JANUARY / FEBRUARY 2022 # 93

the Ophthalmologist®

Vision Research in the Spotlight

The ARVO leadership team provide an insight into the association's evolution – and the important role it has played in their careers

the Ophthalmologist®

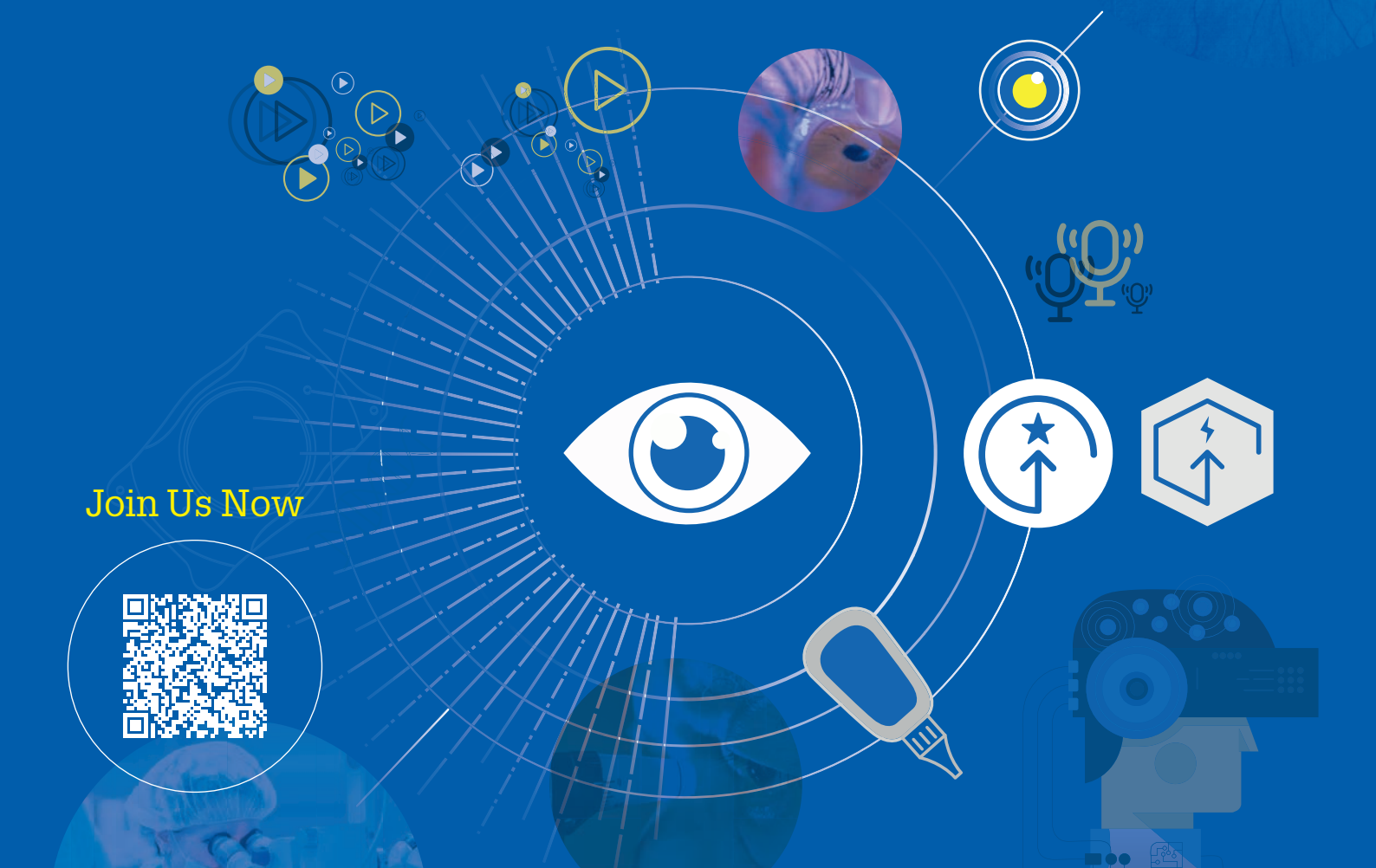
Join Your Ophthalmology Peers and Gurus in our **70,000** Strong Community

We bring you the greatest stories by working with the brightest and best in ophthalmology. Providing a platform for ophthalmologists and vision scientists across all subspecialties, we are fully focused on celebrating achievements across the whole field.

Visit **theophthalmologist.com/register**

Registration is always free and includes:

- access to all of our articles, including online exclusives and our issue archive
- a regular print or digital magazine (or both – your choice)
- a weekly newsletter on the latest ophthalmic practice and research innovations



Join Us Now

If Not Science, Then What?

I love being a vision researcher – like most people I know in this field. And if that ever changes, I will, too.

I tell prospective graduate students and postdocs that our work as researchers can be exciting or groundbreaking but that it can equally be routine or even mundane. Sometimes research is frustrating. You may face problems that need to be fixed so you can move on – but the solution may be elusive. If spending days (and nights) scratching your head doesn't float your boat, research may not be for you. If you love a challenge and the associated problem-solving process, you're likely to succeed in research and move forward.

But what if you start getting up most mornings not feeling excited about going into work (or, worse, you're dreading it). You can take that as a very clear sign that something needs to change.

The need for change doesn't always mean you have to search for a whole new career – you can start with small steps. Perhaps you're on the wrong project, in the wrong team, in the wrong country… When small steps are not enough, you may have to take a wider look at your life and focus on what you really want.

I tell my students and postdocs to choose projects intentionally, with a clear and logical goal in mind, so that if they decide that they don't want to stay in academia, they have still developed the right skill set to succeed, regardless of what they might end up doing. Some end up working in academia, some in industry, some leave science altogether. All I care about – and all they should care about – is that they're doing well and that they're happy.

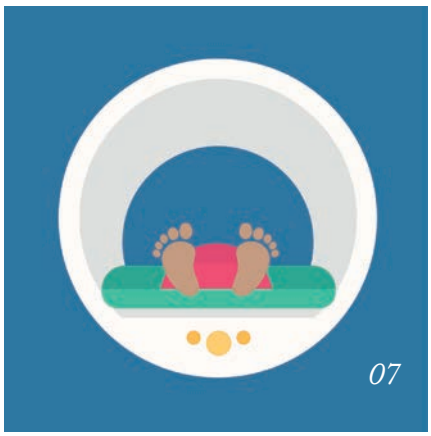
As you can probably tell, I think a lot about recognizing the need for change these days – and I suspect I would have made more changes if I'd spent more time thinking in the past. For example, when I was a younger scientist, arguably I should have changed projects faster than I did. Instead, I was stubborn, insisting that I would succeed at what I was doing – but was I happy? A more profound question: if I had done things differently, would I still be who I am today? That I cannot answer, but I do tell those following in my footsteps that the enjoyment they get from their work is essential. And I think that applies to everyone, including ophthalmologists.

Maureen McCall
Vice President of The Association for Research in Vision and Ophthalmology (ARVO)

Contents

09

37



07

On The Cover

Spotlight on ARVO leadership
People illustrations for cover feature sourced from shutterstock.com

Practice Fundamentals

Sitting Down With

the Ophthalmologist

ISSUE 93 - JAN/FEB 2022

Change of address info@theophthalmologist.com
Hayley Atiz, The Ophthalmologist, Texere Publishing Limited, Booths Park 1, Chelford Road, Knutsford, Cheshire, WA16 8GS, UK

General enquiries
www.texerepublishing.com |
info@theophthalmologist.com
+44 (0) 1565 745 200 | sales@texerepublishing.com

Distribution: The Ophthalmologist (ISSN 2051-4093), is published monthly by Texere Publishing Limited, Booths Park 1, Chelford Road, Knutsford, Cheshire, WA16 8GS, UK. Single copy sales $15 (plus postage, cost available on request info@theophthalmologist.com). Non-qualified annual subscription cost is available on request.

Credit: Pixabay.com

L-ORD Overthrown?

A hybrid approach to disease modeling identifies both a gene therapy and diabetes drug with the potential to tackle late-onset retinal degeneration

Are we on the precipice of a treatment for late-onset retinal degeneration (L-ORD)? Well, knowledge is power – and researchers from the National Eye Institute (NEI) have developed a hybrid tissue engineering and computer modeling approach to decipher L-ORD pathology (1). Not content with one win, they also identified two treatment options at opposite ends of the drug development spectrum – a novel gene therapy and the repurposing of a common diabetes drug (metformin).

Led by Kapil Bharti, the team grew retinal pigment epithelium (RPE) from the stem cells of a patient with the genetic mutation in CTRP5 that causes L-ORD. First, they confirmed that the patient RPE model expressed low amounts CTRP5 protein, which their computer model identified as less likely to bind and inhibit AMPK signaling. Second, they used the patient RPE model to test and prove that inhibition of AMPK signaling reduces L-ORD pathology – a target in the crosshairs. "This hybrid approach has huge potential, because it allows us to test molecular simulations as actual experiments in patient cells," says Bharti. "But this is limited to a small number of cases where the molecular structure of the protein under investigation is known. Our key advantage here was the ability to use patient eye (RPE) cells made from their stem cells."

The findings led to the assessment of a potential gene therapy to inhibit AMPK signaling via CTRP5 overexpression and the use of metformin to modulate AMPK activity – both worked but which avenue to take forward? "Gene therapy trials may take time to set up because it requires extensive preclinical work upfront demonstrating safety of gene therapy constructs manufactured under clinical settings," Bharti explains. "Because of the complexity and significant cost associated with gene and cell therapies, we chose to also test metformin, which has decades of clinical use history. In fact, metformin trials are already being planned by our colleagues and the NEI will soon be announcing an oral metformin-based trial for L-ORD. Stay tuned."

Reference

1. *KJ Mayagishima et al., Commun Biol, 4, 1360 (2021). PMID: 34887495.*

INFOGRAPHIC

Retinal Retirement

Can the gap between retina age and real age be used as an evaluation of patients' risk of death?

80,169

fundus images from the UK Biobank were analyzed using AI

46,969

participants were aged **40-69**

AAO ANNOUNCEMENTS

Updates from the latest American Academy of Ophthalmology meeting

- A study by researchers from the University of Miami, Florida, USA, has shown that pain experienced by dry eye patients depends on the way their nervous system responds to pain signals (1). To assess how the nervous system reacts to these signals in patients with chronic, painful dry eye, researchers used a technique called conditioned pain modulation (CPM). After evaluating 296 patients, they established that those patients had a normal to high CPM response, which suggests that treatments for painful dry eye may be improved by focusing on the nervous system.
- Since the start of the COVID-19 pandemic, most school pupils have had to use virtual lessons for extended periods of time. Now, research from Wills Eye Hospital, Philadelphia, Pennsylvania, USA, has confirmed that increased screen time due to virtual learning has led to more eye strain and convergence insufficiency in children – a condition where eyes are unable to work together when looking at objects up close. This can result in double or blurred vision and make reading difficult for children. Frequent checks for those symptoms, encouraging breaks and frequent blinking helps to resolve eye strain symptoms (2).
- The AAO has outlined the top four issues threatening ophthalmologists' financial stability. These include: Medicare physician payment fee cuts, with US-based physicians facing drastic cuts from January 2022 as well as expiry of pandemic waiver and a further cut from implementing "PayGo" balance budget rules; surgeon and facility payments for cataract and MIGS codes, with the Centers of Medicare & Medicaid only adding $34 for MIGS procedures to be added to the cost of standalone cataract surgery; lack of equity for post-operative visits included in the Medicare global surgical payments; and prior authorization and step therapy burdens.

