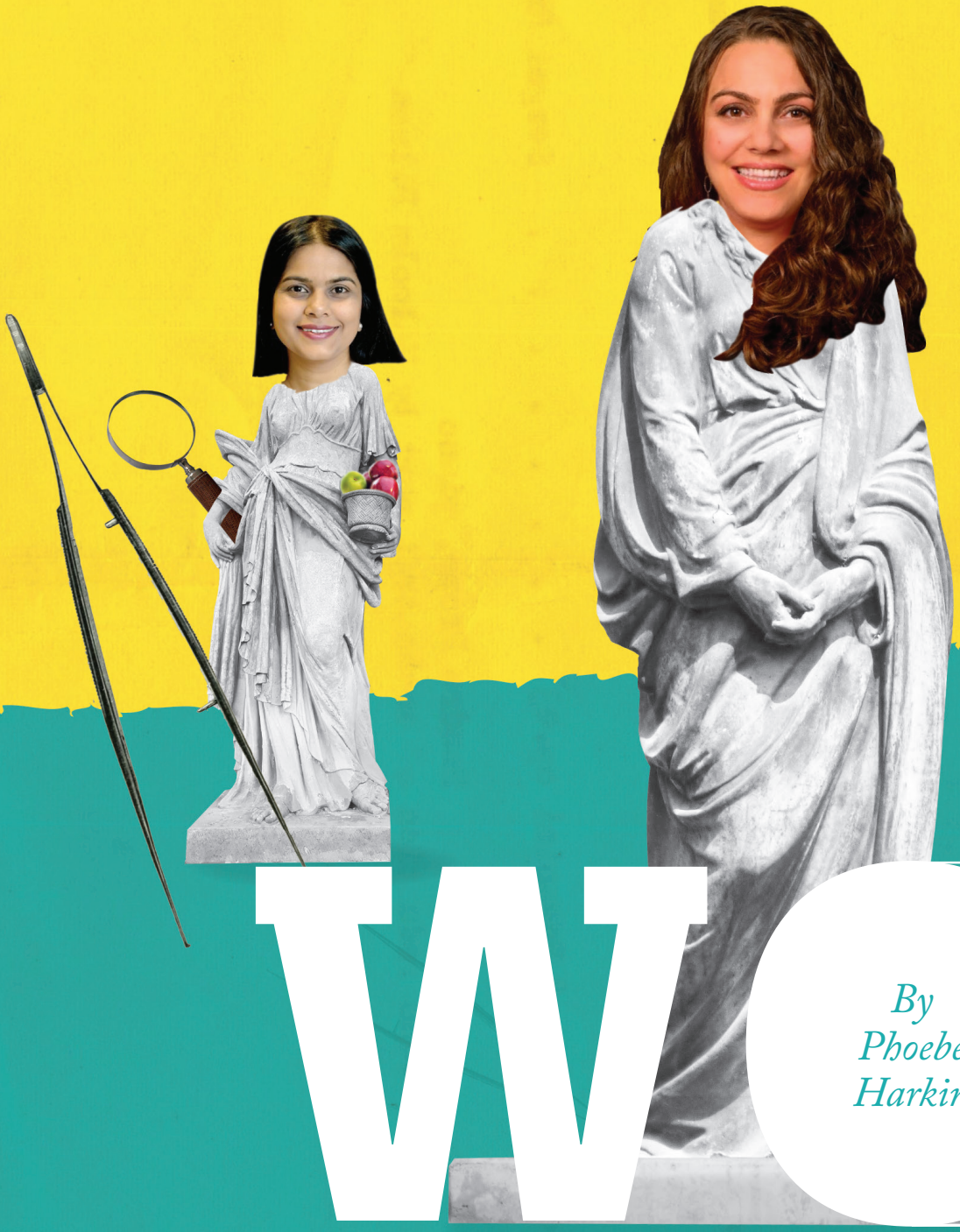
The researchers, led by Martin-Paul Agbaga, performed comprehensive glycerophospholipid analyses to ascertain the differences in fatty acid makeup between rod-rich retinas from nocturnal mice, and cone-cell rich retinas from diurnal animals – in this case, 13 lined ground squirrels, tree squirrels, and tree shrews. The team hypothesized that different PUFA profiles in rod and cone cells could account for their different responses to disease.

The results showed that the membranes of rod-dominant animals had higher levels of long-chain (LC)-PUFAs and very-long-chain (VLC)-PUFAs compared with cone-dominant animals, as well as two-fold higher levels of di-DHA molecular species of glycerophospholipids.

"Our studies confirmed previous research, which highlights significant differences in DHA and VLC-PUFA found in the cone-photoreceptor-rich macula of the human eye relative to the peripheral retina. But our data also show that cone photoreceptors intrinsically have low levels of DHA and VLC-PUFA, which could be due to differences in their metabolic and functional requirements," says Agbaga. "We believe mutations or other factors that cause further decrease in the already low levels of DHA and VLC-PUFA in the cone photoreceptors contribute to disease pathology. In the case of Stargardt-like patients, as ELOVL4 is not involved in DHA biosynthesis, it implies that dietary supplementation of DHA will not be beneficial to them; rather, it is possible that supplying VLC-PUFA could be the best therapeutic approach."

References

1. *M Agbaga et al., "Differential composition of DHA and very-long-chain PUFAs in rod and cone photoreceptors", Journal of Lipid Research, 59, 1586-1596 (2018). PMID: 29986998.*



WIN

By Phoebe Harkin

MEN VISION

In February, we received an email from Rebecca Adams, a reader in Florida. She asked a simple question: "Where are the women?" Her comment was about an article we wrote called 'Ophthalmologists in the Outside World', following two male physicians after retirement. She had a point. The lives of female ophthalmologists are not mentioned nearly as much as those of their male counterparts, and sometimes not at all. And that needs to change. There are more women working in ophthalmology than ever before, yet women remain underrepresented in executive-level jobs and faculty positions. According to statistics provided in The Lancet, women in STEM in general have been short-changed in terms of promotions, higher pay and recognition awards (1), despite making up 54.4 percent of the ophthalmic workforce (2). Earlier this year, the Association of Optometrists (AOP) covered the gender pay gap in the optical sector. It found women were paid between 7.9 percent and 22 percent less per hour than men. Even Moorfields Eye Hospital, one of ophthalmology's leading institutions, had not achieved gender parity – while women represent 51 percent of their highest paid positions, they also represent 71 percent of their lowest paid positions (3). As a publication, we have a responsibility to explore the issues faced by the women in our field, now more than ever. In this feature, we ask 10 ophthalmologists to tell us what is really going on in vision science today. Though they may come from a variety of backgrounds, and might have encountered different hurdles along the way, they all agree on one thing: we need to celebrate how far women have come – but we also need to be honest about how far there is to go.

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VOICES OF VISION SCIENCE

From motherhood to #MeToo – six ophthalmologists give their take on the issues facing women today.

Shahina Pardhan, Director of Vision and Eye Research Unit (VERU), Anglia Ruskin University… On academia

On my first day as a university lecturer, I was barred from entering the senior common room because 'secretaries were not allowed." Back then, that's what women in education were expected to be. Although I'm no longer the only female lecturer, academia itself is still far from equal. As with all professions, women struggle to juggle work with home life commitments, and often lack confidence in their own abilities. Perhaps it comes as no surprise then, that there are 4.5 times as many male professors as female professors in optometry in the UK – women simply aren't represented in senior positions.

Studies have found that external hiring processes – like headhunting – are more likely to work against women who are very capable, but just don't perform well in interviews. So what can we do about it? Ultimately, the impetus doesn't just lie with institutions, it lies with individuals too. Women need to overcome the fraudulent or imposter image they have in their minds to reduce self-doubt, while men need to distance themselves from the 'old boys' network' by actively reducing gender inequality. In some networks it is still possible to hear "I know just the man," whenever a job becomes available – it only serves to keep women from positions of power.

Institutions also need to take into account how absences, such as maternity leave, flexible working patterns and caring responsibilities affect research performance during promotion processes. Differences between internal and external hiring processes can also be addressed by institutions spotting talented individuals early and nurturing their leadership skills.

It might sound daunting but you can do it – and don't let anything or anybody try to stop you! If you start losing confidence, look at women around you for advice. It was only with the help of my family and line managers that I was able to break down some of the barriers in front of me.

Hugh Taylor, immediate past president of the International Council of Ophthalmology… On making change

As men, we have a responsibility to challenge ourselves – and those around us – to consciously think, "Who are the outstanding women in our field and why haven't we asked them to join us?" One of the things I was most proud of during my time as president of the ICO was being

recognized as a "Champion for Change" by the Women in Ophthalmology group. When I first started at the ICO, there was only one woman on the board. People used to describe the ICO Board as a group of old men and their grandfathers! This year, a quarter of our board members and a third of our committee are women. Studies have found that when you reach 34 percent – in our case, of women – on a board, in a committee or in a group – that's when things start to change. We're at the tipping point now.

It is equally important for women to take an active role by identifying people they see as leaders, or to nominate themselves for positions. If you are self-conscious about putting yourself forward, please don't hesitate to nominate your peers or colleagues who are doing outstanding work. Don't be intimidated, don't be shy – just go for it.

I remember listening to female parliamentarians talk about party members making a conscious effort to consider female candidates for positions where previously they might have said: "There won't be any women who would be interested in doing this, we will just look at the men." But for greater involvement of women, you need women who are willing to put their hand up and show they are interested – that's where women can take an active role.

> "As men, we have a responsibility to challenge ourselves – and those around us – to consciously think, 'Who are the outstanding women in our field and why haven't we asked them to join us?'"

Laura Periman, Director of Dry Eye Services and Clinical Research, Seattle, WA, USA… On residency

When I started my residency, women were outnumbered 20 to one. Although my experience was positive overall, there were definitely times I felt left out by my male colleagues. I'm not just talking about the 'guys' poker nights' I wasn't invited to. It was the overt expressions of sexism – harassing comments that male colleagues simply wouldn't get – that made me feel discounted. Motherhood was an issue, too. We had a couple of residents deliver while I was there and I was shocked at the disdain they incurred from the men: "How did you enjoy your vacation?" and "I can't believe I had to cover your call." Yet when two male residents required a leave of absence, it was met with phenomenal support. Why can't pregnancy be met with the same? Of course, some discrimination was more subtle. Female residents were described as bossy, rather than assertive. Emotional, not passionate. Demanding, not precise. Unfortunately, it is still common to hear women addressed by their first name while men are referred to as "Dr" in clinic, on panels, and in internet colleague chat groups. I don't think it is always intentional, but those words limit and diminish power – and I'm more comfortable in correcting it with collegiality and kindness. Things are moving in the right direction. There are more female residents than ever before and though there are still going to be problems in the next chapters – fellowship and private practice versus academia – and the different glass ceilings that exist, we have a chance to make it easier for them. The way to do it is through feel-good stuff, putting a spotlight on heart-first leadership – like the kind championed by OWL, who acknowledge and award supportive leaders. I am fortunate enough to have had the support of many wonderful colleagues – including my friends at the Cedars/Aspens group. These men are some of the most I've ever worked with, and they deserve to be recognized.

While serving on mentorship panels at Millennial Eye 2018 this fall, I was delighted by our young ophthalmologists' egalitarian and meritocratic world views and supportive attitudes and actions towards each other. We have a golden opportunity to support the future leaders of our field and I feel a personal responsibility to help smooth the way. The future looks bright indeed.

Cynthia Matossian, Founder and Medical Director of Matossian Eye Associates, Mercer County, New Jersey, and Bucks County, Pennsylvania, USA… On saying yes

The most obvious discrimination I ever experienced came from the former owners of my practice. I was buying the ophthalmology section from two EENT brothers. The sale progressed as normal – until it came to signing the definitive purchase contract. They refused to

honor my signature because I was a woman. My husband (who had nothing to do with medicine, let alone ophthalmology) had to countersign. And this didn't happen in some small conservative town – this was New Jersey in 1987! Thankfully, things have changed for the better.

Women are now taking on leadership roles within academic institutions, in private practices, writing articles, moderating panels, and are active at the podium with presentations. The visibility of women at conferences as a whole has dramatically increased. There is an understanding that diverse, inclusive teams approach problem solving in more creative ways than homogenous groups. People in leadership roles are becoming more cognizant of gender differences as they build their management teams.

Being more proactive also makes a difference. Take speaking opportunities, for example: women are more likely to wait for an invitation than to ask for an opportunity. I remember a discussion with one of my male colleagues regarding speaking roles and how one goes about getting invited. He said, "All you have to do is ask!" So I took his advice to heart and started to put myself forward, saying: "I'm very interested in participating in this meeting, and if there's an opportunity to speak, please let me know." Once I put my feelers out, the invitations followed suit. So to women starting their careers, know that many women ahead of you have charted the path to success. If you have the initiative and the desire, the sky's the limit.

Michelle Cabrera, Associate Professor of Ophthalmology and Associate Director of Medical Student Education for Research at the University of Washington and Seattle Children's Hospital…
On #MeToo in Ophthalmology

Fifty-nine percent of female ophthalmologists in the United States experience sexual harassment at some point during their careers. Although many incidents occur after training, most victims are medical students or residents – and I was once one of them. I was in the patient room during my residency when an attending touched me inappropriately. At first, it seemed like an accident, but when it happened multiple times on multiple days, I realized it wasn't. I found out he had done the same to others in my department. Many laughed it off, but some were so impacted by his behavior that they changed careers. A decade passed and I learned the attending was still harassing residents – and the incidents were escalating. I realized then that by not speaking up sooner, I was paving the way for others to be victimized, many more vulnerable than I was. So this year,

> "2018 has shifted the needle on how we view sexual harassment as a society. We can no longer stay silent when it comes to abusive behaviors. We need to speak out."

a handful of us spoke out and the attending stepped down from his position.

It is fair to say 2018 has shifted the needle on how we view sexual harassment as a society. We have realized that we can no longer stay silent when it comes to abusive behaviors. We need to speak out. By doing so, we make victims of harassment feel less alone, support their efforts to expose the wrong-doing of the perpetrator and, ultimately, stop the harasser from harming others. We need to do the same in ophthalmology. We can start by adopting a zero-tolerance policy on sexual harassment in our workplaces and in our national organizations. Policies should also be put in place to investigate and handle complaints and to support victims.

On an individual level, we need to start speaking up for victims. If you witness or learn about cases of sexual harassment, encourage the victim to report the incident and take action to support the victim – it is the only way to send a clear message to the harasser and others that this behavior is not acceptable. I feel hopeful that we, as a field, can accept the reality of what is happening all around us. Only when we do that, can we improve the lives of women in ophthalmology.

Mariya Moosajee, co-founder of Women in Vision UK and consultant ophthalmologist at Moorfield's Eye Hospital… On representation

Whilst I was a senior house officer in neurosurgery, I had lunch with my consultant in the hospital canteen. He said to me, "Look around. Why do you think there are no female consultants here?" I said I didn't know.

"It's because your hormones will kick in and you will go off to have children," he said. My reply: "Yes. And they'll be back, so what's the big issue?"

These are the attitudes we are fighting against today. Being a mother shouldn't preclude you from being a consultant in a field, no more than being a woman should stop you from holding a senior position. But if you look at all the boards, they're almost entirely male… Male chief executives, male finance directors, male medical directors of strategy. In fact, 75 percent of consultant ophthalmologists in the UK are men. Some people believe that 25 percent being women is a good statistic, but I don't. We're drowning in senior male figures.

If you look at the applications for clinician scientist fellowships, you see a disproportionate number of applications from men, and thus, a much higher proportion of successful men. Look at ethnicity: it is hugely weighted towards Caucasians. Ultimately, it's fine to publish these findings and say we're in support of a more representative workforce, but unless we start to see change, we're just condoning it.

And that's the stage we're at now. To truly change things, we need to face up to the fact we're self-selecting for this specialty. It's not as if women are not qualified for these jobs; they simply don't have the same networks or opportunities as men. If we want equality and fairness, both men and women need to work together for change.

FIGHTING THE SYSTEM FROM WITHIN

Selwa Al-Hazzaa is one of the most influential women in the Arab world. Despite challenges, she has achieved international success, professionally, medically, academically and politically, and is now empowering other women to reach similar heights. This is her story.

When I was a first-year resident, I won the SOS 'Best Research Award'. The opening ceremony was to be held in Jeddah, a city far from Riyadh, where I lived at the time. I was invited to receive my certificate with recognition. I remember sitting in the elegant conference hall, waiting for my name to be called per the ceremony announcement card – but it never was. At the intermission, I asked the person in charge what happened, why was my award not announced? I was informed the agenda had been made before they realized the recipient was a woman. Rather than presenting the recognition and award during the opening ceremony with all the officials, they would present it in the scientific meeting the following day instead. I asked why. He said: "There are cameras and we don't think it's appropriate for a woman to be broadcasted on stage." I asked to speak to whoever was next in charge, and he pointed me to the head of the Ophthalmic Society, a royal. I introduced myself and explained that I had come all the way from Riyadh per the society's invitation to receive recognition during opening ceremony. I had a family member with me who would be reporting to my parents, parents who had paved the way for me be there. I said I deserved to get my award. He asked what he was supposed to do with the TV broadcasting. I replied: "There is no need for my part to be televised." So it wasn't. I got on stage and collected my award. There were no lights, no cameras, no photos – no one would even shake my hand.

I attended the same ceremony 15 years later as a leader in the ophthalmic field, and was seated in the front row. I watched as a female colleague won the best research award, just as I had 15 years ago. The cameras were on as she shook hands with the minister, royalty, and other officials. It thrilled me to see how my persistence and courage had eased the path for the next generation.

IN THE SPOTLIGHT

Today, I am Chairman of Ophthalmology at King Faisal Specialist Hospital and Research Centre – the first female to be department head in the hospital's history. I have had the privilege of being the late King Fahad's personal ophthalmologist, able to go into a palace where no woman of any nationality had been allowed before, and was a senior advisor to the previous Minister of Health. Like any successful woman, I have had to struggle to get where I am today. Nothing was given to me, I forged my own path. Of course, I experienced obstacles along the way, but if I hadn't faced those obstacles, I wouldn't be as strong as I am now. It was those challenges that made me so resilient. As a woman, I have had to work ten times harder than my male colleagues – but when I do succeed, I get ten times the credit, so it balances out in the end.

When I was chosen as department head in 1997, my superiors considered my skills and credentials over my gender – and I share that philosophy. I believe we are all colleagues, regardless of gender, ethnic background, or religion. I preach to my students: there are no short cuts to being a leader. You

> "I decided right then that I was going to prove that a female can make a difference for her country."

> "There are no short cuts to being a leader; you have to have a strong foundation. Build yourselves up, and if you fall, fall forwards as it is easier to get back up."

have to have a strong foundation. Build yourselves up, and if you fall, fall forwards as it is easier to get back up. One recently said to me, "You are so lucky, you have no more challenges." But she was mistaken. Every morning is a challenge because I don't know what I'm up against. When I'm in the hospital, I'm protected because I have proven myself there. When I leave that environment, I am no longer a physician in a protected environment. But I believe in the saying 'when in Rome, do as the Romans do,' so I try to fit in. I have never fought the system from the outside. I learn the system inside out, and fight it from within. Colleagues may despise me, but they can never hate me or hurt me because I am part of them. It is only by getting to know the system that I have been able to challenge it and help my fellow colleagues.

POKING HOLES THROUGH THE MUD CEILING

We have to remind ourselves that as some of the first women in ophthalmology, we are pioneers and like all pioneers, we are faced with challenges. I remember being appointed to an all-male committee and sitting quietly for the first two meetings, despite having answers to the subjects being discussed. I wanted my male colleagues to feel comfortable with the fact I was the only female there. That's important because most men, no matter who they are – Saudi, American, European – have an ego. That's just the way they are made. It took a while but once they realized my skills, they became accustomed to my presence. Only then did I start to progress and flourish.

In Saudi, we don't have a glass ceiling, we have a mud ceiling. We are told to our faces, "This is your boundary, you cannot cross it." But the good thing about mud is that you can always make a hole in it, and I have done that repeatedly. You just need to be patient and resilient. When things get hard, remember there is a light at the end of the tunnel. Even if you progress three steps forward and get pushed back two steps, you are still one step ahead. I got this positive mentality from my father. He came from a wealthy family who thought you did not need to read and write when you have money. But my father wanted to go to school. After a hard day's work, he would pretend to be blind and go the nearest mosque to practice reading and writing while his family slept. During his home schooling days, he got married to my mother and had five daughters, studying all the while. Upon graduation, my father was accepted for a scholarship to study in the United States. When he informed his family of his desire to continue his education, they refused. They gave him an ultimatum: "If you want to go, you have to leave your five girls behind." Although my father preliminarily agreed to keep the family content, he had other plans in mind. He ensured that we were with him in the States, defying his family's desires. I was 16 before I saw Riyadh again.

A TURNING POINT

The journey from King Khalid International Airport was a turning point in my life. I remember sitting with my sisters in the car, talking to each other in English, our mother tongue. The relative who came to pick us up was the most educated family member and he listened to us in amazement. He turned to my father and said, "Uncle Abdullah, can you imagine if these girls were boys? What they would do to this country with their education and their language?" The doors closed before they even opened. I decided right then that I was going to make a difference in changing this stereotype and prove that a female can make a difference for her country.

I am proud of what I have achieved in making positive changes for my country, my institute and my gender. Even today, female physician candidates are asked in interviews, "What happens if you get married and have children?" It is humbling to hear them reply, "Dr Al-Hazzaa got married and had children, and she is our role model." I know I have made a difference. Some will say the prejudices I have faced stem from the fact I am a Saudi woman, but that is not the case. I have friends in Europe, Asia and United States who have experienced similar prejudices because of their gender. Regardless of what part of the world we are from, as women, we are the minority. It is only when we acknowledge that, can we truly succeed.

Selwa Al-Hazzaa is Chairman of Ophthalmology at King Faisal Specialist Hospital and Research Center, Professor in the College of Medicine at Alfaisal University and Former Shura Parliamentary member.

DOCTOR AND MOTHER

Rebecca Adams, self-proclaimed 'ordinary ophthalmologist' whose letter sparked the idea for this feature, reflects on a life spent between two great loves

I consider myself to be an ordinary ophthalmologist. I have been practicing for a long time and I have seen a great deal over the years. One basic thing I have noticed is that women ophthalmologists are not talked about as much as men. Sometimes they are not talked about at all. And though some of the old attitudes towards men and women have changed, certain social stereotypes are still in full force. Women are still expected to be mothers before everything else. But my love for my family has always been equal to my love of ophthalmology. My husband would probably disagree.

Our home life has been built around my career. If there was an emergency, it took priority over everything else – and I think that's true of a lot of physicians, not just ophthalmologists. To be successful, you need to have a support system. Mine was my husband, who was a parent, bodyguard, assistant and partner – the 'wind beneath my wings' person who allowed me to be the 'star' of the family. It's taken for granted that the wife of the physician will take on that role, but not many men can do it. It's too bad his name isn't on my 35 years certificate from the American Academy of Ophthalmology, because he earnt it too.