References

1. *A Galor, University of Miami, "Neuropathic pain: a critical missing piece in dry eye?" (2021). Available at: https://bit.ly/3g2jXnu.*
2. *J Lavrich, Presented at 125th AAO, November 14, 2021, New Orleans, US.*

Mapping Post-Stroke Vision on the Map

Multimodal MRI brain maps could help clinicians improve visual field rehabilitation

Strokes are common, and though rapid treatment can save lives and reduce residual damage to the brain, 30 percent of patients suffer some vision loss as a consequence of stroke. Of course, the severity of damage to vision varies – as does the physical location of disruption to the visual pathway, which can result in non-optimal treatment regimens at a time when effective action is crucial to saving sight.

Researchers have found a way to improve our understanding of post-stroke sight – using multimodal MRI-based mapping of the brain (1) – with the aim of better guiding treatment. Typically, perimetry is used to measure only the visual field following stroke. But, through brain mapping, they establish whether visual field loss is caused by the absence of gray matter or disconnections between areas of cortical white matter – enabling targeted visual rehabilitation to maximise recovery.

Reference

1. *A Beh et al., Front Neurosci, 737215 (2022). DOI: 10.3389/fnins.2021.737215.*

Association between retinal age and real age – "retinal age gap" – was accurate to within

3.5 years

in the healthy group

The remaining subjects were monitored for 11 years and large retinal age gaps were found to correlate with up to

67 percent

increase in risk of death

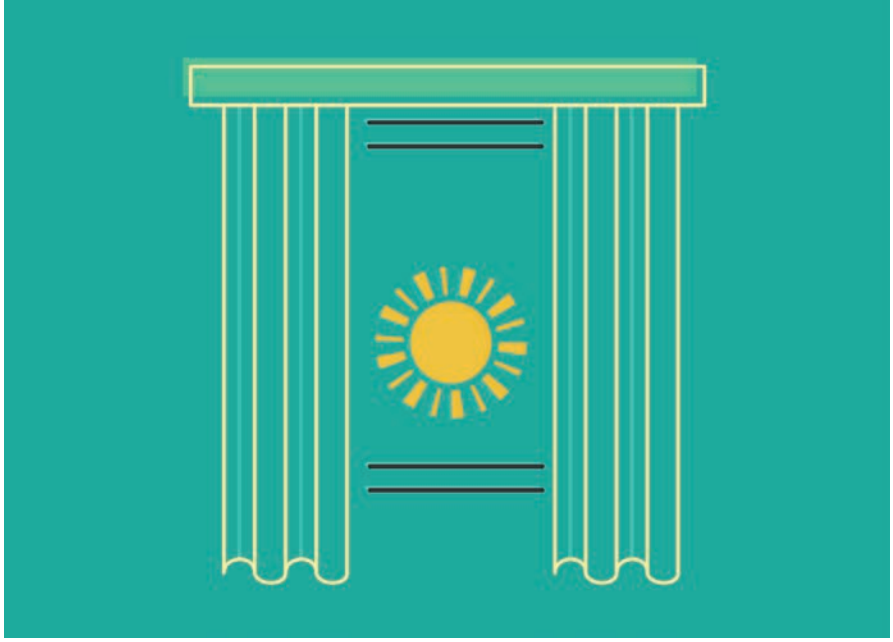
Each year added to the gap was associated with the risk of death from any cause increased by

2 percent

Reference

1. *Z Zhu et al., Br J Ophthalmol, [Online ahead of print] (2022). PMID: 35042683.*

MIND THE GAP



Seeing Dementia Burden Clearly

How does cataract removal affect the risk of developing dementia?

Diseases of aging tend not to be found in isolation; comorbidity is common, with one or more diseases exacerbating the progression of others in a damaging feedback loop of pathology. Vision loss and dementia have long been tied together in this way, with poor eyesight often leading to isolation and inactivity that can accelerate dementia. Dementia already places a huge burden on healthcare systems, as well as patients and their families – and this burden is only set to rise with an increasingly aged population.

Evasive "cataraction"

So, is it possible to tackle the growing rates of dementia by targeting cataracts? In the first study to directly explore the relationship, researchers from the University of Washington, USA, found that cataract removal significantly reduces the risk of the patient developing dementia (1). The researchers analyzed a large pool of data from the Adult Changes in Thought study; specifically, the team assessed 3,038 participants, all of whom were over the age of 65 with glaucoma or cataracts before enrollment. Interestingly, glaucoma surgery did not appear to affect the risk of dementia developing, but those who had cataract surgery had close to a 30 percent lower risk, which persisted beyond 10 years.

The authors suggest that both increased quantity and quality of light may be behind the significant effect of cataract surgery on dementia risk. In particular, blue light, which acts on photosensitive retinal ganglion cells, is associated with positive measures in cognitive function and Alzheimer's disease; the researchers note that the yellow hue of cataracts blocks blue light, possibly speeding the onset of dementia by inhibiting mental stimulation.

Healthy heart, healthy brain?

Another potential explanation (or co-conspirator) is the role of vascular health; visual impairment can be accompanied by a reduction in mobility and activity, which contributes towards poor vascular health – a major risk factor for dementia onset and progression. The removal of cataracts and the recovery of vision may enable more active and healthy lifestyles, increasing vascular health and thus reducing dementia risk.

The researchers admit that further research is needed to determine the mechanism of action. But, whatever the reason, their work provides another reason why cataract surgery is so important – if further justification were ever needed.

Reference

1. *CS Lee et al., JAMA Intern Med, e216990 (2021). PMID: 34870676.*

OCT Under Pressure

Could optical coherence tomography ever replace current – highly invasive – intracranial pressure monitoring methods?

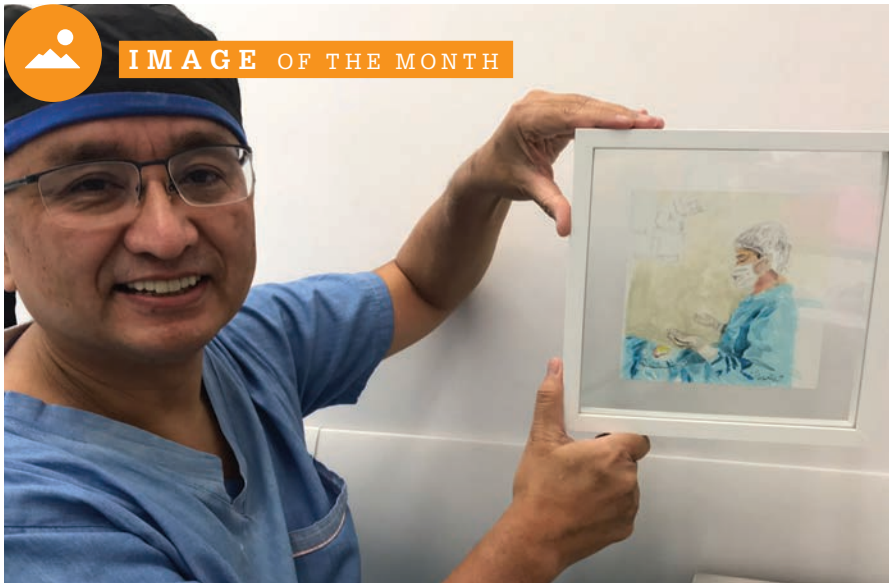
The pressure within the skull is a critically important factor in numerous conditions, including traumatic brain injuries and intracranial haemorrhage. But the only way to monitor intracranial pressure relies on a probe or catheter inserted into the intracranial compartment – an invasive procedure that brings the risk of further complications.

Looking for an alternative, researchers from Oslo University Hospital-Ullevål and the University of Oslo, Norway, have been exploring the predictive potential of optical coherence tomography (OCT). The team's previous research showed that OCT could be used to estimate static intracranial pressure measurements. And their latest work provides evidence that OCT parameters can also predict elevated pulsatile intracranial pressure (1). Are we witnessing the birth of a noninvasive alternative? OCT manufacturers will likely be watching with a keen eye…

Reference

1. *HH Jacobsen et al., Transl Vis Sci Technol, 11, 31 (2022). PMID: 35050344.*

IMAGE OF THE MONTH



Life in Watercolor

Milton Yogi, Head of Cataract Division at Hospital Beneficência Portuguesa SP and Managing Director at IPEPO, Instituto da Visão in São Paulo, Brazil, saw an Instagram picture of Isabel Brazil, a cornea fellow who works at the Barra Eye Clinic and Oculistas Associados in Rio de Janeiro. He decided to paint the scene and contacted Brazil to present her with the finished piece.

Credit: Archives of Milton Yogi and Isabel Brazil.

Would you like your photo featured in Image of the Month? Send it to edit@theophthalmologist.com

Credit: Shutterstock.com

Light the Way

A guide to providing the right lighting for patients with sight loss

Lighting is an important element of visually impaired people's surroundings – so you might be surprised at how many of these patients regularly deal with low light levels or uneven lighting that leaves areas of their homes in shadow. To support those patients, their families, and the professionals who work with or care for them, the Thomas Pocklington Trust – a UK-based charity dedicated to improving visually impaired people's quality of life – has published a guide to "Lighting in and around the home" (1). In this comprehensive publication, Peter Hodgson, the Trust's Lighting Consultant, and Peter Raynham, Professor of the Lit Environment at University College London, UK, outline the benefits of good lighting, explore the range of available lighting options, and examine best practices in lighting various rooms. The guide is available online as a free resource.

Reference

1. *Thomas Pocklington Trust (2021). Available at: https://bit.ly/3fhkaCK.*

THE OPHTHALMOLOGIST'S
TIME MACHINE

Casanova and the first attempt to implant an IOL

With Andrzej Grzybowski

The first, although unsuccessful, attempt to insert an intraocular implant after cataract removal was reported in Leipzig in 1795, when Johan Virgilius Casaamata inserted a glass lens into a patient's eye. This was reported by a Swiss surgeon Rudolph Schiferli in his dissertation "On Cataract" in the following words: "It is known that through [cataract] operation the vision is not restored as it was before, because of experiencing the loss of the lens. Casaamata has made an attempt, to bring through the round of the cornea a distant lens. He claimed, however, that this glass lens could not serve as the patient's natural lens, since it fell on the bottom of the eye. But there is another solution of attaining the loss of the lens, and this is the most common: glasses."

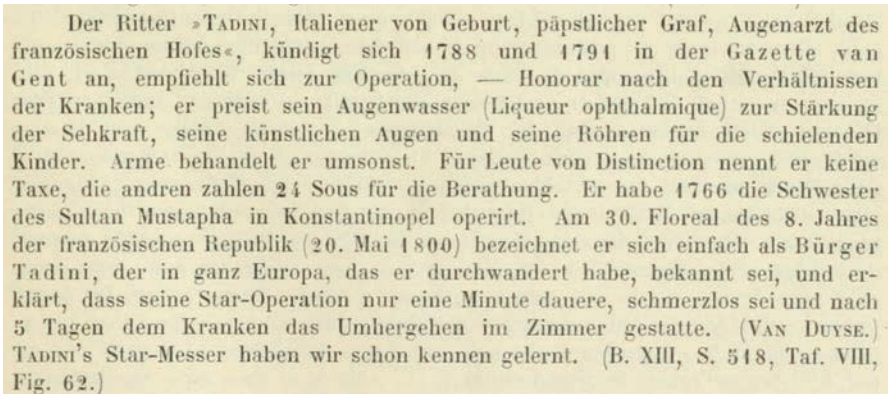
Who was Casaamata and how did he get the idea?

Casaamata was born in 1741 in Quero, Venecia, and was the oculist at the Royal Court of Dresden. Augustus II The Strong, as well as his successor Frederick Augustus II were kings of Poland, who helped Dresden, located in Saxony, become one of the most pompous capitals in Europe.

Interestingly, we can find a description of the idea in Giacomo Casanova's memoires. Casanova was an Italian writer and adventurer from the Republic of Venice. His autobiography, Histoire de ma vie (Story of My Life), is regarded as one of the most authentic sources of the customs and norms of European social life during the 18th century. It contains an account of the first-known idea of intraocular lens implantation from an oculist named Felice Tadini. During their meeting, which took place in Warsaw in 1766, Tadini presented a box containing highly polished tiny crystal lenses, which he claimed he could insert under the cornea to replace the eye's natural lens.

Tadini was an Italian itinerant ophthalmologist living in the second half of the 18th century who performed eye operations in many places throughout Europe, documented by his advertisements in newspapers of the day (see Figure 1).

Casaamata's attempt to implant an artificial lens could have been based on Tadini's idea. It is certain that they did not know each other, albeit Casanova could have been the connection between them. It is not possible that Casaamata read Casanova's memoirs, as they were published 20 years after his death, but there is another possible solution of this puzzle. The mother of Casanova, Gianetta Casanova, moved to Dresden in 1735, where she was a court actress and received a life pension, while Casanova's younger brother, Giambattista, became the director of the Academy of Fine Arts in Dresden. Thus, Casanova visited his family in Dresden many times, and a meeting with the Court Eye Doctor could have occurred.



Der Ritter »Tadini, Italiener von Geburt, päpstlicher Graf, Augenarzt des französischen Hofes«, kündigt sich 1788 und 1791 in der Gazette van Gent an, empfiehlt sich zur Operation, — Honorar nach den Verhältnissen der Kranken; er preist sein Augenwasser (Liqueur ophthalmique) zur Stärkung der Sehkraft, seine künstlichen Augen und seine Röhren für die schielenden Kinder. Arme behandelt er umsonst. Für Leute von Distinction nennt er keine Taxe, die andren zahlen 24 Sous für die Berathung. Er habe 1766 die Schwester des Sultan Mustapha in Konstantinopel operirt. Am 30. Floreal des 8. Jahres der französischen Republik (20. Mai 1800) bezeichnet er sich einfach als Bürger Tadini, der in ganz Europa, das er durchwandert habe, bekannt sei, und erklärt, dass seine Star-Operation nur eine Minute dauere, schmerzlos sei und nach 5 Tagen dem Kranken das Umhergehen im Zimmer gestatte. (Van Duyse.) Tadini's Star-Messer haben wir schon kennen gelernt. (B. XIII, S. 518, Taf. VIII, Fig. 62.)

Figure 1. Advertisement of Felice Tadini's ophthalmic services.

Andrzej Grzybowski is a Professor of Ophthalmology and Chair of Department of Ophthalmology, University of Warmia and Mazury, Olsztyn, Poland, and Head of Institute for Research in Ophthalmology, Foundation for Ophthalmology Development, Poznań, Poland. He is also expert in the history of ophthalmology with over 100 peer-reviewed articles published in this area. He is a member of AAO Museum of Vision's Program Committee, curator of ESCRS Archive, founder of history section at EVER. He is the president of the Polish Society for History and Philosophy of Medicine; Editor-in-Chief of Archives of History and Philosophy of Medicine, and Historia Ophthalmologica Internationalis, the only journal devoted solely to the history of ophthalmology.

See references online.

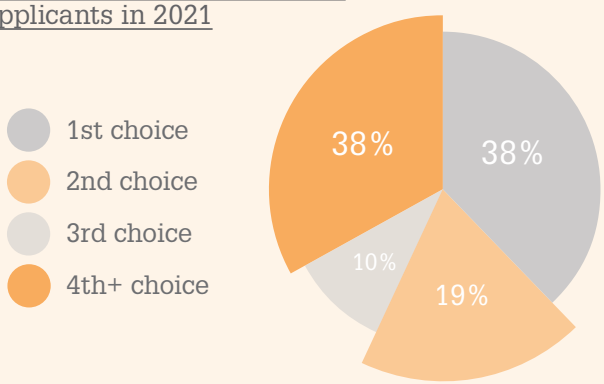
Meet Your Match

A summary of ophthalmology matches for 2021 US residencies, compared with previous years

Total match participants in 2021:

677

Ranking results by matched applicants in 2021



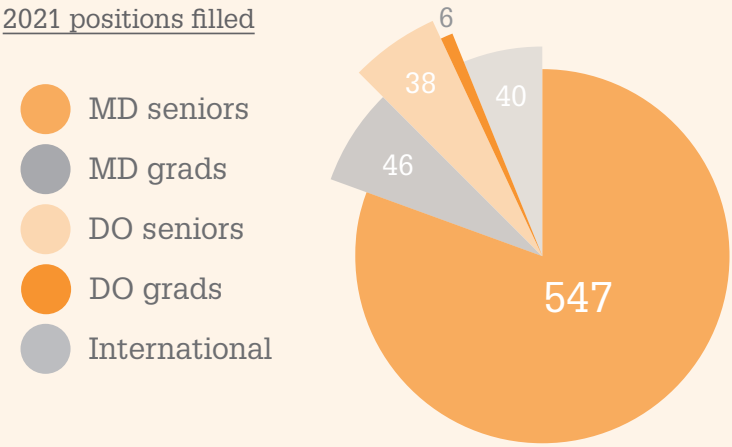
Reference

1. *Association of University Professors of Ophthalmology, "Ophthalmology Residency Match Summary Report" (2021). Available at: https://bit.ly/3r5P5sm.*

Positions offered and filled

2019		2020		2021	
485 positions offered	**484** positions filled	**496** positions offered	**495** positions filled	**499** positions offered	**498** positions filled

2021 positions filled



Ophthalmology matches over time

Year	Matched
2017	78%
2018	76%
2019	75%
2020	78%
2021	74%

In My View

Experts from across the world share a single strongly held opinion or key idea.

Closing the Distance

How does modest monovision work as a strategy for balancing near and far vision?

By Graham D. Barrett, ophthalmic surgeon at Lions Eye Institute, Sir Charles Gairdner Hospital, Perth, Australia

When choosing an intraocular lens in patients undergoing cataract surgery, we are often challenged with a patient's desire to achieve adequate distance vision while maintaining some degree of spectacle independence for near vision. In patients who have expressed the desire for full spectacle independence, multifocal lenses are often considered. However, these options are not without their downsides, as patients may experience a higher rate of night vision disturbances, halos, or glare that reduces their satisfaction with the procedure.

As a result of these ongoing challenges, I began my pursuit of a consistent strategy for modest monovision as early as 2008 to provide a better balance between distance and near vision. I spent many years considering whether it would be feasible to design a custom IOL to specifically enhance this strategy – all of which led me to the concept of positive spherical aberration to extend the depth of focus of a monofocal IOL. Positive, rather than negative, spherical aberration is the key to a modest monofocal approach because it acts in a synergistic fashion with myopia, providing a greater overlap or blending between the distance and near sight on the respective eyes. Positive spherical aberration achieves consistent visual acuity and maintains a smoother transition between distance, intermediate, and near vision.

To make this concept a reality, I partnered with the R&D team at Rayner to research, develop, and bring to market a patented technology: an aspheric IOL with an optimized level of positive spherical aberration designed for use when monovision is sought in cataract surgery.

The enhanced monofocal IOL we developed (RayOne EMV) provides an extended range of vision and is the only available IOL optimized for use with monovision. Results from early testing showed that this new lens can provide on average 2.25 D of extended depth of vision when using a 1 D monovision offset. In addition, the dominant eye is more forgiving of postoperative myopic outcomes compared with extended depth of focus IOLs based on negative asphericity or phase shift technology. As a result of these properties, the patient has clear binocular vision more often than would be possible with a standard monofocal IOL used in the same way, reducing the likelihood of patient complaints related to asthenopia and other effects associated with transitions

"The IOL is designed to optimize for monovision with an expectation of excellent binocular distance vision."

between near and far vision.

The IOL is designed to optimize for monovision with an expectation of excellent binocular distance vision. In fact, a unique feature of RayOne EMV is a stretched focal point that allows the near eye to contribute to distance vision, even with a -1.0 D offset. From a patient perspective, this allows for more blended vision between the two eyes, which has been reflected in positive patient feedback.

The appearance of the IOL's optic, even under microscopic conditions, is much like that of other monofocal IOLs, with no zones or rings. The patented feature that sets it apart is enhanced spherical aberration in the center of the lens that gradually reduces at the periphery, allowing for an increased range of functional vision. The diffractive-free design reduces the likelihood of dysphotopsia, which should increase patient satisfaction. Compared with a standard monofocal IOL, RayOne EMV provides better intermediate vision, with 1.25 D of extended range of vision on average.

The level of spectacle independence sits between traditional monofocal IOLs and trifocal IOLs, depending on how the IOL is used. For instance, if this IOL is used with no monovision offset, it offers spectacle independence similar to that provided by available extended depth of focus IOLs. If a surgeon calculates the IOL power with a -1.5 D or more offset in one eye, the ability of the enhanced monofocal to achieve spectacle independence competes with multifocal IOLs that usually have the trade-off of rings or zones. To date, RayOne EMV has not been associated with unwanted effects, such as glare or halos.

When using a monovision approach, ophthalmologists should aim for as close to emmetropia as possible in the distance eye. For the near eye, the target should be determined based on the patient's previous experience with monovision. Importantly, it is critical to remember that post-operative refraction of up to -0.5 D will still provide very good distance acuity. Though the lens is optimized for monovision, it can also be used with a target of emmetropia in both eyes, providing excellent distance and intermediate vision bilaterally.

The RayOne EMV IOL could be an attractive choice for patients wishing to achieve excellent distance vision while maintaining good intermediate vision and some spectacle independence with near vision. Thanks to the optical design, it is more forgiving in terms of missed target refraction and complements the natural positive spherical aberration of most eyes, which naturally increases the depth of focus. Unlike multifocal IOLs, it is designed to accommodate a wider range of pupil conditions, including variations in decentration and tilt.