Now, like many others approaching retirement age, I am currently working part-time, which is a wonderful transition. It allows the practice to continue to have the expertise and manpower of the ophthalmologist, while allowing the ophthalmologist to have a life outside of the practice. And that's important to most of us at some point in our careers.

Medicine in general is so overwhelmingly time-consuming, there is very little time for anything else. If a woman does have a husband and a family, it is all she can do to combine those into her life – which is why you only seem to hear about women who start new careers after their kids have left home (there's simply no time before that!). Those who have outside interests are exceptional; it seems to me that between ophthalmology and any family duties, most women neglect themselves. Everything else comes first – and you come last.

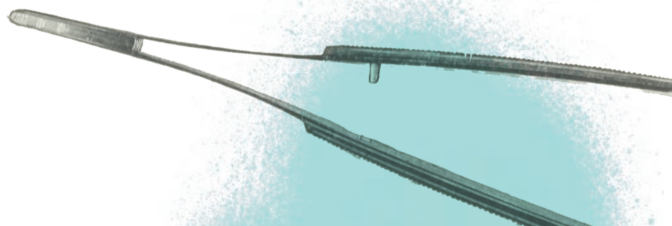
I know that is something that won't change in my lifetime. Women are still going to be the ones who have babies and they're still going to want to spend time with their families. But if we look at specialties where there are very large numbers of female physicians, such as pediatrics, OB-GYN and psychiatry, you find that they are a lot more mom – and women – friendly; they are much better at offering childcare, and the provision of shared or part-time positions.

> "Now that half of our residents are women, hopefully the landscape of ophthalmology will change for the better."

I am hopeful for the future. Now that half of our residents are women, hopefully the landscape of ophthalmology will change for the better – and not just for women. Men need to have family time too.

I remember starting my residency in 1977 and there only being two or three other women residents in the years above me. At the time, they had five paid training positions for each class. The chairman started offering one, sometimes two, of those positions – unpaid – to married women. The concept sounds hard to believe in 2018. The chairman was very traditional – and I'm being kind with that word – just like everyone else running the show in those days. But women couldn't have progressed without that kind of support. In a strange way – sexist though he was – that chairman was the reason more women entered ophthalmology and, in turn, why there were more women mentors. Maybe it was an unexpected consequence of his actions, but it was a consequence nonetheless. And that's worth remembering: for there to be change, you need the help of the oppressors. Someone needs to open up the door and let people in. Luckily, patients have always been very accepting of female physicians and their support has made a big difference, and will continue to in the future.

The next frontier will be achieving a more realistic attitude to work. I can only hope that a balanced workforce will help women – and men – have a more satisfying personal and professional life, without having to sacrifice so much of one for the other.



THE SOCIAL NETWORK

While initiatives like the Athena SWAN charter work to address gender imbalance in higher education, online support groups are fighting for equal representation – and equal recognition – in the wider world. We ask those championing change why, in a post #MeToo era, female ophthalmologists need support more than ever.

"On the surface, one might question why Women in Ophthalmology is still relevant today. The number of female ophthalmology graduates stands between 40 and 50 percent, but admitting more women into residency alone does not achieve parity. When you look at the number of women serving as leaders in organized medicine, receiving major awards for their work or speaking at the podium, the numbers plummet dramatically" says Lisa Nijm, president of Women in Ophthalmology, the group creating safe spaces for women to talk, collaborate and network worldwide. "At WIO, we recognize this deficiency and strive to educate our members on the tools they need for success. We collaborate with our supporters and sponsors to open the door to new opportunities for women ophthalmologists, and showcase our members' talents to achieve their desired leadership goals."

And they have certainly made an impact. Mohita Sharma is founder of Women Ophthalmologists Society of India (WOS), one of WIO's newest chapters: "WIO helped me evolve from a shy, introverted woman to a successful practitioner and surgeon – and I wanted that for my colleagues too. WOS has become a place where women who were once dealing with their challenges in isolation can now discuss them together. It teaches us how to communicate, negotiate and network, and thanks to our surgical skill enhancement and collaborative international research program, it opens up new avenues of growth growth, too."

Femida Kehrani, founder of WIO's Canadian chapter, echoes Sharma's sentiments. "I was very lucky to have been introduced to WIO by one of my Fellowship mentors, Dr Terri Young. I will never forget the kindness and support that was extended to me through this group. The experience inspired me to create a chapter upon my return home. Our meetings provide an opportunity for women to make new connections, learn from each other's struggles and foster growth for the future. We're a community."

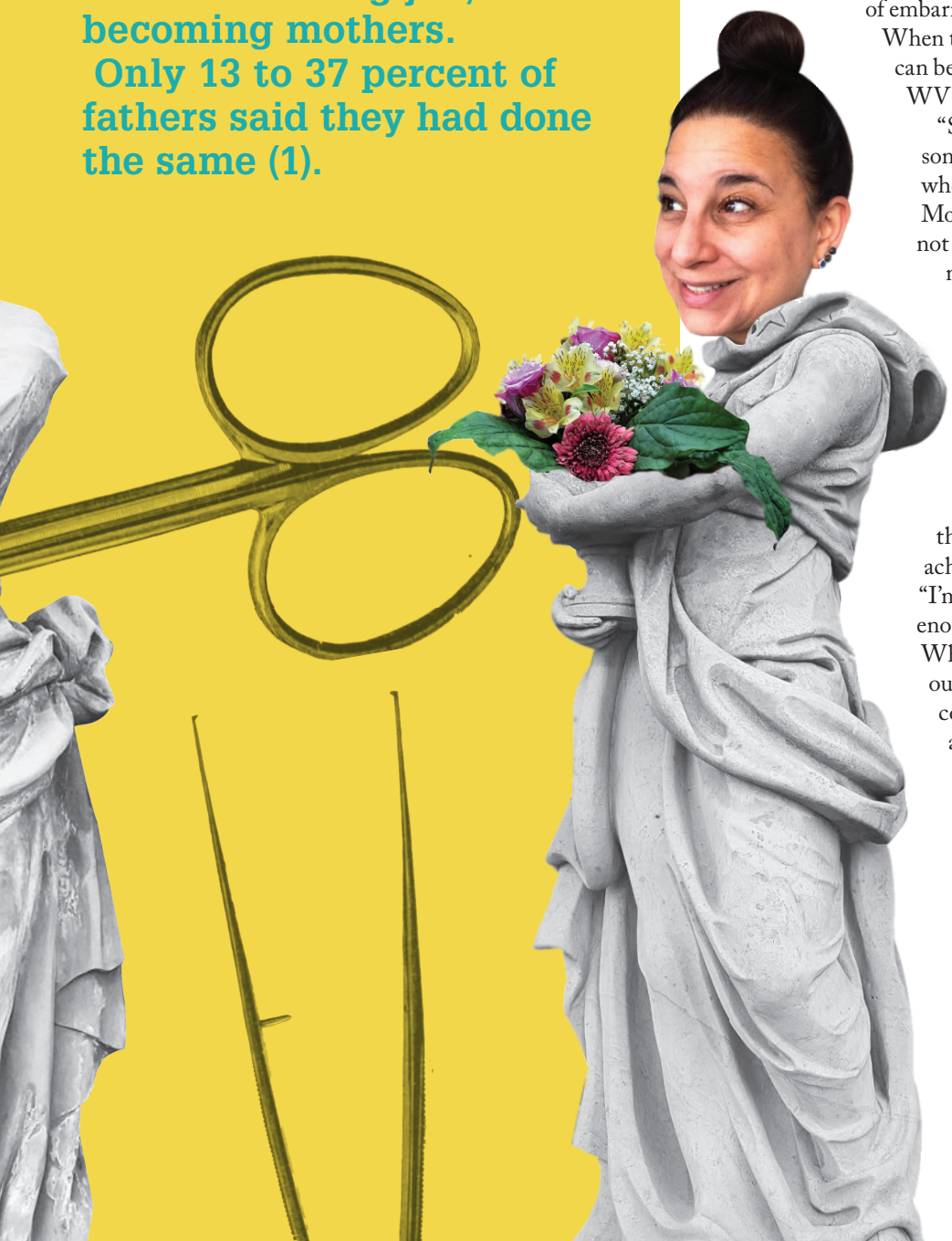
And that community keeps growing. Last year, Maryse Bailly, Mariya Moosajee and Julie Daniels co-founded Women in Vision UK (WVUK). What started as a simple female speakers list to encourage representation at meetings and conferences, has grown into a full support network, fostering collaborations between women in all aspects of vision science, from basic research to clinical practice. Bailly, a cell biologist, only started thinking about gender bias as she developed her lab at the UCL Institute of Ophthalmology. "It became clear that some people were dominant and others weren't. It's not like that in cell biology. It's a much more open field" she says. "In fact, basic science in general is. There are a lot of male egos in ophthalmology."

> "The network we're building is open and friendly. It's not about promoting one person or the other, it's about helping each other."

The network Bailly, Daniels and Moosajee have created is the opposite of a boys' club. "We decided to boost our own interests in a way that doesn't involve going to the pub and drinking beer," she says. "The network we're building is open and friendly. It's not about promoting one person or the other, it's about helping each other." Through a combination of networking and events, WVUK is working to increase the profile of women in ophthalmology and vision related research across the board. "What we want is equal representation," says Bailly. "We promote awards to women on our website and there are plans to start a mentoring programme. Some very eminent women professors and those holding senior positions in industry have already volunteered to help." WVUK will hold its next meeting in December in Liverpool, England. "There will be speakers talking about their work, but also how they got to where they are and what problem they faced along the way," explains Bailly. "It's good to give a bit of perspective on things that occur behind closed doors in research which we don't usually learn about," says Bailly. Along with talks, there will be rapid-fire presentations, question and answer sessions, business meeting, prizes and networking. She explains, "The idea is there will be lots of opportunities for members to mix and make connections."

Networking plays an important part in all these groups for good reason. Opportunities often arise from socializing, such as after-work drinks with senior members of staff – and so job opportunities may be skewed towards men if women are

In eight countries polled by The Economist and YouGov in 2017, 44 to 75 percent of women with children living at home said they had started working fewer hours or switched to a less-demanding job, since becoming mothers. Only 13 to 37 percent of fathers said they had done the same (1).



not invited or unable to come because of home commitments. Mariya Moosajee, co-founder of WVUK and a consultant ophthalmologist at Moorfields Eye Hospital, has her own experience with this 'old school mentorship'. "Since I had children, I don't go out much in the evening and I've hardly ever gone to a pub for a drink after work. I genuinely feel that I work full time and shouldn't then have to, but I know job opportunities can come that way."

But barriers to career advancement aren't just an inability to make the right connections. It is not instinctive for women to promote themselves, it causes a sense of embarrassment for fear of seeming arrogant. When these issues combine, talented women can be left by the wayside. And that is what WVUK is trying to change.

"Sometimes we need to belong to something that's going to put us forward where we as individuals wouldn't," says Moosajee. "Take your Power List, I would not feel comfortable asking someone to nominate me. It feels unnatural. We need to acknowledge that women are not good at promoting themselves, and facilitate a way of doing it where we don't feel uncomfortable," says Moosajee.

"We also need to accept that a lot of that self-doubt comes from Imposter Syndrome. Even though you've got this huge list of achievements, you can't help but think, "I'm not going to get this, I'm not good enough, everyone else is better than me." What we need to start doing is shifting our mind set. We need to breed more confidence in the next generation, and in ourselves – and WVUK can help. There's resilience in knowing that other people have gone through similar situations, and are able to pass on their wisdom."