That said, I might not consider any aspheric lens in patients with extensive decentration or zonulopathy. I also might exclude its use in patients with pseudoexfoliation syndrome as this could cause late decentration. Likewise, the unique spherical properties of RayOne EMV might further exacerbate pre-existing spherical aberration in patients with previous radial keratotomy.

We are increasingly recognizing the value of better presbyopia correction, as individuals are more likely to engage with screens at near focus in their daily work and leisure time. Instead of focusing on excellent far vision only (at the expense of near vision), I now prefer modest monovision as an appropriate strategy in many of my patients, with a target of about -1.25 D in the more myopic eye. In fact, modest monovision is a popular choice for many surgeons around the world – a third of surgeons on a regular basis according to some estimates. In my practice, I offer it to all patients who achieve 6/9 or better in the first eye, and more than 70 percent select this option rather than targeting emmetropia in both eyes.

"I now prefer modest monovision as an appropriate strategy in many of my patients, with a target of about -1.25 D in the more myopic eye."

Ultimately, I am enthusiastic about modest monovision based on the levels of patient satisfaction I have seen in my own practice. In previous published studies, including my own, the overall satisfaction rate is well over 90 percent because the technique does not compromise the quality of vision. Furthermore, unlike diffractive multifocal and extended depth of focus IOLs, modest monovision is not associated with dysphotopsia, halos, or glare that can further impact patient satisfaction.

In my opinion, this new lens represents a next-generation, premium IOL that offers excellent distance vision while maintaining an extended range of intermediate and near vision and offering significantly more spectacle independence than is seen with standard aspheric monofocal IOLs. This lens offers surgeons a new way to approach modest monovision, and I would encourage you to evaluate the technology in your own practice.

SPECIAL SERIES
Vision Research

VISION RESEARCH IN THE SPOTLIGHT

The leadership team of ARVO give us an insight into how the organization has grown in challenging times

A rundown of the leadership challenges and the exciting developments made by ARVO – from Stephen Pflugfelder, Maureen McCall, Irene Gottlob, and Justine Smith.

By Geoffrey Potjewyd

STEPHEN PFLUGFELDER

I'm a clinician scientist and a cornea specialist – so I obviously specialize in the front part of the eye! But I've also run a fundamental research lab for about three decades or more, which has allowed me to investigate my keen interest in diseases of the cornea and the ocular surface, primarily dry eye. That's where most of my research has been focused.

I was the president and I've been involved in ARVO for four decades now. During the time that I've been involved with the organization, I was elected to be the trustee for the cornea section, and from that pool of trustees the ARVO president is selected – which happened to me to serve for the one year term. This term ended last May, so currently I'm the immediate past president and that position is really to oversee the Board of Trustees activities. I would help organize and run the meetings, and I would be the principal liaison with the ARVO administration, which is based near Bethesda, Maryland, USA.

CHALLENGING TIMES

As you might expect, a lot of challenges over the past couple years have been pandemic related. I was involved in planning the first virtual meeting, which was the 2021 meeting, which was a learning experience for the organization, and for the Board of Trustees and me. We had to learn quite a bit about virtual communication platforms, for which I am thankful that ARVO did most of that work, but we provided the necessary guidance and feedback about how to do that and gave a great meeting given the circumstances.

LEADING ARVO: ADAPTIONS AND ADVICE

ARVO is a somewhat unique organization, in that it's international, and it also includes clinicians, some of whom are pure clinicians that don't do much research, as well as very technical bench researchers – and, of course, everything in between. We have to be open to the needs of all of the constituents and we try to take their suggestions and harmonize the meeting.

Ultimately, this collaboration between clinicians and researchers, and the people who wear both hats, are the reason that ophthalmic therapies get to helping the actual patients. Both sides really enjoy that interplay too – for the bench researchers, they're looking for the relevance of their work, and, for the most part, translation to the clinical arena. The fundamental researchers have an opportunity at the meeting to attend the clinical sessions, and to get the perspective right from the clinical side as to what the real needs are.

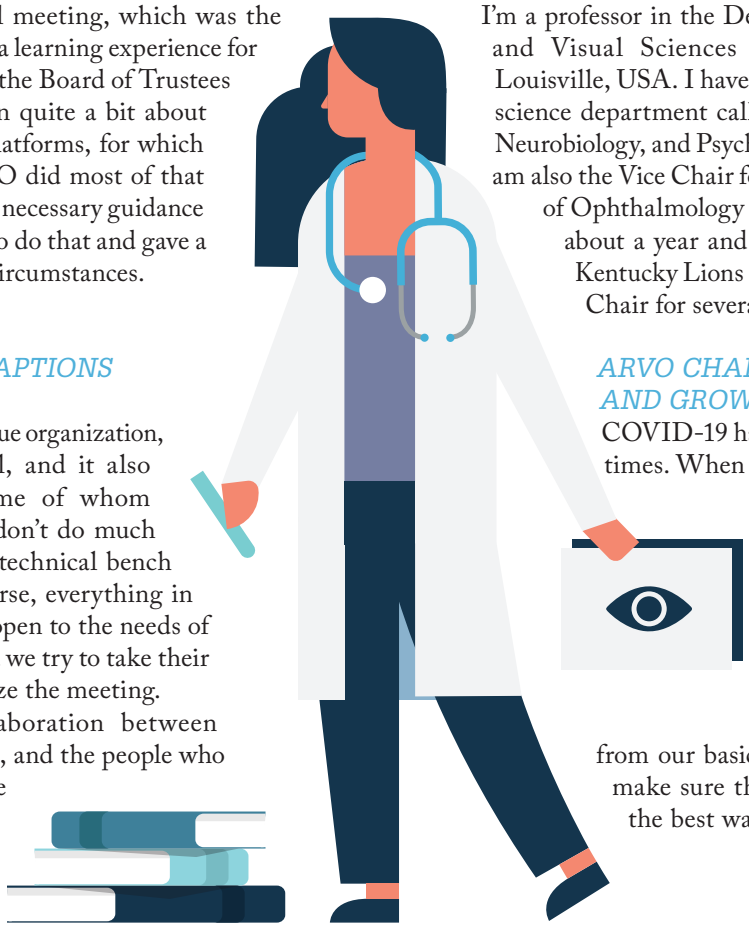
ARVO IN MY CAREER

ARVO has had a huge role in my career since I first got involved when I was still in training. That early opportunity made me realize the value of the meeting, not only as an educational experience, but as a forum for communication and exchange. As I move forward in my career and become a little more senior, it's been a great opportunity to try to help the next generation of scientists, to mentor them and provide advice.

I'd say to anyone thinking of joining ARVO, if they really want to get involved in research, whether that's clinical based research or fundamental research, then it's essential for them to be a member and an active participant in ARVO.

MAUREEN MCCALL

I'm a professor in the Department of Ophthalmology and Visual Sciences here at the University of Louisville, USA. I have a joint appointment in a basic science department called Anatomical Sciences and Neurobiology, and Psychological and Brain Sciences. I am also the Vice Chair for research in the Department of Ophthalmology and I've held that position for about a year and a half. Finally, I've been the Kentucky Lions Eye Center research Endowed Chair for several years.



ARVO CHALLENGES AND GROWTH

COVID-19 has been the challenge of recent times. When I first started on the board we had meetings in person, with discussions around a large round table, you got to know people a lot better, and you formed friendships that last for forever – that's what I miss. It doesn't take away from our basic focus, in terms of trying to make sure that ARVO moves forward in the best way possible, but I do miss that

human contact with these people.

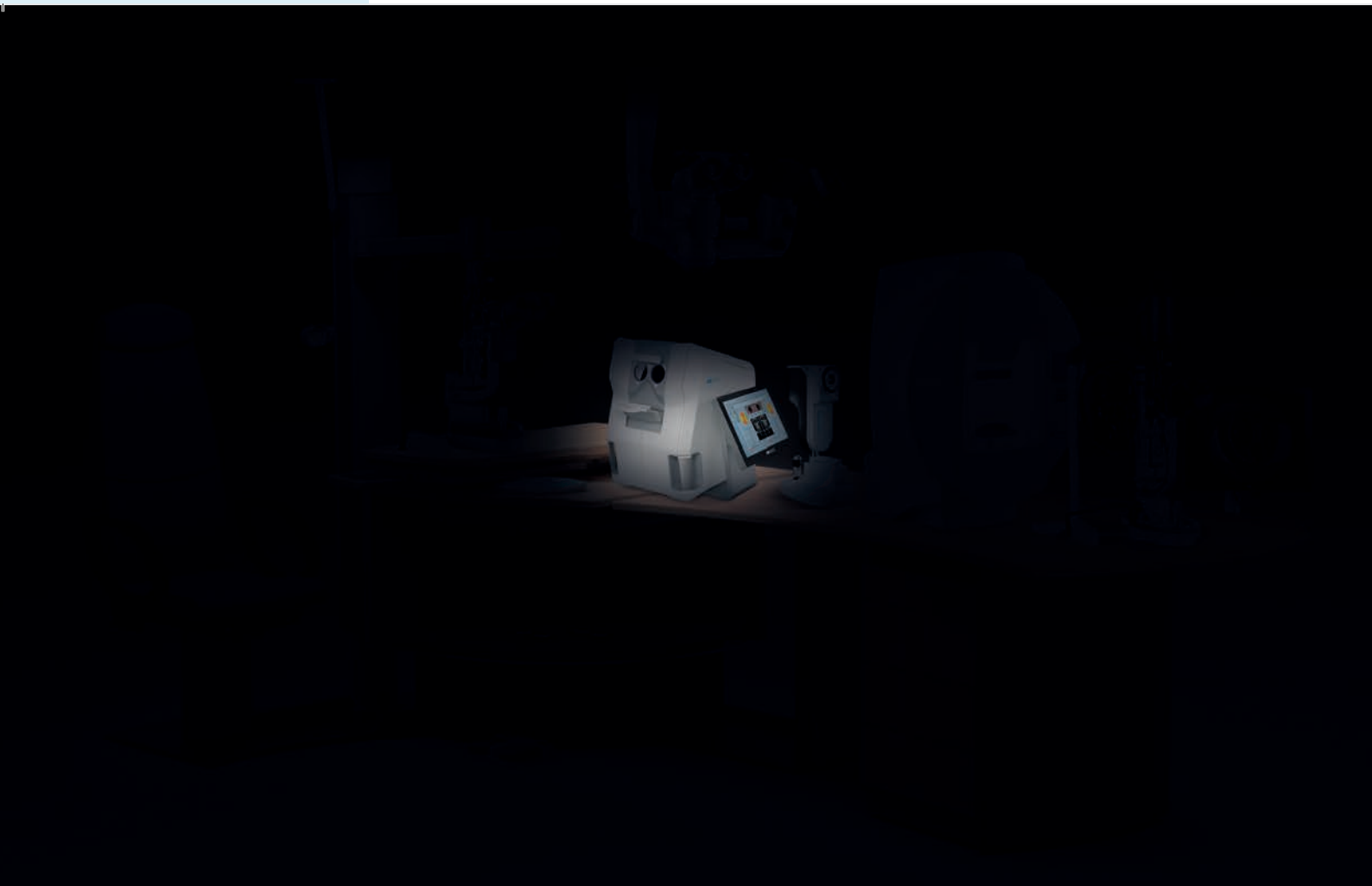
I'm also the liaison to the members in training, so I'm always looking out for what ARVO is doing and how it will impact our young members. Our young members will become our old members, therefore we need to continue to recruit our new people to make them feel welcome, otherwise ARVO loses vitality. Making sure that they are well represented and get their moment in the sun has been a big goal for me.

STEERING IN THE RIGHT DIRECTION

ARVO is an organization that is constantly striving to provide more for its members and they have been very forward thinking in terms of diversity, and trying to address issues of diversity. This is from well before the tide of the pandemic swept over us and it is still continuing now. There's a Women's Leadership Development Program, and a Women in Eye and Vision Research (WEAVR) program that makes sure women are represented. Then there's a global member mentorship program, so people in third world countries can be mentored by more established scientists. ARVO has also been trying to do a lot of online learning programs, to ensure that everyone can get intensive online training – and this resource that's developed by ARVO using our own members. ARVO even trains you on how to represent diversity in the right way – because the best ideas come from when we cross pollinate. So all of these things are huge milestones that the society has taken on and is in various stages of accomplishment.

ADVICE FOR FUTURE LEADERS

If I could give advice to someone who is going to lead an organization like ARVO, the key part would be to listen carefully at the beginning. I was pretty naive about how these societies worked and I think that I learned a lot by listening and listening to the way that the conversation was framed, how the discussion was allowed to move forward with some gentle nudging, and generally learning the process. If you have something you are passionate about then you can make a huge impact. I didn't know how to do that, but it's a learning curve and you just have to get stuck in and learn as you go.



MEET THE ARVO LEADERS

Stephen Pflugfelder is Professor of Ophthalmology at Baylor College of Medicine, and the ARVO Cornea Section Trustee and Immediate Past President.

Maureen McCall is Professor of Ophthalmology and Visual Sciences at the University of Louisville, and the ARVO Visual Neuroscience Trustee and Vice President.

Irene Gottlob is is a Cooper University Hospitals and Neurological Institute Ophthalmologist, and a gold fellow of ARVO.

Justine Smith is Matthew Flinders Distinguished Professor at Flinders University, and ARVO Executive Vice-President.

IRENE GOTTLOB

I have recently moved from University of Leicester in the UK, to Cooper University Hospital in New Jersey, USA.. At the University of Leicester I was chair of ophthalmology for more than 20 years, with my work being split to 50:50 clinical work and academic work.

There have been so many challenges over the last couple of years – believe it or not, not all of them have been pandemic related! Personally, although ARVO is an international organization, being one of few non-US members was a little difficult at the beginning. This was mainly due to the US members being more familiar with the structures, the financial aspects, and also with each other. But this was a learning curve that was quickly overcome – and this was the same case when getting familiar with everyone involved.

ARVO LEADERSHIP CHALLENGES

One of the major things I've learned from being involved in ARVO (such a large research-oriented organization) is that it is very important to be flexible and to adapt to any changes in the research emphasis, and to support interdisciplinary sessions. More generic advice for leading any organization, but it still needs to be said, is to listen to all the different members and to be very inclusive. ARVO is already working very intensely on diversity and inclusion, with emphasis on equal opportunities and by having specific meetings for young investigators. For new ARVO members the main meetings can be quite intimidating, and I think it is crucial that we continuously address this so that we don't lose talented ophthalmologists and researchers.

Obviously the activities in our pandemic landscape have all been virtual – hopefully this will be changing very soon. But this has naturally taken away the more informal interactions that go hand in hand with conferences and meetings. Casual meetings have been very important for problem solving or ideas, for example for new symposia, etc. Fortunately for all of our members, the ARVO management has adapted exceptionally well with the challenges and coordinated extremely well-organized meetings for the leaders and for the entire ARVO

meeting – a shining example of how organizations can deal with the challenges of the last couple of years.

PROFESSIONAL PANDEMIC CHALLENGES

Before the pandemic I travelled to many meetings every year, which has been significantly reduced now. I am optimistic and believe that the virus will get less pathogenic, more like the flu. Things will get better, and work and meetings will return to being much closer to what was normal two years ago. In the long-term, I think people will work more from home and communicate electronically more and more – more flexibility and a more hybrid approach to work seems to be one of the major take aways from the pandemic.

ARVO AND YOUR CAREER

ARVO had a very important role in my career. When I attended ARVO for the first time, as a first-year resident, the meeting was an eye opener – just the access it gave me to all the ongoing research. It was fantastic to be able to directly speak to the authors whose papers I had read and poster sessions were a fantastic opportunity for meeting people in person. Over the years ARVO meetings gave me the opportunity for important collaborations and to make many lifelong friends all over the world. After each ARVO meeting I come home with new research ideas – another major advantage of the diversity in research and translational studies that are presented at the meeting. If I could offer any advice to people who have only just, or are thinking of, joining ARVO, is to interact with more established researchers and not to be shy to ask for advice, for collaboration or even asking to join their group.

JUSTINE SMITH

I am the ARVO Executive Vice-President (EVP), and Matthew Flinders Distinguished Professor, at Flinders University, Australia. EVP is elected by the ARVO membership. The key responsibilities include: Chair of the Annual Meeting Programming Committee and oversight of scientific aspects of the meeting (as well as other ARVO meetings, such as ARVO-Asia); and ARVO Board Liaison to ARVO Executive Director and staff.

LEADERSHIP ADVICE, CHALLENGES AND CHANGING DIRECTIONS

One of the leadership challenges is actually geographical – I am based outside the US (in Australia), and I am the first ARVO EVP who did not live in the US. You could not have been in this position and not lived in the US 20 years ago. However, with so many options for global connectivity – for meetings as well as logistical matters – this has worked well, and it has been a good experience for the organization.

The direction of ARVO has continued to evolve with membership needs. ARVO holds a formal strategic planning process approximately every five years to ensure the direction is on the right course for the membership. ARVO leadership constantly turns over, as per our bylaws. The EVP serves a five year term – the Presidents and Vice-Presidents serve a one-year term (and the President spends a year in the position of President-Elect and another year in the

position of past President).

Important advice for anyone leading such a large research-oriented organization is to keep the communication channels open. ARVO uses the electronic community, ARVOConnect, as a key mechanism for allowing all members to communicate with each other, and with the ARVO Board.

PANDEMIC DIARIES

Due to the pandemic, like other organizations, activities have moved into the virtual environment – ARVO 2021 was a fully virtual meeting. ARVO 2022 will include an in-person component, held in Denver, along with virtual components that should appeal to all and hopefully increase attendance (even if not numbers in the building).

Although the pandemic hasn't been a good experience for anyone, there are some aspects which we should take with us as we move back to a semblance of normality. The eye and vision community has learned how to capitalize on electronic communication, which will ultimately open our doors to more people than ever before. If we are to ever have another pandemic, the world has now learned pandemic strategy, which hopefully will be applied and make any future pandemics, as well as for the present.

ARVO IN YOUR CAREER AND COLLABORATIONS

ARVO has provided the main route to establish my collaborations. The Annual Meeting, other ARVO events, and the journals have been and continue to be my major resources of information in the eye and vision sphere. It has also been where I've progressed my leadership skills, as I have learned leadership on-the-job at ARVO.

I would advise anyone who is thinking of joining to get on the website and see all that ARVO has to offer – there is a lot! And if I had to offer advice to someone early in their career, or even back to myself as I was starting, it's not to expect your career to follow a straight path: some of the most exciting opportunities come during the detours.

To read the full version of this feature visit: https://theophthalmologist.com

The Laser's Edge

Lasers and ophthalmology have come a long way. Here, we track the key developments that culminated in the production of Norlase LION and LEAF technologies

1917: Albert Einstein develops the theoretical concept for the laser.

1959: Gordon Gould first publishes the acronym "LASER" in a paper. It stands for "Light Amplification by Stimulated Emission of Radiation."

PHYSICS

1960: Theodore H. Maiman builds the first ever laser.

OPHTHALMOLOGY

1949: Gerhard Meyer-Schwickerath pioneers photocoagulation procedures – taking patients to the roof or balcony of his clinic to treat retinal detachment and retinal melanomas using sunlight and his self-constructed device.

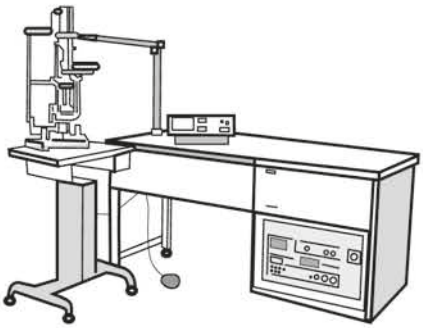
1945: José Morón performs the first photocoagulation using a sunlight in rabbit and human eyes. The work was presented in his 1946 doctoral dissertation, but the research paper with these experiments was only published a few years after this – resulting in the widespread recognition of the invention from the time point above...

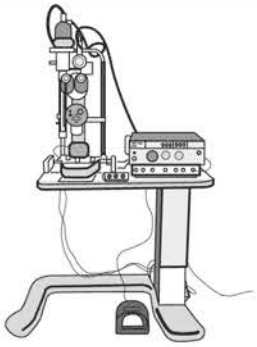
1867: The first record of photocoagulation is performed by Vincenz Czerny, who used a mirror and lens to focus and direct sunlight into the retina of animals.

1970s ▶ LARGE AND WATER COOLED

1990s ▶ TABLE-TOP LASER

TODAY ▶ ULTRA-COMPACT, PORTABLE LASER





1973: Invention of the excimer and Argon-ion laser – this device was further developed and modified for use on eyes in the early 1980s. The technology still needs water cooling and is still too large to fit on a desktop.

1996: Frequency-doubled Nd-YAG laser technology / Diode-Pumped Solid-State Laser technology is introduced to ophthalmology. Photocoagulators are based on this technology.

2019: Norlase receives FDA clearance for its next generation photocoagulator, the LEAF – 90 percent smaller than previous lasers and able to fit on top of the slit-lamp, eliminating the need for fiber-optic cables and slit-lamp adapters. The LEAF is controlled wirelessly via a tablet or by voice command – a first in the ophthalmic laser industry.

LASERS IN OPHTHALMOLOGY

1985: David Payne dopes optical fibers with rare-earth elements – breaking the "kilowatt threshold" and paving the way for smaller desktop fiber laser devices.

2014: Researchers reach unprecedented power from a new type of compact, semiconductor-based lasers. Norlase is founded to commercialize this technology.

1961: Charles J. Campbell is the first person to use a laser for a medical purpose by performing a retinal laser coagulation.

2006: Details of PAtterned SCAnning Laser (PASCAL) technology are published. The large system is built into a table and allows for shorter treatment times and reduced patient pain perception.