This is a view shared by Ophthalmic World Leaders (OWL), one of the most established support groups in ophthalmology. Founded in 2003, OWL champions the idea that diverse leadership results in better outcomes – for physicians, practices, organizations and industry. "We're

> "If you look through history, women have definitely been overlooked, but we should stop looking backwards and start looking forward to stop that happening again."

inclusive," says president, Georgette Pascale. "We welcome everyone from those starting out in this awesome industry, to CEOs and beyond. It's such a holistic approach, bringing all these different people together to advance diversity in leadership within ophthalmology, which is what we're all about."

Originally Ophthalmic Women Leaders, OWL now provides professional and personal development opportunities to all members, regardless of gender. "We promote diversity through mentoring, programming, newsletters, and of course, networking," says Pascale. "It's all about making real connections, and that's the invaluable, intangible thing OWL offers."

She explains how members have gotten new jobs or positions on panels after meeting someone at an OWL event. "And it's not just about getting ahead, it's about teaching you how to deal with adversity," she adds. In an increasingly global world, OWL remains one of the leading advocates for diverse leadership. "The benefits are huge," says Pascale. "You can get real time input from people with new ideas, rather than a group of people with a similar vision. Everyone brings something different to the table. It's the culmination of each person's individual talent that makes a great finished product, and can only make our industry stronger."

And it is diversity that is needed now more than ever. "If we work together – both men and women – to bring conscious awareness to the need to advance women in leadership roles, we will change the landscape of ophthalmology," says Nijm, "for the better of our patients, and our profession."

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1. *The Economist, "Men, Women and Work. The Gender Pay Gap", Available at: https://tinyurl.com/ya3sme6o. Accessed September 11, 2018.*

THE PIONEERS

Marguerite McDonald

McDonald became the first person to perform excimer laser treatment in 1987. She was the first to use it to treat farsightedness in 1993 and the first North American to perform Epi-LASIK in 2003. More recently, in 2015, she became the first person in the Americas to perform the EBK procedure. She also holds the prestigious title of first female president of the ASCRS and AAO, in 2002 and 2009, respectively.

Patricia Bath

Bath was the first female staff member at the Jules Stein Eye Institute, the first to head a post-graduate training program in ophthalmology, and the first to be elected to the honorary staff of the UCLA Medical Center. She was also the first black ophthalmology resident at New York University and the first black surgeon at the UCLA Medical Center. An inventor as well as an academic, Bath was also the first African-American woman to receive a medical patent for her Laserphaco Probe.

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A Clear-Eyed Look at RLE

Received wisdom tells us that refractive lens exchange is safe and effective. But what does the evidence say?

By George Beiko

Refractive lens exchange (RLE) is becoming an increasingly common procedure. Typically, people in their early 40s and 50s, who have disposable funds, elect for the operation to address deteriorating vision or gain spectacle independence. In the short term, they appear happy with the procedure; RLE seems to gives them what they want (1). But is patient satisfaction with early postoperative outcomes lulling us into a false sense of security? Some ophthalmologists are starting to question whether RLE is as safe – and effective – as we think. Indeed, in my practice, I now try to talk patients out of it. Why? Because I believe that, for the typical RLE patient, the procedure risks adverse outcomes for little or no long-term benefit. Let's look at the evidence.

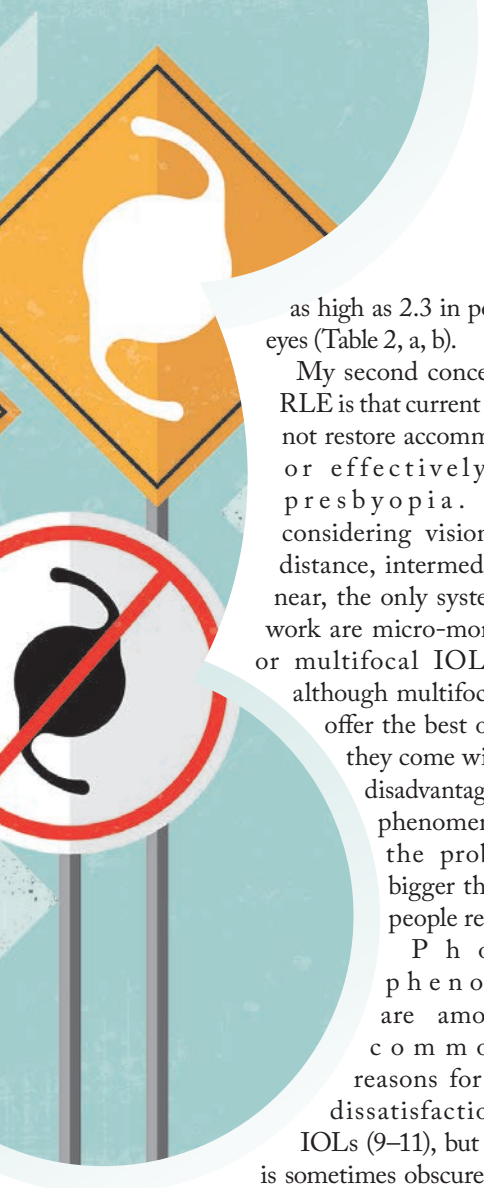
At a Glance

- *For the typical patient, RLE does not satisfactorily resolve dysfunctional lens syndrome, and may cause more problems than it cures*
- *Many implanted lenses cause significant forward light scatter, and none improve presbyope accommodation*
- *Over time, lens implantation increases the risk of photic phenomena, retinal detachment, lens dislocation and visual impairment*
- *It is time to rethink the rationale behind RLE – and re-evaluate whether it is as safe and effective as people think.*

It's useful to consider what visual problems RLE patients seek to resolve, and to what extent current IOLs actually address those problems. Briefly, patients request RLE because they have one or more symptoms of dysfunctional lens syndrome (DLS) – presbyopia, disability glare, decreased contrast sensitivity and decreased night-time vision. DLS symptoms such as disability glare are caused by forward light scatter from an early cataract; it's been said that if the ocular scatter index (OSI) value is greater than one, then you should consider surgical intervention (2). The assumption is that providing an IOL will improve their DLS symptoms – but I believe this deserves to be examined more closely.

My first concern is that the majority of current IOLs actually produce forward light scatter (Table 1) – so they may end up causing the very problems patients hope to escape with RLE. Further, the level of forward scatter associated with IOLs is not trivial – it is similar to that of a mild cataract. The effect has been reported by different groups who looked at various IOLs and at different follow-up times (3–6); in all cases, post-RLE eyes had OSI values in excess of 1.0 – so patients who start with an OSI above 1.0 will again have an OSI above 1.0 after the RLE procedure. Results from our own studies and from the investigations of others (7, 8) have indicated that OSI can be

"Records have indicated that operated eyes have a five-fold higher risk of RD following surgery compared with non-operated eyes, and this risk remains elevated for 10 years following surgery."



as high as 2.3 in post-RLE eyes (Table 2, a, b).

My second concern with RLE is that current IOLs do not restore accommodation or effectively treat presbyopia. When considering vision across distance, intermediate and near, the only systems that work are micro-monovision or multifocal IOLs. And although multifocal IOLs offer the best outcome, they come with a key disadvantage: photic phenomena. And the problem is bigger than most people realize.

Photic phenomena are among the commonest reasons for patient dissatisfaction with IOLs (9–11), but this fact is sometimes obscured by the very low self-reported incidence of dysphotopsia (0.2–1.5 percent). When you proactively ask patients about dysphotopsia symptoms, you find that the real incidence is between 20–77 percent. In other words, about half of IOL recipients have some photic phenomena (12–17). This frequency of visual disturbance is even supported by statements on multifocal IOL package inserts, with glare and halo incidence alone reported to be about 20 percent (18, 19).

Collectively, the weight of evidence suggests that RLE fails to improve symptoms of DLS. So why are we recommending a procedure that has little benefit? I think the actual situation is worse still: RLE may actively increase risks for patients.

Increasing risks

We should remember that IOL implantation is not risk-free. Retinal detachment (RD) may be a particular concern. In the general population – those who have not received ocular surgery – the RD risk is very low (0.0061–0.0179 percent per year). For those who have undergone phacoemulsification the risk rises, reaching 3.6 percent over a follow-up period of four months to two years. Even more tellingly, data from over 200,000 patient records have indicated that operated eyes have a five-fold higher risk of RD following surgery compared with non-operated eyes, and this risk remains elevated for 10 years following surgery (20). And younger, more myopic patients – that is, the ones who are most likely to elect for RLE procedures – actually have a 25-fold higher risk of RD than the standard cataract patient (21). Moreover, because they are younger patients, this risk is elevated for a much longer proportion of their lifetime than an older patient.

We also need to consider IOL decentration – which can occur in around 25 percent of all cataract patients – and dislocation. The frequency of dislocation increases over time: at 10 years there is a one percent risk of IOL dislocation requiring surgery, a 0.7 percent risk of pronounced pseudophakodonesis and a 1.4 percent risk of moderate pseudophakodonesis (22). Concerningly, the frequency of IOL dislocations seems to be increasing (23): in a retrospective cohort study of 140 eyes, the cumulative risk of late dislocation was found to be significantly higher ($p<0.001$) in patients who were operated on between 2002 and 2012 compared with patients who had IOLs implanted between 1992 and 2001.

We must conclude that some aspect of more recent IOL procedures increases the subsequent dislocation risk; we don't know the cause, but we should be aware of the effect – and advise our patients accordingly.

Optical quality

Finally, we should remember that the optical quality of an implanted IOL is not constant, but degrades after implantation. Acrylic IOLs (such as AcrySof, which has over 100 million implantations worldwide) are known to develop significant glistenings

IOL	*Number of patients*	*Follow-up (months)*	*OSI*
Alcon SN60WF	40	3	1.38 +/- 0.73
Alcon SN60WF	22	12	1.6 +/- 1.0
Alcon SA60AT	17	11	1.8 +/- 1.4
Acri.LISA 366D	20	3	1.83 +/- 0.91
AcrySof IQ ReSTOR	20	3	1.82 +/- 0.76
AMO Tecnis ZM900	20	3	2.00 +/- 0.74

OSI, ocular scatter index

Table 1. Post-RLE OSI per IOL (3–6).

	Alcon AcrySof (82)	*AMO Tecnis (99)*	*P Value*
Months post-op	57.09 +/- 20.50	62.51 +/- 17.05	0.054
OSI	2.01 +/- 1.36	1.65 +/- 0.92	0.033

Table 2. (a) OSI values for AcrySof and Tecnis IOLs at ~5 years post-implantation (7).