2020: Norlase introduces LION – an indirect ophthalmoscope with an integrated treatment laser that offers even greater portability and flexibility. It features an even more compact laser, which is integrated on the back of the ophthalmoscope headset, and powered by a battery in the foot-switch. It is also controlled wirelessly via a tablet and voice commands. With no need for a fiber-optic cable, power cable or table, the LION enables doctors to treat in any room, anytime, anywhere.

the Ophthalmologist

DRY EYE
Practice Fundamentals

Watch an esteemed panel of ocular surface experts – Cynthia Matossian, Eric Donnenfeld, Jai Parekh and Christopher Starr – discuss steps practices can take to effectively manage patients' dry eye disease. The discussion includes the importance of assessing the ocular surface, pre-operative treatment algorithms, increasing patient eye drop compliance, managing MGD and Blepharitis, affordability of treatments, and more.

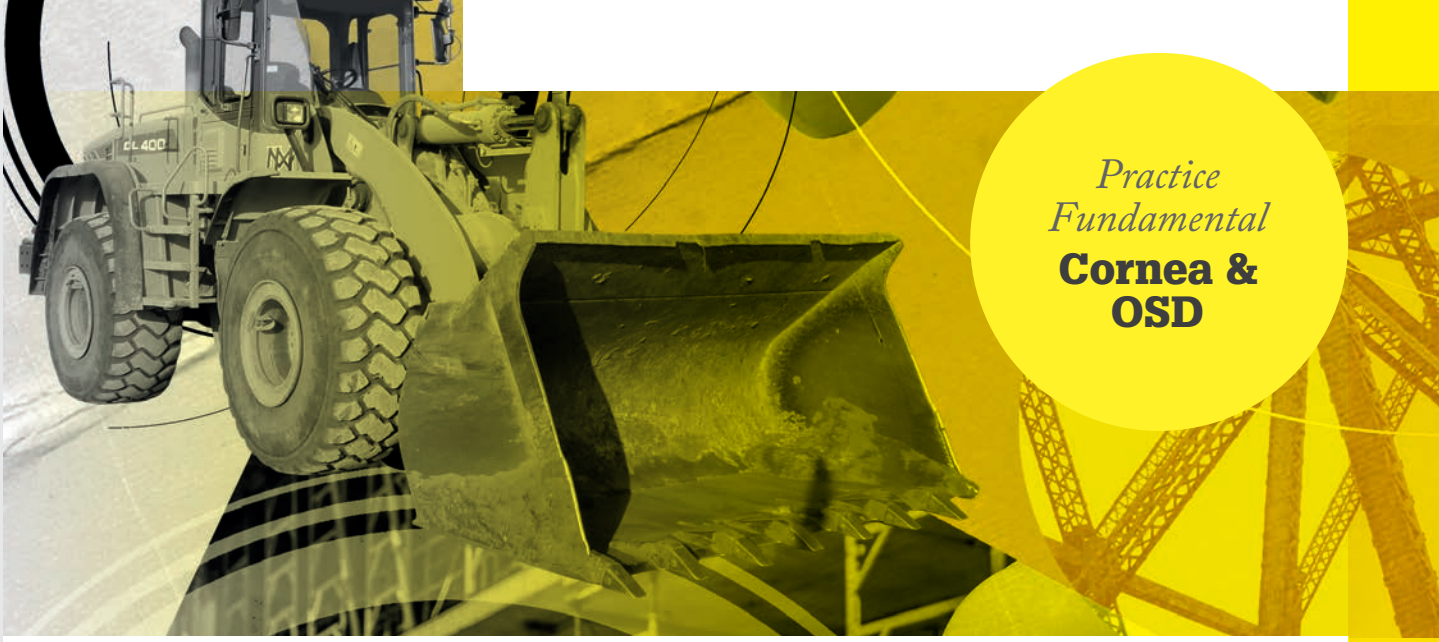
WATCH OUR FREE ROUNDTABLE TODAY:
https://bit.ly/33XOlNr

HEADLINE *Sponsor*

SIGHT SCIENCES

SUPPORTING *Sponsors*

Bruder imprimis Rx QUIDEL tarsus



The Template for Transplantation

The answer to a growing demand for corneal tissue may be to grow more corneal tissue

By Che J. Connon

I'll start with a horrific statistic: one in 70 patients globally who would benefit from a corneal transplant will actually receive one – and the lack of available tissue is a major reason why. Even in locations around the world that have good eye bank management, the supply is only just keeping up with demand. Trying to solve this significant problem and unmet need has been a major driving force and inspiration for me and my colleagues in our work on tissue engineering.

To make progress, we've had to really understand the cornea to its core – how does it actually work? And that's meant increasing our fundamental understanding of corneal biology. For example, uncovering how cells interact with their surrounding resident extracellular matrix (ECM) to inform our tissue engineering approaches. We've also needed to consider the tissue as a whole – what is the spatial orientation of cells, what is their specific phenotype?

Bioinspiration not perspiration

What we now work on is a bioinspired approach to growing cornea, using the concept of tissue templating. Although bioinspired is a fashionable word, it basically means that you're taking the tissue and building from the bottom up. As opposed to the more conventional approach, where you generate a scaffold, often a biopolymer or synthetic polymer, with specific stiffness and porosity, and then add the cells to it. The common flaw in this latter approach is that you've already decided on the properties of the scaffold. But we don't know how to make the scaffold as well as the cells do and, right now, we definitely can't make it with all the same attributes – it's extremely complex with different growth factors, it responds physically to different tensile loads, and so on. This should come as no surprise, as the cornea has developed over many millennia.

The importance of the scaffold in which transplanted cells are being introduced to humans is something that can be underestimated to drastic effects – you only have to look at the tracheal implants' disaster, where patient stem cells were seeded to plastic trachea…

Inside the body, cells know what to do, they're given instructions, and they can create a cornea during development. And the corneal tissue that the cells are able to generate has all the different features that it requires – from types of ECM to the specific arrangement within the ECM and the cells that reside there.

"Although bioinspired is a fashionable word, it basically means that you're taking the tissue and building from the bottom up."

In tissue templating, we need to identify the right instructions – the specific biochemical and biomechanical signals that direct cells to grow and produce ECM with the correct alignment, the correct structure and the correct composition. If we get it right, we can ultimately create the tissue outside the body. Using tissue templating, we can grow cornea,

Che J Connon

skin, and even muscle into hierarchical structures – something that is beyond the traditional engineering capabilities that exist today. Creating a cornea with collagen fibers of a certain diameter, density, alignment that form collagen bundles that stack in the appropriate manner (an extremely important property of functioning cornea) is beyond the limitations of a top-down approach with scaffolds.

Put even more simply, you can imagine the cells acting like mini 3D bioprinters, producing the tissue and extruding the scaffold themselves. We basically say to the cells, "You know what you're doing, so we're just going to let you get on with it – with some guidance."

Speaking of 3D bioprinting…

Initially, we did look at 3D bioprinting to create the necessary spatial deposition of cells for the growth of a cornea. We were one of the early adopters of this technology in the UK back in 2018, and purchased a CellInk 3D bioprinter. After getting the bioink right – my major focus – we managed to print the corneal tissue with corneal stroma cells (see Figure 1).

We had the aforementioned advantages of knowing how to handle corneal cells and extensive knowledge of the ECM, which allowed us to publish a nice paper detailing 3D bioprinted corneal tissue – a good first step in our journey.

On paper at least, 3D bioprinting seems like the ideal solution to corneal tissue generation – with precise deposition of cells in the correct surrounding ECM (a bioink) you could form a fully functional tissue. However, a major issue is the resolution of the structures being printed whilst

"Using tissue templating, we can grow cornea, skin, and even muscle into hierarchical structures – something that is beyond the traditional engineering capabilities that exist today."

maintaining cell viability and avoiding viscosity issues. Today's printers can hit a resolution of maybe 20–50 µm – but that's a long way off the intricacy of real corneal tissue. And that's why it's not a big part of our plans moving forward. Presumably, the technology will one day reach a point where it can be used for this purpose, and it will no doubt continue to develop as a useful tool for cell-free devices like contact lenses…

Running a lab – and a company

Serendipitously, the publicity gained from our 3D bioprinting paper generated international interest in our lab and the work that we do. It also waved a flag at investors, who wanted to know how real it is and what we can actually do with it – ultimately, this helped me and co-founder Ricardo Gouveia acquire the initial investment for 3D Bio-Tissues – a spinout from Newcastle University, UK.

The corneal tissue engineering lab is still running at the university, with PhD students exploring different aspects – some are even sponsored by 3D Bio-Tissues.

One of the major differences going from academia into the industrial space is the need to scale up – if we truly want to meet our goal of addressing corneal tissue availability, we'll need to create high numbers of corneas in the same predictable fashion with all the same attributes.

I've had to separate my University and commercial work, partly for intellectual property (IP) reasons and partly to avoid any blurred lines between ownership and my role at the University. This separation is more challenging than you might expect – you have to be regimented, strict, and fair with IP (what is created in service of the University is the University's IP, and vice versa). Thankfully, I find the interplay and movement between academia and industry to be both rewarding and exciting. After all, getting technology and discoveries out into the real world is why I started doing research in the first place.

Given my industry experience – I lived through the process, the pitfalls, the opportunities, the good and the bad – I've been able to take on the role of director of business development for the faculty of Medical Sciences at Newcastle University. I get to oversee the IP opportunity committee and deal with spin outs, but I'm also there to encourage academics (young and old – whatever their career stage) to think about opportunities to commercialize their work – offering my oversight whilst they work with companies or deal with IP.

The cornea transplant of tomorrow

Looking further ahead, a professor of microelectronics and I also share a PhD student who is developing a bionic cornea. Put simply, we want to embed a microchip within the tissue. First, we have to determine how to power the microchip and how to send and receive signals. Typically, a major problem when integrating microchips into tissue is rejection or integration – but as the cornea is an immune privileged site, partly due to the absence of blood vessels, pre-implantation of an electronic device into an immune-tolerated tissue will side step current issues with bio-electronic integration. Once our lab-grown cornea is indiscernible from the real thing – and we are 90 percent there – then including other structures - like a microchip – doesn't seem so much like science fiction.

If we can reach our goal, the big question becomes: What do we want the electronics to do? For example, it would be relatively easy to monitor intraocular pressure (IOP). But what about including an internally facing camera to measure blood flow – or an external camera enables vision on different wavelengths… Now we are back in the realm of science fiction, but the technology is almost within grasp.

But before we start enhancing vision, we need to save it. We are focused on replacing human corneal donor tissue with our approach – and we are getting much closer to that bold goal.

Che J. Connon, Director of Business Development and Professor of Tissue Engineering, Newcastle University, Newcastle upon Tyne, UK, and founder of 3D Bio-Tissues.

Reference

1. *A Isaacson, S Swioklo, CJ Connon. "3D bioprinting of a corneal stroma equivalent," Exp Eye Res, 173, 188 (2018). PMID: 29772228.*

In Agreement

PolyPhotonix names Prevail Partners as its lead US investor whose affiliate will lead Noctura 400 FDA clinical trials

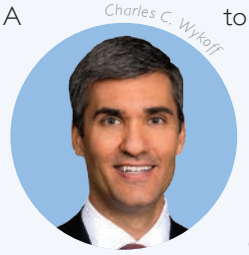
PolyPhotonix, the manufacturer of the Noctura 400 Sleep Mask, a treatment for diabetic retinopathy, has entered into an agreement with Prevail Partners who has agreed to invest significantly in PolyPhotonix as lead investor in a US$10 million Series A investment round. In addition, Prevail InfoWorks Inc. will lead the management of FDA regulated human clinical trials of Noctura 400. The successful completion of the FDA clinical trial will open the US market to the treatment.

Worn at night, the sleep mask treatment reduces and reverses the effects of diabetic retinopathy by delivering light therapy during a patient's normal hours of sleep in a home-based setting. The Noctura 400 administers low-level light to reduce the risk of hypoxia and retinal damage in the diabetic patients' eyes.

A recent UK NHS Real World Evaluation undertaken during the COVID-19 pandemic found that 98 percent of eyes achieved positive clinical outcomes using the Noctura 400 Sleep Mask. The results have been published in The Journal of Ophthalmology, one of the sector's leading publications (1).

PolyPhotonix's new strategic partner, Prevail InfoWorks Inc, is a global company based in Philadelphia, Pennsylvania, US, providing biotech, pharmaceutical, medical device and diagnostics companies with the most innovative and complete technology and service solutions for its clinical development. The deal will leverage Prevail InfoWorks' capabilities and technological expertise for achieving the highest quality data in the shortest possible time to expedite the clinical trial process.


Jack Houriet


Charles C. Wykoff


Richard Kirk

Jack Houriet, Chief Executive, Prevail InfoWorks, says: "The extraordinary visionaries and scientists at PolyPhotonix are making major advances in the treatment of diabetic retinopathy. We are delighted to be working with PolyPhotonix to take the treatment through to successful FDA regulatory approval as quickly as possible with our technologies and clinical services. Early-stage treatments are more urgently required than ever with more than 40 percent of diabetic patients suffering from diabetic retinopathy.'

Charles C. Wykoff, Director of Research at Retina Consultants of Texas, US, comments: "There is more need than ever for a non-invasive modality to treat diabetic retinopathy. Current treatment options are excellent, but carry the challenge of being invasive and requiring repeated injections over time. Having a safe treatment option which was much less invasive, such as Noctura 400, when validated, would likely translate into substantially more patients initiating treatment earlier in the disease process before vision-threatening complications develop."

Richard Kirk, Chief Executive of PolyPhotonix, says, "Our new global strategic partnership with Prevail InfoWorks will be a valuable asset to our vital work in tackling diabetic retinopathy worldwide. We are delighted to be working with such a major player in the industry and hope to break into the US market in the very near future. The investment and the forthcoming FDA trial will help support and develop the evidence base for Noctura 400's clinical effectiveness for diabetic retinopathy patients at risk of losing their sight. This multimillion-pound deal will accelerate the clinical trial process and advance other indications in our biotechnology pipeline. At a time when health services across the globe are struggling to bounce back from the COVID-19 crisis, our sleep mask can be used by patients at home, reducing the pressure on frontline hospital services."

"Early-stage treatments are more urgently required than ever with more than 40 percent of diabetic patients suffering from diabetic retinopathy."

PolyPhotonix's recent investment success marks the latest chapter in the company's international expansion plans; with the mask already in use in Europe including the UK, France, and Portugal

Reference

1. *U Meyer-Bothling et al., "A real-world single-centre study of patients with diabetic macular oedema who wore a home-use sleep mask (Noctura 400) for one year," J Ophthalmol (2021). PMID: 34258049.*

UNCOVER MORE

ADJUST THE SPEED TO YOUR NEEDS

SPECTRALIS®

Uncover SHIFT

SPECTRALIS® with SHIFT technology enables you to switch between three OCT scan speeds to find the ideal balance of image quality and clinical workflow. SHIFT combined with the other SPECTRALIS core technologies, optimizes performance for different clinical applications and individualized patient care.

Standard presets ensure efficiency and you now have the flexibility to speed up or slow down when needed.

Uncover more detail: spectralis-shift.com

- **Optimized performance**
- **Improved workflow**
- **Customized patient care**

HEIDELBERG ENGINEERING

Varied Views on VUITY

What do refractive experts think about the recently approved presbyopia eye drops?

In late October 2021, following two Phase III clinical studies – GEMINI 1 and GEMINI 2 (1, 2) – that showed improvement in intermediate vision and no impact on distance vision of presbyopic patients for up to six hours after instillation, the FDA approved the first-ever eye drop developed to treat presbyopia: pilocarpine HCl ophthalmic solution 1.25%, better known as VUITY (3).

In December 2021, the manufacturer of VUITY, Allergan, an AbbVie company, announced that the eye drop was available – if prescribed – in pharmacies across the US.

Have US-based specialists decided to prescribe it to their patients? What have their impressions and experiences been like, and – more importantly – how have their patients reacted? What do their colleagues from other parts of the world think – are they eagerly awaiting approvals in their countries or regions and will they decide to make use of VUITY when available – or are they ambivalent?

We invited world renowned specialists to share their perspectives.

Is the approval of VUITY a big ophthalmology milestone?

Arthur Cummings: I think it is! For the first time, the general population will get to hear that you can improve reading vision without the use of reading glasses. This will drive patients seeking the new miracle drop to ophthalmologists and optometrists. It will work for some, and they will return to the practice one day for surgical solutions when the drops are no longer sufficient, or they are tired of using them. Those it doesn't not work for, will learn about surgical alternatives such as blended vision laser vision correction or refractive lens exchange and custom lens replacement with trifocal and EDoF IOLs. Bottom line: VUITY and similar drops are going to create awareness of presbyopia like nothing has done before.

David Goldman: In a sense, this is a very big milestone. In the past we've only had invasive techniques to combat presbyopia such as specialized contact lenses or corneal inlays. Now, we have the opportunity to correct presbyopia in a pharmacologic fashion, but with a reversible application.

Kjell Gunnar Gundersen: In my opinion, it is not a milestone, and the approval means close to nothing

Arthur Cummings

Clockwise from left:: David Goldman, Guy Kezirian, and Vance Thompson.

to our profession.

Guy Kezirian: Presbyopia treatments represent a new market space that will expand rapidly. It is important to view this new market correctly. Applying "market share" mentality to this area is misguided. By market share mentality I mean looking at the market as a fixed size and competing over which product or approach captures the largest share at the expense of others, similar to cutting a fixed pie and apportioning it among hungry diners. This approach does not apply to the presby market. It is a "market growth" opportunity where new entries will grow the market and speed adoption, benefitting all participants. As they enter the market, the pie will grow.

Robert Osher: In my opinion, the approval of VUITY is not a milestone. The concept of pilocarpine as a biotic agent has been known for a long time. In lower concentrations we used it to treat dysphotopsia after LASIK or diffractive IOL implantation. Latest models of pinhole implants like Karma or on IOL base like IC-8 or the Morchel add-on show good results. Still – subjectively – patients do complain about loss of visual field even it is not measurable. Also, German driving law does not allow patients after miotic or mydriatic drops to operate a car at night. Nevertheless, as soon as VUITY makes it across the Atlantic, it will be an option to help patients cope with presbyopia and cover for residual refractive errors.

Florian Kretz: The approval of a reversable pharmaceutical treatment of presbyopia is very promising. Patients in their forties have always sought options beyond the age-defining reading glasses to restore their near vision and maintain their youthful active lifestyle. With this first, as well as the expected future approvals, we have the potential to help these patients and address their visual needs and desires.

Ray Radford: I don't see it as anything new, but rather as using old knowledge for a purely marketing exercise to sell a product. After all, the pinhole effect has been known for so long!

Vance Thompson: I believe the approval of VUITY is huge for ophthalmology, optometry, eyecare in general, and mankind. Presbyopes are notorious for not having had their eyes examined for years. And then when near leaves them, many just go get a pair of reading glasses and still do not get their eyes examined. Now that they are hearing about VUITY drops, they are calling us and we are suggesting a quality eye exam, not unlike a refractive consult, to make sure their eyes are healthy, they are good candidates for presbyopia drops, and we are planting the seed about surgical options to help their presbyopia journey if the drops do not serve all their needs in the near or long term. These drops are great for presbyopes, but also our profession.

Blake Williamson: This approval has created a new category, putting presbyopia on the map. Right now, many people outside of ophthalmology don't consider dysfunctional lens syndrome or presbyopia a disease, but through direct consumer marketing, the general public will find out what presbyopia is. It's going to be seen for what it is: a disease of aging

and unconditional loss of vision.

To those who say that "it's just pilocarpine," I say that the vehicle used in the drop changes into a more physiological PH than in other solutions within a couple of minutes, resulting in better penetration of the cornea and less discomfort for the patient. This formulation offers great bioavailability.

Have you prescribed VUITY to any of your patients or will you in the future?

Arthur Cummings: Unfortunately, VUITY is not available in Ireland yet. When it does receive approval, I will be making it available to my patients and prospective patients. I don't know of a better educational tool for presbyopes to illustrate the benefits of being able to see up close without reaching for glasses first. If you want to grow your refractive practice, you need to offer VUITY or similar drops when they are approved.

David Goldman: I have already begun prescribing VUITY for patients. Many patients specifically called in wanting to try it after they heard about it in the news.

Kjell Gunnar Gundersen: It is not yet available in Norway, where I practice, but I have no plans to prescribe it to my patients when it is approved here.

Florian Kretz: VUITY is another option we will have available. I would love the drug to be labelled also for residual refractive errors.

FEATURING

Arthur Cummings, Consultant Ophthalmologist and Medical Director of the Wellington Eye Clinic, Dublin, Ireland

David Goldman, Founder and CEO of Goldman Eye, Palm Beach Gardens, Florida, USA

Kjell Gunnar Gundersen, ophthalmic surgeon at the Ifocus Eye Clinic AS in Haugesund, Norway

Guy Kezirian, President of SurgiVision® Consultants, Inc., Founder of the Refractive Surgery Alliance, Founder of the World College of Refractive Surgery & Visual Sciences, based in Scottsdale, Arizona, US

Florian Kretz, Founder, CEO and Lead Surgeon of Precise Vision Augenärzte, based in Rheine, Germany

Robert Osher, Professor of Ophthalmology, University of Cincinnati and Medical Director Emeritus, Cincinnati Eye Institute, Cincinnati, Ohio, USA

Raymond Radford, Independent Consultant Ophthalmic Surgeon, based in Preston, UK

Vance Thompson, Founder of Vance Thompson Vision, Sioux Falls, SD, USA

Blake Williamson, ophthalmic surgeon at the Williamson Eye Center, Baton Rouge, Louisiana, USA

Vance Thompson: We are getting lots of phone calls about the VUITY drop. We are asking patients who their eye care provider is and when they had their last exam. We are emphasizing the importance of an exam first. If possible, we are coordinating their care to see the doctor they have trusted for years. We are also asking them about their distance vision and their night time image quality. If they are blurry at a distance and their night time image vision quality is reduced, we suggest they see us, since they may have a surgical issue already. If they have a great exam and refractive consult and would like the drops, we prescribe them. We are handling different situations differently.