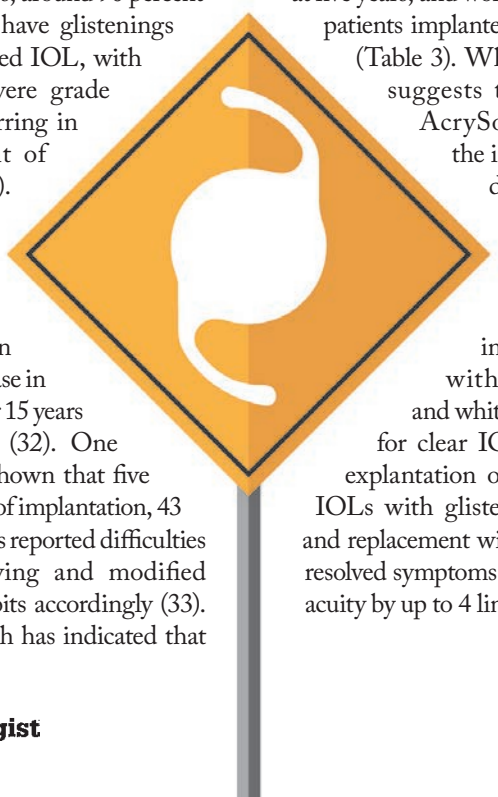
	AcrySof (42)	*Control (17)*	*P Value*
Age	69.8 +/- 78.3	70.2 +/- 7.0	0.871
Post-op, years	6.48 +/- 2.80	0.59 +/- 0.69	<0.0001
OSI	2.3 +/- 1.2	1.6 +/- 0.8	0.0076

Table 2 (b): OSI values for AcrySof IOLs vs. controls at ~6 years post-implantation (8)

	Alcon AcrySof (82)	*AMO Tecnis (99)*	*P Value*
Months post-op	57.09 +/- 20.50	62.51 +/- 17.05	0.054
Visual acuity (logMAR)	0.788 +/- 0.135	0.836 +/- 0.138	0.020

Table 3. Comparing visual acuity AcrySof vs Tecnis implants (33).

(microvacuoles) and whitenings (subsurface nanoglistenings) over time (24, 25). At three years, around 90 percent of patients will have glistenings on their implanted IOL, with moderate to severe grade glistenings occurring in over 60 percent of patients (26–31). One study has suggested that glistening-induced light scattering can continue to increase in AcrySof lenses for 15 years post-operatively (32). One study has even shown that five years after AcrySof implantation, 43 percent of patients reported difficulties with night driving and modified their driving habits accordingly (33). Our own research has indicated that AcrySof-implanted subjects are more likely to have self-reported road traffic accidents at five years, and worse visual acuity, than patients implanted with Tecnis IOLs (Table 3). What's more, evidence suggests that removing the AcrySof lens ameliorates the increased risk of RD, disability glare and IOL dislocation; our data from five patients has shown that visual acuity is improved when IOLs with severe glistening and whitening are exchanged for clear IOLs (24). Similarly, explantation of multifocal acrylic IOLs with glistenings in the optic, and replacement with monofocal IOLs, resolved symptoms and improved visual acuity by up to 4 lines (36).



Conclusions

My strong feeling is that it is time to rethink the RLE procedure. I recognize that I may be 'swimming against the tide' – but I am not swimming alone. The problems with RLE have started to become apparent to those who think about these matters. For example, this very issue was raised last year by a colleague in Mexico who frequently participates in clinical trials involving innovative lenses, and therefore sees results that may not be well-publicized. It is interesting that Alcon has very recently introduced a glistening-free lens; perhaps this could be read as an acknowledgement of the problems associated with the current generation of IOLs.

In summary, my basic premise is that RLE is not as safe or effective as we believe, and we need to collectively sit back, look at all the data and think again about how it is used. I am not against IOL procedures altogether – but I certainly try to dissuade young patients with clear lenses from electing for RLE. I show them all the data and tell them about the potential problems, and try to persuade them to try contact lenses or even corneal surgery instead. My experience has been that most patients, when presented with the data, decide against the RLE procedure – and I think that's wise.

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Shifting Patterns in Glaucoma Management

Earlier diagnosis, more timely intervention and more rational clinical decisions: the advantages of steady-state pattern electroretinography should not be ignored.

By Peter Good

Current methods of glaucoma diagnosis using visual field (VF) testing or OCT can fall short on their sensitivity to glaucomatous changes, partly because of their dependence on surrogate markers of VF deficits. Even markers which accurately reflect VF loss only signal neuronal cell death – which remains irreversible. Far better would be to diagnose the disease at an earlier stage, when retinal cells are only damaged rather than already dead.

Pattern electroretinography (ERG) detects subtle changes in electrical responses within the retinal ganglion cell (RGC) layer, and is capable of sensing abnormalities well before these cells atrophy and die. As an objective measure of function, the test is much more sensitive to glaucomatous changes than either VF testing or OCT, and provides invaluable data to identify glaucoma suspects and inform the diagnosis and management of glaucoma patients.

The importance of interpretation

Pattern ERG testing has several potential uses when it comes to following a glaucoma suspect patient. But not all pattern ERG tests are equivalent; different modalities used for testing may provide rather different results. In particular, the slower stimulus frequency used in transient pattern ERG systems generates two response patterns: a positivity at ~50 ms (P50) and a larger negativity at ~95 ms (N95) (1), which reflect dysfunction in the macular and RGC regions, respectively. One challenge with transient pattern ERG results is that both P50 and N95 signals interact with signals from adjacent cells and neuronal generators, which can complicate the interpretation of whether pathology resides in the ganglion cell layer, other retinal layers, or structures within the visual pathway anterior to the lateral geniculate.

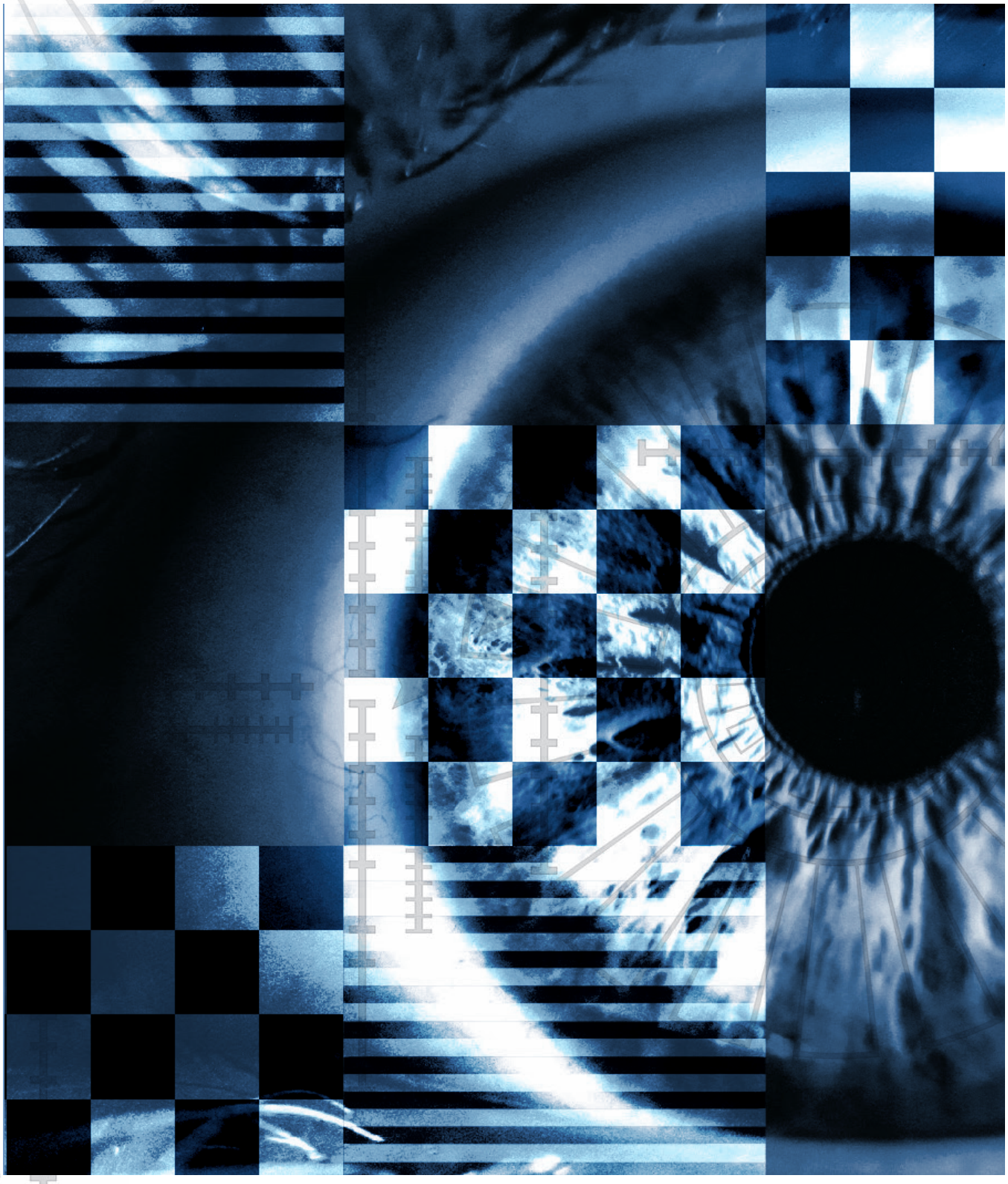
Pattern ERG testing with a steady state modality, like the testing offered from Diopsys platforms, can be much less ambiguous. The steady state modality increases metabolic demand within RGCs, and leads to functional habituation. Any delay in subsequent RGC recovery – changes in phase or amplitude – represents an objective indicator of ganglion cell dysfunction. Some instruments report these abnormalities with a flag system (Figure 1): a convenience which removes the need for subjective electrophysiological interpretation, and assures the clinician that the changes in RGC electrophysiology truly represent a loss of functionality in the cells that matter most in glaucoma.

"Pattern ERG detects subtle changes in electrical responses within the RGC layer, and is capable of sensing abnormalities well before these cells die."

Also, pattern ERG data can work in synergy with other electrophysiological tests – in particular, visual evoked potentials (VEPs). These measure the output of the central visual pathways,

At a Glance

- *Visual field testing and OCT are not always sensitive to glaucomatous changes, delaying diagnosis of disease*
- *Pattern electroretinography (ERG) can detect subtle changes within the retinal ganglion cell (RGC) layer, sensing abnormalities before these cells atrophy and die.*
- *Pattern ERG data works well in synergy with other tests, such as visual evoked potentials (VEPs), which helps differentiate glaucoma-related optic neuropathy from other conditions*
- *Pattern ERG helps monitor therapeutic efficacy so that adjustments can be based on each patient's disease features.*



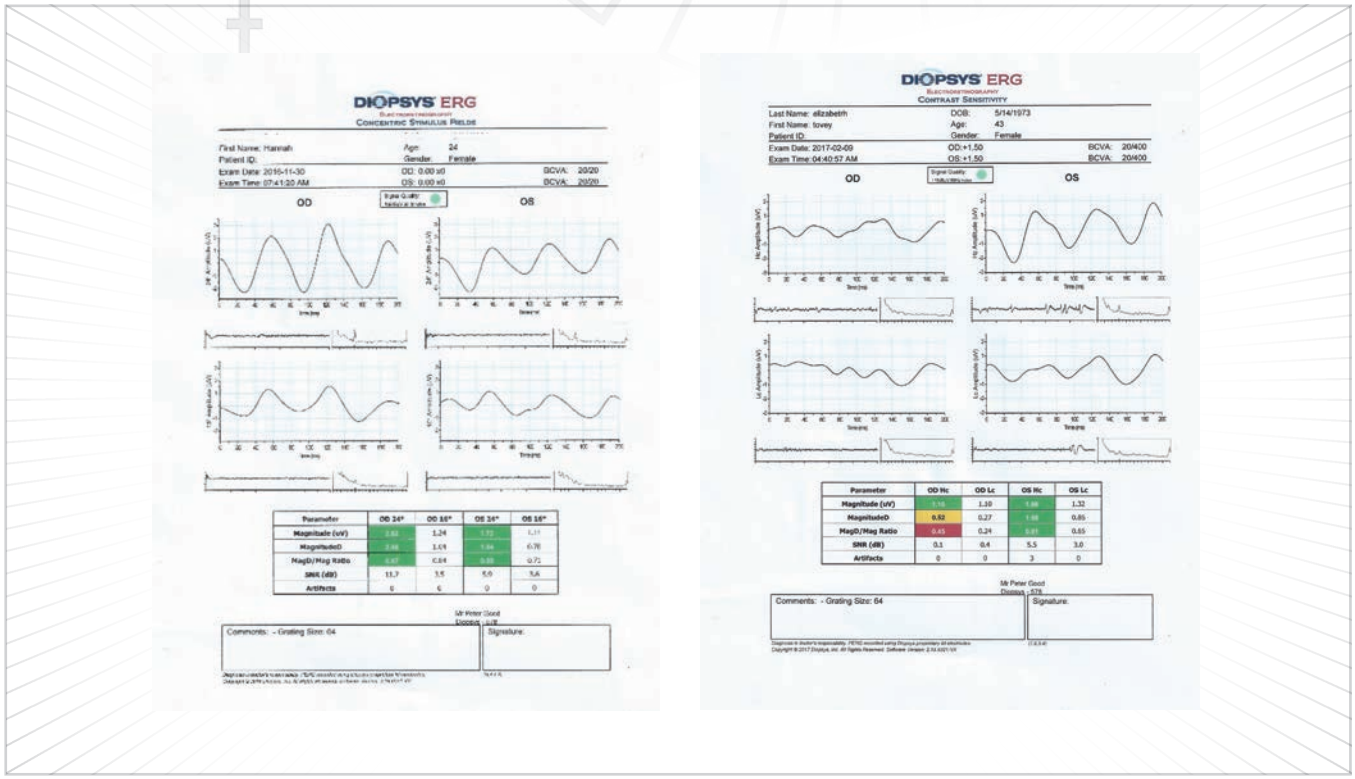


Figure 1. A: Steady-state pattern ERG recording from normal eye. B: Steady-state pattern ERG recording from glaucomatous eye; note the green / amber / red system of flagging abnormal readings.

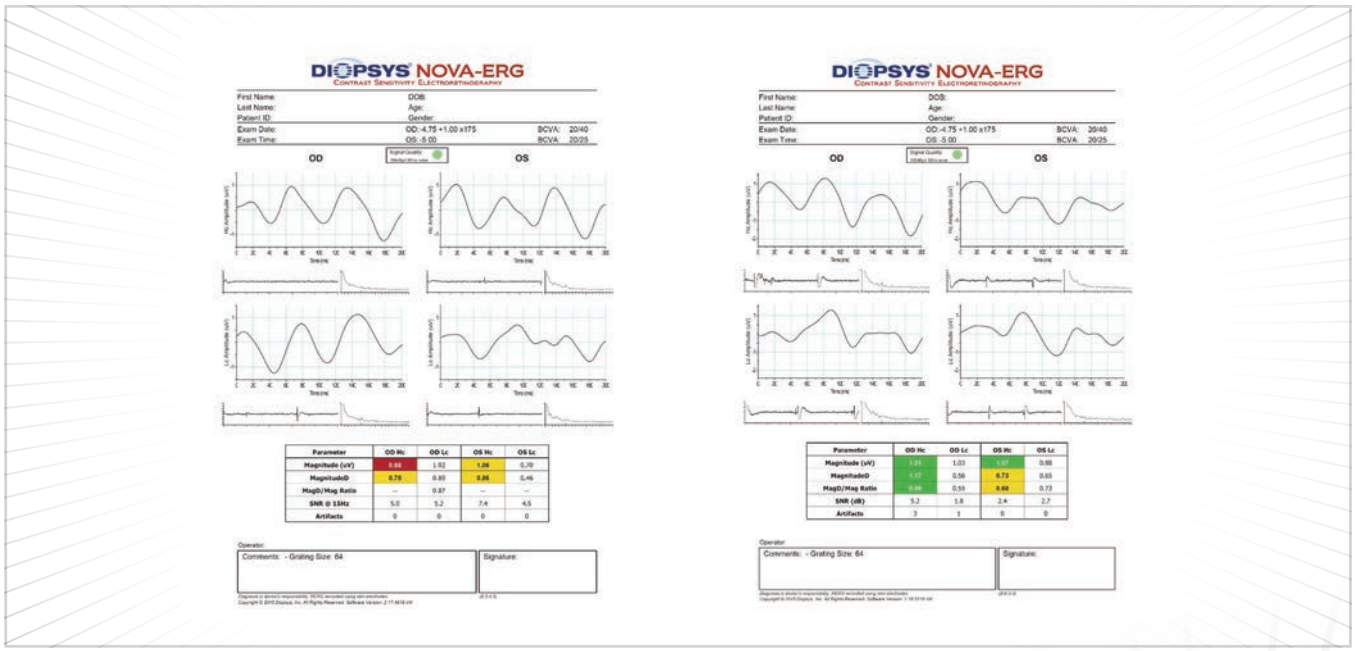


Figure 2. A: Steady-state PERG in an untreated patient with normal VF and OCT findings (IOP 24 mm Hg, both eyes). B: Same patient after SLT treatment; note recovery in steady-state PERG (IOP now 16 mmHg).

The Power of PERG: Three Scenarios

Treatment decisions rarely hinge on a single piece of evidence. More often, good patient management requires consideration of data from many diagnostic modalities. However, different types of information usually have different – and additive – advantages in managing glaucoma patients. Below are three clinical scenarios that describe how I exploit the specific advantages of steady-state PERG in order to develop rational treatment decisions.

Scenario 1: Patient has elevated IOP but no other evidence of glaucoma

- Perform baseline test with steady-state PERG; if results are normal, repeat PERG every 6 months to monitor status
- If PERG remains normal after one year, and no other evidence of glaucoma is apparent, follow-up frequency may be reduced to two-year intervals
- If PERG remains normal after a total of three years follow-up, there is probably no mechanical explanation for the elevated IOP (i.e., angles are not narrow); conclude that the patient is unlikely to progress to glaucoma

Scenario 2: Patient has elevated IOP and abnormal baseline PERG, but no other evidence of glaucoma

- Repeat PERG after three months; initiate treatment if follow-up PERG data are abnormal
- If therapy is initiated, repeat PERG after one month; improved PERG readings will validate the initial indication of RGC dysfunction
- Repeat PERG every six months to one year, adjusting therapy or switching interventions as necessary

Scenario 3: Patient has elevated IOP, irregular OCT findings, VF defects and abnormal PERG readings

- Presentation suggests relatively advanced glaucoma which may require aggressive treatment to control IOP
- Use PERG measurements to: monitor response to therapy; titrate treatment accordingly; and/or choose from available treatment options (drops, SLT, stents or more aggressive drainage procedures).

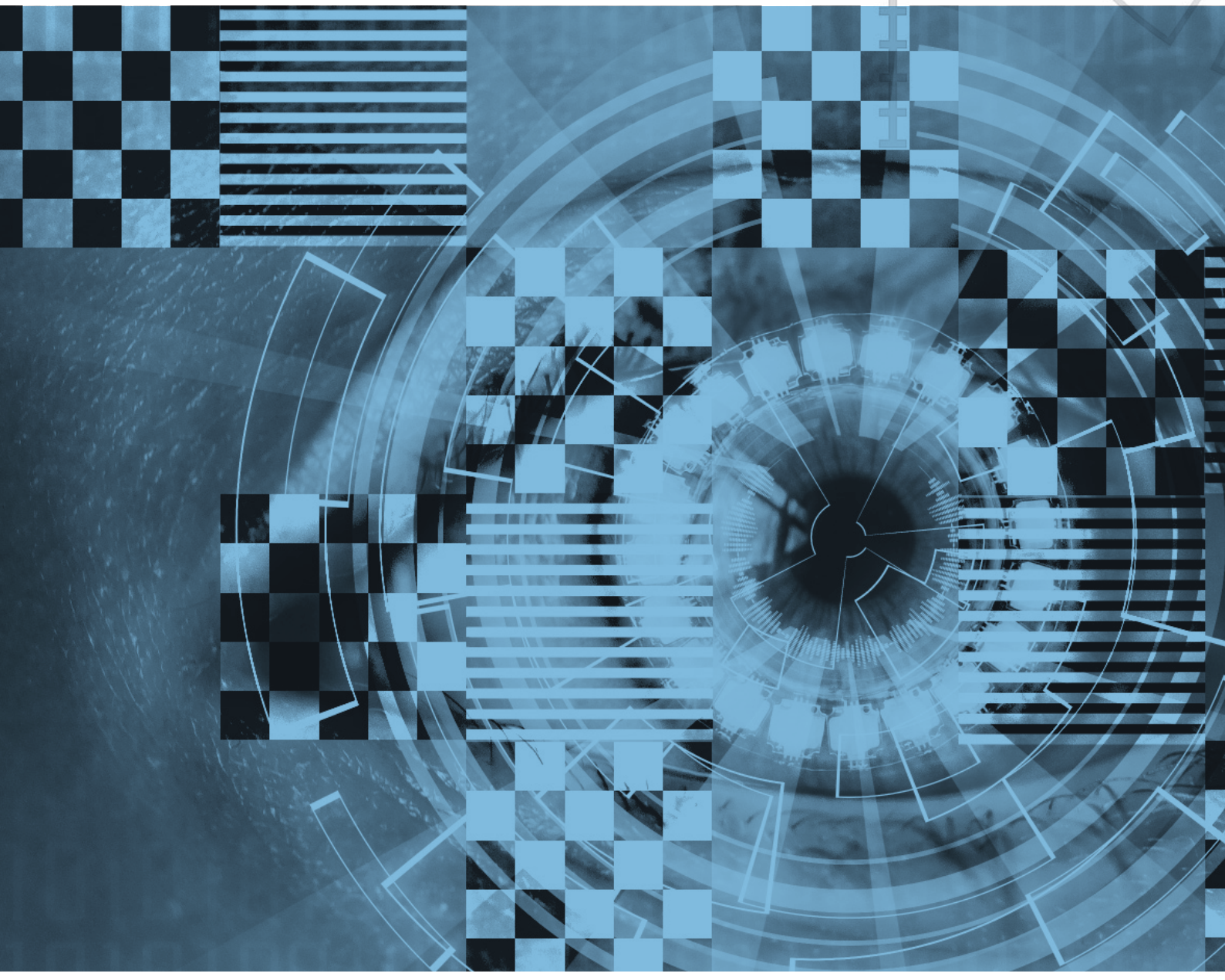
up to and including activity in the occipital cortex, and are especially useful when VF tests are inconclusive (as they often are). Measuring the VEPs evoked by a low-contrast stimulus will disclose glaucoma-related damage in the magnocellular pathway; by contrast, glaucoma-irrelevant pathologies affecting the parvocellular pathway are detected using a high-contrast stimulus. Thus, VEP testing helps differentiate glaucoma-related optic neuropathy from other conditions; after confirming the diagnosis in this way, pattern ERG can be used to assess severity and monitor progress.

Guiding decisions

Numerous studies have shown that steady-state pattern ERG detects changes in the RGC layer several years before they are evident by OCT or visual field assessment (2). But are these very early loss-of-function findings clinically relevant? My experience is that they are: I have seen a number of patients in whom the steady-state pattern ERG signal improved after starting treatment (Figure 2), in the absence of documented evidence of structural changes per OCT, and this type of observation has been documented by others (3). The implication is that if patients' pattern ERG can be stabilized, or at least kept within the normal range for that patient, then additional RGC loss can be avoided.

I believe it is feasible to base treatment decisions on pattern ERG data. Initiating treatment on the basis of pattern ERG data is especially justified if other clinical markers of glaucoma are present, such as IOP elevation, relevant family history, cupping of the optic disc, or progressive VF loss (see Sidebar).

A great benefit of the pattern ERG approach is that treatment may commence earlier than is possible with either OCT or VF data. Indeed, VF or OCT abnormalities are not unambiguous indicators of glaucoma, and clinicians who rely on these tests are faced with two unsatisfactory options: either initiate therapy and follow up to assess the eye over time, or monitor the patient to identify any changes that would unambiguously indicate that therapy should be initiated. The first option may expose patients to unnecessary treatment, and will result



in health services incurring potentially avoidable costs; the second option risks irreversible vision loss in the patient. Pattern ERG, in contrast, enables clinicians to make better-informed treatment decisions much earlier in the disease process, such that prevention of vision loss is more feasible.

Consequently, pattern ERG not only triggers a decision to start treatment, but also helps avoid treating patients unnecessarily. For example, high myopia may induce abnormal OCT findings; in the absence of any other evidence of glaucoma, such patients would require imaging follow-up for two or more years to determine if these abnormalities were glaucoma-related. Pattern ERG, however, exposes RGC function and thus indicates whether structural abnormalities are indeed due to glaucoma, thereby avoiding the treat-or-monitor conundrum. Unnecessary treatment does not just expose patients

to unnecessary risk, it also incurs unnecessary costs to the system; tailoring therapy to the individual patient avoids both, and pattern ERG is an excellent aid in this process.

Once patients have been diagnosed with glaucoma, following them with pattern ERG allows me to monitor therapeutic efficacy and to make adjustments based on each patient's disease features. I believe pattern ERG is a more reliable marker of glaucoma progression than IOP, which does not correlate perfectly with either structural or functional loss and indeed is inconsequential in low tension glaucoma. Therefore, assessing the efficacy of IOP reduction therapy requires follow-up with other diagnostic modalities. As discussed above, it can take a long time for changes in disease status to become unambiguously manifest using standard tests (OCT or VF). Why wait so long for such important information when you can get the answer far more rapidly with pattern ERG?

Conclusions

Glaucoma is a complex clinical entity, affected by many variables. Diagnostic data must be interpreted in the context of other findings, which is why we take manifold diagnostic measurements in glaucoma cases: IOP readings, fundus examinations and so forth. Do we really need additional data points? In terms of pattern ERG, I believe the answer is unequivocally "yes." I find the quantitative and qualitative information provided by steady-state pattern ERG extremely helpful, both in its own right and in making sense of other clinical findings. Crucially, basing treatment decisions on pattern ERG findings may prevent RGC death, and therefore avoid VF loss. For example, pattern ERG may help determine if current IOP is sufficient to stabilize disease, or if additional measures should be taken (for example, if abnormalities persist or worsen). Such decisions can be made without pattern ERG – but why do without additional information that gives greater clarity and more confidence in glaucoma management?

"Unnecessary treatment does not just expose patients to risk, it also incurs costs to the system; tailoring therapy to the individual patient avoids both."

Peter Good is the head of the Visual Function department at Birmingham Midland Eye Centre, Birmingham, UK.

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Real Advances from Virtual Reality

Combining VR 'gaming' technology with advanced wireless electroencephalography may transform the monitoring and diagnosis of visual disorders – particularly glaucoma.

Felipe A. Medeiros

I have always been interested in virtual reality (VR) technology and its potential applications to the evaluation and management of eye conditions; to me, the potential in this area seemed self-evident. But recently, the dramatic improvements we've seen in VR systems – in the news almost every day – have been matched by radical advances in data processing algorithms and electroencephalography (EEG) systems. The combination gives us a golden opportunity to develop something of real benefit to glaucoma patients: an accurate, portable and objective method of assessing visual field (VF) loss.

At a Glance

- *Standard automated perimetry (SAP) is a cumbersome and poorly objective method of assessing and monitoring visual field deficits*
- *Recent improvements in virtual reality technology and non-invasive electroencephalography suggest we can directly monitor visual field function at the neurophysiological level, thus eliminating subjectivity*
- *We have combined the best of these advances into a single, portable device – the nGoggle*
- *The system has potential to not only improve diagnosis and monitoring, but also broaden patient access and ultimately make a 'game' out of visual field assessments*

It's no game…

At present, the accepted and broadly used technique for monitoring glaucoma progression is standard automated perimetry (SAP), which can sometimes be an unreliable guide to the extent of visual function damage. As it depends on inherently subjective responses from the patient, the data can be inaccurate, and test-retest variability can be high, making it difficult to identify genuine glaucomatous changes over time.

SAP is also limited by practical drawbacks. Notably, the devices are bulky and cumbersome, which restricts patient assessments to well-equipped clinical settings and means that patients in underserved or remote locations may not be assessed at all. Furthermore, in the resource-limited environment typical of clinical settings, SAP tests may not be performed frequently enough to permit timely diagnosis or detection of progression. How can advanced VR/EEG technology change this?

Part of the answer lies in the ability of new generation VR devices to allow for portable and convenient systems that can present different kinds of stimuli to test visual function. The VR system can be integrated with EEG to measure the so-called visual evoked potentials – the brain electrical responses generated by the visual stimuli. In a technique known as steady-state visual evoked potentials (SSVEP), the stimuli are not one-off events, but rapidly-flickering, on-off signals, which evoke characteristic electrical waveforms in the brain. Multifocal VR systems can stimulate many different areas of the retina simultaneously, thereby evoking concurrent responses in each area – we call these multifocal SSVEPs (mfSSVEPs). If stimuli presented to different parts of the VF flicker at different rates, mfSSVEPs that are specific to each flicker rate will be induced. Thus, multifocal stimuli covering the VF will trigger multiple specific mfSSVEPs accordingly; by comparing the observed mfSSVEPs with the expected pattern, we can precisely identify areas of VF loss.

The other part of the answer involves improved techniques for non-invasively

Building the nGoggle

- Starting point: Samsung Gear VR Goggle headset, to which we added the following:
  - mA current stimulators
  - six flexible, polymer-based, wireless dry EEG electrodes
  - four foam-based, wireless dry electroculogram (EOG) electrodes
  - WiFi
  - Bluetooth 4 radio
  - Systems for simultaneous detection of 3D linear acceleration and 3D angular velocity (200 samples / second)
  - Wireless neuromonitoring system with dual core processor running Yocto Linux
- Result: a novel brain-computer interface that can generate, record and transmit neurophysiological responses to visual field stimuli

monitoring brain activity. Until recently, data could only be collected in the clinical or laboratory settings. In addition, the technology relied on methods that were time-consuming and sometimes uncomfortable: for example, electrode placement on the scalp required skin preparation and gel application. The mfSSVEPs that we generate, however, allow the use of more advanced monitoring methods. Recordings of mfSSVEPs are acquired wirelessly, and do not require cumbersome preparation techniques such as application of conductive gels. The mfSSVEP waveforms have other desirable properties too: they are less susceptible to background noise and to artefacts arising from blinking or eye movement. Finally, mfSSVEP detection has been significantly improved by the application of sophisticated data processing techniques such as machine learning.

Mix 'n' match device development: the nGoggle

We wanted to combine these sets of advances into a single device that would elicit, capture and transmit mfSSVEP data in real time. To develop a portable device with all the required functionality to objectively assess loss of visual function, we had to combine disparate technologies in a single unit (1). In brief, we incorporated a VR goggle with head-mounted display, a wireless EEG system and a computer processing unit into a device we called nGoggle (NGoggle, Inc., San Diego, CA). (Box 1). The initial prototype system used a Samsung Gear VR goggle. More recent iterations

of the nGoggle have incorporated other goggles and the development of a customized VR goggle is underway.

In the original prototype system, VF testing included sending visual stimuli to the headset display through a connected cell phone. The visual stimuli included 20 sectors covering 35 degrees of the field of view; each sector flickering at a specific frequency – from 8 to 11.8 Hz – inducing different mfSSVEPs from different VF sectors. We capture the mfSSVEPs using 6 EEG electrodes that can be applied and worn without gel preparation, located at the occipital region. The system also included 4 electrooculogram (EOG) electrodes for monitoring fication losses. The computer processing unit processes the data and transmit it to the cloud via wireless or Bluetooth technology. Real-time monitoring can be done by a tablet. The entire system is completely wireless, and very portable (Figure 1). And of course there is no need for any subjective patient input like button-pressing – it is all objective.

We successfully developed a phone-based, head-mounted system that enables effective – and objective – detection of specific mfSSVEPs associated with stimulation of specific parts of the visual field. But does it provide clinically meaningful information?

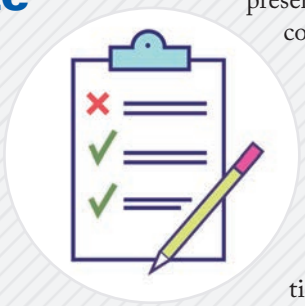
Addressing real questions

One of the first questions we addressed was: can our system distinguish between glaucomatous and healthy eyes? We designed a pilot clinical study (Box 2) to uncover the answer, and to get some idea of the accuracy and repeatability of the nGoggle system. We summarized our results on diagnostic performance by means of receiver operating characteristic curves (ROC curves), which despite the complicated name are just simple plots that provide information on the

sensitivity/specificity trade-off (the area under the ROC curve summarized the diagnostic accuracy of each parameter – a value of 1 represents 100% accuracy, whereas 0.5 represents pure chance).

The data from this pilot study were very encouraging: they showed that nGoggle was at least as good as, if not better than, SAP. Specifically, our ROC curve data indicated that nGoggle mfSSVEPs were lower ($p<0.001$) for glaucoma eyes (0.289) than healthy eyes (0.334). The area under the ROC curve for nGoggle mfSSVEP was 0.92, which was larger than for SAP mean deviation (0.81), SAP mean sensitivity (0.80) and SAP pattern standard deviation (0.77). At an 80% specificity, the mfSSVEP parameter had a sensitivity of 85%, as compared with 64% for SAP; at a specificity of 90%, the corresponding figures were 71% and 43%.

Testing the nGoggle



- Inclusion criteria: Eyes with POAG or healthy eyes.
- Exclusion criteria: BCVA < 20/40; spherical refraction outside +/-5 D; cylinder correction outside 3 D; any coexisting disease that might affect optic nerve or VF.
- Recruitment: 33 glaucoma patients (62 eyes); 17 healthy participants (30 eyes), all patients were recruited and tested within three months of diagnosis.
- Test procedure: Patients were presented with visual stimuli comprising two patterns of 20 sectors covering the central 35 degrees of the field of view. Five seconds of visual stimulation were followed by a one second break; this six-second cycle was repeated 30 times, so that each patient was assessed over a total of three minutes.
- Comparison procedure: Patients also underwent SAP tests with a Humphrey Visual Field Analyzer II (Carl Zeiss Meditec).
- Repeatability of nGoggle data was assessed in 20 glaucomatous eyes (10 patients) by collecting three sets of measurements, each set separated by one week

The games we can play

In summary, we have developed a device, nGoggle, which removes the subjectivity from conventional VF assessments, and can discriminate between healthy and glaucomatous eyes in a clinical setting. Our preliminary data also suggested that the nGoggle was more accurate than global parameters from SAP. In addition, the portability of the device may allow it to be used in home-based settings, where many more tests could be acquired over time than what can be done nowadays with SAP, potentially leading to earlier detection of progression. Such application, however, still requires validation.

Looking ahead, we believe that nGoggle may have applications beyond the assessment of VF loss. For example, it has potential to assess higher cognitive functions via the development of VR-based tests. It could also be modified to allow assessment of contrast sensitivity. Long term, our goal is to make a game of VF assessment: can you imagine a patient playing Candy Crush on nGoggle while the device tests their VF? Well, it's possible – the subject could play the game using central vision while a type of imperceptible flickering stimuli are presented peripherally. The patient wouldn't subjectively notice, but the retina and brain would, and the nGoggle would record that response. Just because assessing VF is a serious part of glaucoma diagnosis and management doesn't mean patients shouldn't enjoy it!

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Figure 1: The nGoggle: a portable system for objective assessment of visual field deficits

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Reflections of a Global Chameleon

How working in different parts of the world influenced my outlook on the most important aspects of life as an ophthalmologist.

By David Almeida

In the course of my career, partly thanks to my background, partly the choices I made, and partly coincidentally, I have had the opportunity to work in different countries on both sides of the Atlantic. In terms of education, I truly feel like a citizen of the world, and my upbringing made it quite easy for me to blend into different environments, almost like a chameleon, as I'm sometimes affectionately referred to by my wife. I often feel the need to move from one country to another and can't seem to be able to stay in one place for too long.

I was born in Lisbon, Portugal, and moved to Canada when I was eight years old. That's where I received my education, up to the point of starting my PhD at the University of Toronto. I was focused on drug design and new product development and unexpectedly got a chance to finish my PhD in Szeged, Hungary, a couple of hours south of Budapest. The year spent in Hungary opened my eyes to how colleagues and collaborators from all over the world look at the same problems in unique ways. It really taught me how helpful it is to look at a specific challenge using different points of view.

The experience proved very useful when I returned to Canada to do my medical degree and complete my residency at Queens University in Kingston, Ontario. My thinking process was this: if I'm going to design good drugs and work on the innovative side of product development, I need to learn more about the end users: patients.

I've never lost my ability to compare diverse viewpoints and I got another chance to explore different attitudes to healthcare and work-life balance when I moved again to Washington DC. Later, I did my vitreoretinal diseases and surgery fellowship at the University of Iowa and, after a few years in Minnesota, we are very fortunate to call Charlotte, North Carolina, home; this is where I joined a dynamic and growing practice, Metrolina Eye Associates. Through all my travels, with my wonderful wife Jasmine and now our children, I have appreciated the adventures of the past and the growth it has given me on a personal and professional level.

Different folks, different strokes

I've had a chance to observe dissimilar healthcare systems in Europe, Canada and the States, and each one has advantages, as well as constraints. During my time in Canada, which has a more socialized healthcare system (largely due to the government being the overwhelmingly dominant single payer), I thought a lot about equal distribution of resources; and how it could serve the greatest number of people. Trying to figure out how best to allocate available funds and give individual patients the best outcomes without paying extra inspired me to do an MBA in healthcare management at The George Washington University School of Business.

And that really was an eye-opener. I was able to get a great insight into the American healthcare system and compare it with the structures I'd seen in Canada and in Europe. It was surprising to see how within a private system, by definition focused on individuals rather than society as a whole, innovation was at the forefront, with a lot of resources available for research and development. There were so many new projects able to get funds, which I knew from experience

At a Glance

- *David Almeida spent time in Hungary, Canada and the USA over the course of his varied career*
- *He compares different types of healthcare systems he's observed in Europe and in North America and points out their strengths and weaknesses when it comes to treating patients*
- *David reflects on different attitudes to the right balance between work and life outside of it, and shares the lessons he's learnt from practicing in different parts of the world.*


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was much harder in Canada and in Europe. I was really intrigued. At that point, I got into the vitreoretinal space, and diabetic retinopathy was probably one of the key areas in ophthalmology that needed product development: new drugs for the future.

From the point of view of an ophthalmologist, I can see a difference in how doctors are able to treat patients, depending on the system they are working within. In Canada, there's a joke: "Everyone has a right to healthcare, and everyone has a right to wait for that healthcare." In these socialized structures you always have to think about the patient population as a whole, focus on the entire group, rather than the individual. That means that more people are able to receive care, but within the limits set by the system. There is a utilitarian component of working for "the greatest good for the greatest number."

However, each patient is different, so treating them all as a homogenous group doesn't always work. And that's where the American system comes in, focusing on the individual patient and his or her specific needs. This particular point of view is individualistic without being deterministic. There are often more options available in terms of treatment, although you always have to take insurance into consideration. The Canadian approach might have fewer options available, but you know that those options can mostly be used, without discussion, as they have already been approved. In the US system, there is a cost aspect that needs to be taken into consideration and discussed every time. It's really important to me to make sure that patients know exactly what costs to expect and that we can choose the best solution for each particular situation, based on the available resources. This, for me, is 'healthcare realism,' which,

I believe, is missing from the serious political debates on healthcare.

Another aspect of the privatized system is that private practices usually have the latest equipment and machines, as there certainly is an element of competition. A practice can't afford to use old equipment or implement old standards. My multi-specialty practice relies on excellence in care; if we don't provide the best care with the most up-to-date and evidence-based tools, we cannot achieve that mission statement.

Finding the right balance

Different approaches to treatments are not the only thing I've noticed while working in different countries; there is a noticeable disparity when it comes to work-life balance. In Hungary, it seemed that work had to be done, but doctors had a keen sense of consideration for other personal and professional commitment. If we were going to a research meeting, everyone would get the train, which might have taken a bit longer, but we would use the time to prepare our talks or posters. In my opinion, no one works harder than US physicians and doctors due to the demand from the multiple vantage points of healthcare, innovation and economics. Because of this, I see a lot more opportunities for doctors in the States, so it seems like people have more of an incentive to work longer hours. There are certainly more collaborative research projects available, with more funding, which is helped by the size of the population. In my experience, Canada probably falls somewhere in between the European and American attitudes.

I've found that Canadian doctors tend to be happier to stay in one location than their American counterparts. Many of my colleagues did their undergraduate and medical studies in Toronto, followed by residency and finally a job in the same place. In the US, people seem to be constantly traveling to different places, often switching states for a year. I never thought I would be doing as much traveling as I do, because my mentors in Canada didn't seem to move around so much. But I think that the willingness to travel keeps ideas flowing and makes professionals feel more connected. In this regard, I feel more American than European or Canadian.

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Ophthalmology around the world

Today, the way that ophthalmic conditions are treated in Europe and North America is becoming increasingly standardized and protocol-driven. One difference that I have noticed is that techniques and instrumentation seem to get adopted much faster in Europe, perhaps thanks to fewer regulatory barriers. I find being able to try new instruments and new approaches to surgical problems very exciting.

I feel that I've benefited greatly from having the insights into different healthcare systems and attitudes to providing care. Canada's more socialized structure taught me to treat every single patient equally, not according to their ability to pay or their socio-economic status. If a person needs to see me, it doesn't matter whether they have the funds or not; I deal with all the financial issues later. I'm also a minimalist when it comes to resources, which I think is another aspect I picked up while working in Canada. I have learnt to do the most with the tightest resources and I apply it to the way I perform surgery. This, of course, has implications for the final bill presented to the patient and works very well in the American system because of my relative frugality when it comes to extraneous tests and procedures. Make no mistake, this does not mean taking chances or depriving the patient of needed interventions; instead, it means having a strategy to ensure the best care without waste.

My time in Hungary taught me that collaboration – gaining different perspectives – is absolutely crucial to finding good solutions. I'm a co-founder of a pharmaceutical company Citrus Therapeutics and we try to apply this philosophy constantly, working with various people who have different inputs into designing new and better drugs. The cross-pollination of ideas is one of the most rewarding outcomes of collaboration.

Consider the stereotypes: American doctors down a jug of coffee or Red Bull before starting a day at the clinic, because they know they're going to be working long hours, seeing hundreds of patients; Canadian doctors struggle to work with limited resources, cursing the government that doesn't spend enough on healthcare or value their role in the delivery of care. There are elements of truth and myth to any stereotype but, in reality, I feel that many cultural generalities break down in the operating room, when it comes to the vitreoretinal ophthalmic space. There we become more alike than we are different, irrespective of geography and habits.

La Vie En Rose

Sitting Down With… Liliana Werner,
Co-Director of the Intermountain Ocular Research Center,
John A. Moran Eye Center, University of Utah, UT, USA

What inspired the jump from medicine to IOL research?

After medical school and my ophthalmology residency in Brazil, I went to Paris (Hôtel-Dieu de Paris) for a retina fellowship. After two years, I was approached by one of the professors in the ophthalmology department about a PhD program that included a project on surface modification of IOLs. I thought it would be great for my CV, and (I admit, more importantly) it would mean staying in Paris for at least four more years! Through this program I really entered the IOL world, and became fascinated by these devices that can be implanted inside of the eye and remain transparent and functional throughout a lifetime. Also during that time, I realized that scientific methodology is a good match to my personality.

You have moved a lot during your career; what led you to the Moran Eye Center?

When finishing my PhD in Paris, my thesis director suggested I spend a year in the laboratory of David Apple, in Charleston, South Carolina. It was supposed to be only a year, after which I would go back to Paris. However, six months into the fellowship, David was diagnosed with cancer, and I was invited to stay longer, obtaining the status of Visiting Assistant Professor. David had started working on IOL research at the University of Utah with our chair, Randall Olson. So, after spending three and a half years in Charleston, we moved the laboratory back to Salt Lake City, and that is how I ended up making my career at the Moran Eye Center. It is an absolutely great center, and I cannot emphasize how supportive our chair and the whole professional environment here is to our research!

What are you focusing on right now?

There are three main types of work we perform in our laboratory. We perform a significant number of in vivo preclinical studies in the rabbit model, and are currently evaluating the uveal and capsular biocompatibility of new IOL materials/designs, including accommodating, modular, adjustable and drug-eluting lenses. We also perform ex vivo studies using human eyes obtained postmortem, evaluating new implantable devices, surgical techniques or surgical equipment, as well as evaluating the biocompatibility of IOLs in pseudophakic donor eyes. One of my favorite parts of our work involves analyzing IOLs and other implantable ocular devices that have been explanted from patients because of different complications. To analyze these, we have to use various techniques, such as histochemistry, surface analytical methods and histopathology.

Which area of your research is having (or has had) the most impact?

Perhaps the body of work on IOL complications, including various causes of IOL opacification and their impact on visual function. Considering the number of new materials and designs under development – or entering the market – constant vigilance is necessary.

What do you hope to achieve in 10 years' time?

An IOL that, besides exhibiting excellent biocompatibility, clarity, and optical quality, would also allow for insertion through very small incisions, non-invasive multiple and reversible power adjustments, and be accommodating.

Who have been your mentors?

We never arrive anywhere alone, and there are so many people throughout my life to acknowledge. To name just a few, I have to first of all acknowledge my parents for their constant and unconditional support. At the professional level, Jean-Marc Legeais was my PhD thesis director, and helped me enter this interesting world of IOL research. My move to the US to work with David Apple was fundamental to my career and I am so grateful to all opportunities I had while working with him. And, since 2002, I feel very privileged to work with prominent colleagues such as Nick Mamalis and Alan Crandall under the leadership of Randall Olson at the Moran Eye Center.

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What do you find most rewarding about your work?

I love that our research to help improve an IOL or other ocular device has the potential to impact so many patients around the world – many more patients than I could help as an ophthalmologist. Also, it's great to be able to significantly help our colleagues when they face some unknown complication for which we have already performed studies evaluating its natural history and preventative measures.

Any advice for those following in your footsteps?

I believe we can have a general life plan, but we have to remain open to unexpected opportunities. Many times we think we really want something, and then an opportunity to do something else shows up, and we can be very pleasantly surprised! We are the happiest when we discover what we really like to do, whatever that might be, and in my case that is research. There is no work that is unimportant, and it is great that we are all different so we can complement each other!

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