Blake Williamson: I used the drops for a patient in the same week they were commercially available in the US, and have used them for several patients since then. It is a fantastic tool for patients in their 40s and 50s with presbyopia that allows them to reduce or even eliminate the need for reading glasses. More than the drop itself, I love the mindset shift it's going to create in our patients to let them know that there's something to address longsightedness other than reading glasses.

In what situations do you recommend VUITY or advise against it?

Arthur Cummings: I'd recommend it to early presbyopes, patients with previous laser vision correction that are becoming presbyopic or where their blended vision has run out of road, like a -1 D target – it should provide reading vision to 52 years of age or thereabouts. When this happens, VUITY may be an excellent bridge to enhance reading vision until they are ready for IOL surgery.

I would be careful with previous high myopes as pilocarpine has been seen to add to the risk of retinal detachment in high myopes.

David Goldman: Based on the clinical trials, I would still prescribe it to the older pseudophakic patients in my practice, but with a warning that it may not provide as much benefit.

Florian Kretz: Constriction of the pupil usually results in slight headaches. I would be very careful with prescribing presbyopia drops to migraine patients; it would not be my first choice.

Vance Thompson: For patients who are new presbyopes with great distance vision and a normal eye exam this seems like such a natural fit to start their presbyopia journey. Why not try it? Many will love it and some won't. And the risk is low so why not have them decide after a trial if it is for them? And remember, for some it may not be as great for near as they want and they may use some readers, but I predict many will like it for computer and will also not have to grab their readers as much.

Blake Williamson: The trials looked at patients down to -4 D, so I would be more cautions with high myopes. They would certainly need a good retinal exam. I would recommend starting with patients in their 40s and 50s who don't have high prescriptions and are just looking to get rid of reading glasses. There are various other potential functions of VUITY that can be examined further – perhaps pseudophakic patients after cataract surgery with a monofocal lens who would like to have better near vision? Many things are possible, but I would still start with the basic indication.

Left to right: Robert Osher, Blake Williamson, Kjell Gunnar Gundersen, and Ray Radford.

Have you had any feedback on VUITY from your patients? Do they see this as a major milestone?

David Goldman: I've seen a veritable cornucopia of responses. Some patients did not like it at all, while others were blown away by the results and feel it is a life changing technology. I have seen multifocal IOL patients say it helps with haloes in the evening.

Vance Thompson: My practice was in the FDA monitored trial for this drop in the US, so we were able to see in the trial that this was a game changer, and we are also seeing it in our post-approval patients. It is not for everyone, but it is helping a significant number of people. Also, remember, it is useful for post-refractive and cataract patients who may want additional help at near and intermediate. The drop is so versatile.

It has been amazing to see the look on a presbyopes face when they feel like they are turning back the clock. I had one patient say, "This is how I used to see up close!" This concept is very intuitive to patients and with proper patient education and quality pre-prescribing exams it can be a huge plus in their life.

Blake Williamson: Patients who have been prescribed VUITY by me are routinely gaining several lines of vision: from J7 to J2! It's been amazing for me to watch. They are noticing that they don't need their glasses as much in the workplace. I treat several golfers who tell me that not only can they fill out their score card on the golf course, but they notice an improvement in their distance vision, too! They are able to follow the golf ball better because of pinhole optics. Sometimes use of the drops also cuts out some of astigmatism and other aberrations. Other patients enjoy going to the restaurant and being able to read the menu without their reading glasses.

References

1. *Clinical Trials, "Efficacy study of pilocarpine HCl ophthalmic solution (AGN-190584) in participants with presbyopia (GEMINI 1)" (2021). Available at: https://bit.ly/3Avl34b.*
2. *Clinical Trials, "A Phase 3 efficacy study of pilocarpine HCl ophthalic solution (AGN-190584) in participants with presbyopia (GEMINI 2)" (2021). Available at: https://bit.ly/3fTgsQ7.*
3. *AbbVie, "US Food and Drug Administration approves VUITY (pilocarpine HCl ophthalmic solution) 1.25%, the first and only eye drop to treat presbyopia (age-related blurry near vision)" (2021). Available at: https://bit.ly/3rOaNQN.*

OPHTHALMOLOGY INNOVATION SOURCE

Ophthalmology Innovation Source is the prime spot for Ophthalmic Innovation. We offer top-notch live events where ground-breaking innovations are unveiled and impactful connections are made between entrepreneurs, start-up companies, clinical thought leaders, industry executives and investment professionals.

In addition to our live events we provide compelling podcasts, news, videos, and virtual programs — plus our latest and most exciting addition is the EyeDealSource™ database of ophthalmic start-up companies and investors! This platform takes meaningful connections to the next level! Its members will have insight and gainful information to drive innovation forward at their fingertips with the ability to identify companies based on technology type, clinical indication, stage of development, funding to date and much more!

Telemetry for Glaucoma Management During the Pandemic

Kaweh Mansouri shares the pros and cons of using telemedicine – including remote measurements – for glaucoma patients

In order to appropriately manage glaucoma, the clinician needs at least three parameters measured reliably: IOP measurement, the patient's visual field, and fundus exam in the form of OCT or fundus photography. None of these measurements can be taken easily and consistently at home. For IOP, there are home tonometry devices available, but they're not common and at least one third of patients has been shown to struggle to obtain reliable measurements despite previous training. There are sensors, such as Eyemate (Implandata, Germany) approved in Europe that can be implanted in the eye during cataract or glaucoma surgery, which stay in the eye for the patient's lifetime and measure the IOP at any given point. The implants are connected to an external device, which can transmit the results to the physician. These sensors came in very useful during the initial COVID-19-related lockdowns. Studies have shown that the data transmitted by the sensors proved useful for monitoring patients during the first lockdown when it was impossible for glaucoma specialists to see the patients (1). For those patients whose target IOP was as expected, this was reassuring news for the patient and the physician and avoided unnecessary visits, and in the few cases where the IOP measurements were higher than expected, additional medication was sent to the patients or they were invited in for surgery.

For one of these studies, we had access to 8415 IOP measurements from 370 measurement days of 24 patients. We looked at variations of IOP in a short-term period of three months, and a longer one of one year and beyond. We found that even during the short period, the IOP was only moderately reproducible, and in the longer term it wasn't reproducible at all – the variation was huge. This shows that our current way of measuring IOP is insufficient. It is almost surprising that we manage our glaucoma patients as well as we do with such imperfect data, but think what we could do if we had access to other types of data, such as night-time measurements, data obtained during daily activities, and similar. The types of patients' daily activities and the way they impact on their IOP measurements should be taken into account for risk stratification, in a truly patient-centric model of glaucoma management.

As I mentioned, IOP is only one of the three key elements of assessing glaucoma progression. I have now seen really interesting start-ups offering approaches to obtain visual field measurements and fundus photography or OCT at a patient's home. It seems like telemedicine, and telemetry in particular, has made huge advances over the past few months. These innovations can be extremely useful as we navigate managing our patients' glaucoma effectively in difficult circumstances, so I hope we can continue using them even when we are no longer in a pandemic.

Nevertheless, I don't think these technologies will replace office visits. In my opinion, there are three components that make face-to-face appointments unique. First, patients simply like to see their physician in person. There is an important relationship that develops with patients who suffer from a chronic disease such as glaucoma that is best cultivated in person. Second, there are some interventions, such as SLT, that can be done immediately, on the same visit, when the need arises. Third, in-person visits are hugely valuable for educating fellows and residents.

Reference

1. *K Mansouri et al., "Intraocular pressure telemetry for managing glaucoma during the COVID-19 pandemic," Ophthalmol Glaucoma, 4, 445 (2021). PMID: 33358988.*

Glaucoma and the Pandemic

How has glaucoma care and management changed since the start of 2020?

Anthony Khawaja, Consultant Ophthalmologist at Moorfields Eye Hospital and UCL Institute of Ophthalmology, London, UK

Anthony Khawaja

The way we started managing glaucoma when the pandemic started might be partly what we have been aspiring to, but this transformation of the way care for patients has been forced upon us quite suddenly. Glaucoma specialists have known for a long time that with the aging population, the way we used to manage patients was unsustainable. This is where virtual clinics/telemedicine come in, where the patient's data is collected without the need for them to see a physician. What follows is an asynchronous review of that data, with the specialist making contact with the patient by letter or phone call.

Risk stratification is a crucial aspect of this type of care. We always aimed to assess risk accurately, but we would often test even our low-risk patients frequently. Now – this has had to change. Surgical strategies have also been adapted, with surgeons considering approaches requiring less intensive follow ups.

There are many patients who will come to harm due to delays in their glaucoma management, but there is a big number of them who will not. There are even patients who stop using their anti-glaucoma eye drops and are better for it, as the side effects are gone, and their disease doesn't progress. The issue is, we don't know which patient belongs to which risk group, so reviewing available evidence is crucial. Originally, at Moorfields Eye Hospital, we didn't have a proper system for analyzing these data, and we would go through each set of notes individually. A system has slowly been developing, relying heavily on the risk assessment done by the last glaucoma specialist who saw the patients (how long they thought the patient should wait for their next appointment) and average intervals between the patient's visits – the longer the average intervals, the more stable the patient is deemed to be. In the near future, we need better, more objective ways of stratifying risk, such as using visual field mean deviation and other factors.

Before the pandemic, our healthcare services in the UK were completely stretched, and now the capacity has reduced again due to social distancing, so risk stratification has helped us deal with this situation.

Constance Okeke, glaucoma specialist at Virginia Eye Consultants, Assistant Professor of Ophthalmology, Eastern Virginia Medical School, Norfolk, Virginia, USA

Since the start of 2020, there have been a number of changes to my practice.

"Surgical strategies have been adapted, with surgeons considering approaches requiring less intensive follow ups."

My team and I have had to change the way in which we approach patients in our clinics, as many of them weren't feeling comfortable coming into our office. For the first time, we introduced telemedicine in glaucoma treatment – it was a completely new model. We used a hybrid technique of patients coming in just for diagnostic tests, which we would follow up with a phone call to review the test, along with the exiting medical records. We would assess whether the patient was stable or if there was a need for intervention – a change in management or a laser procedure. It was a challenge to implement this in a practice with multiple clinicians. I developed my own risk stratification algorithm – dependent on how often patients had visits scheduled in the past, changes in their medications, and the stage of their disease – and giving patients a green, amber, or red light, making sure that "red lights" would be brought in for an appointment as soon as possible.

Looking at the patient population at this time, I realized again what a disruptive disease glaucoma can be. Many

Constance Okeke

Kaweh Mansouri

patients who had missed their appointments and ran out of medication did not get in touch, and once they came in for a visit, I noticed that their disease progressed substantially. As a result, I started doing a lot more surgical interventions to make up for the time when glaucoma wasn't kept under control.

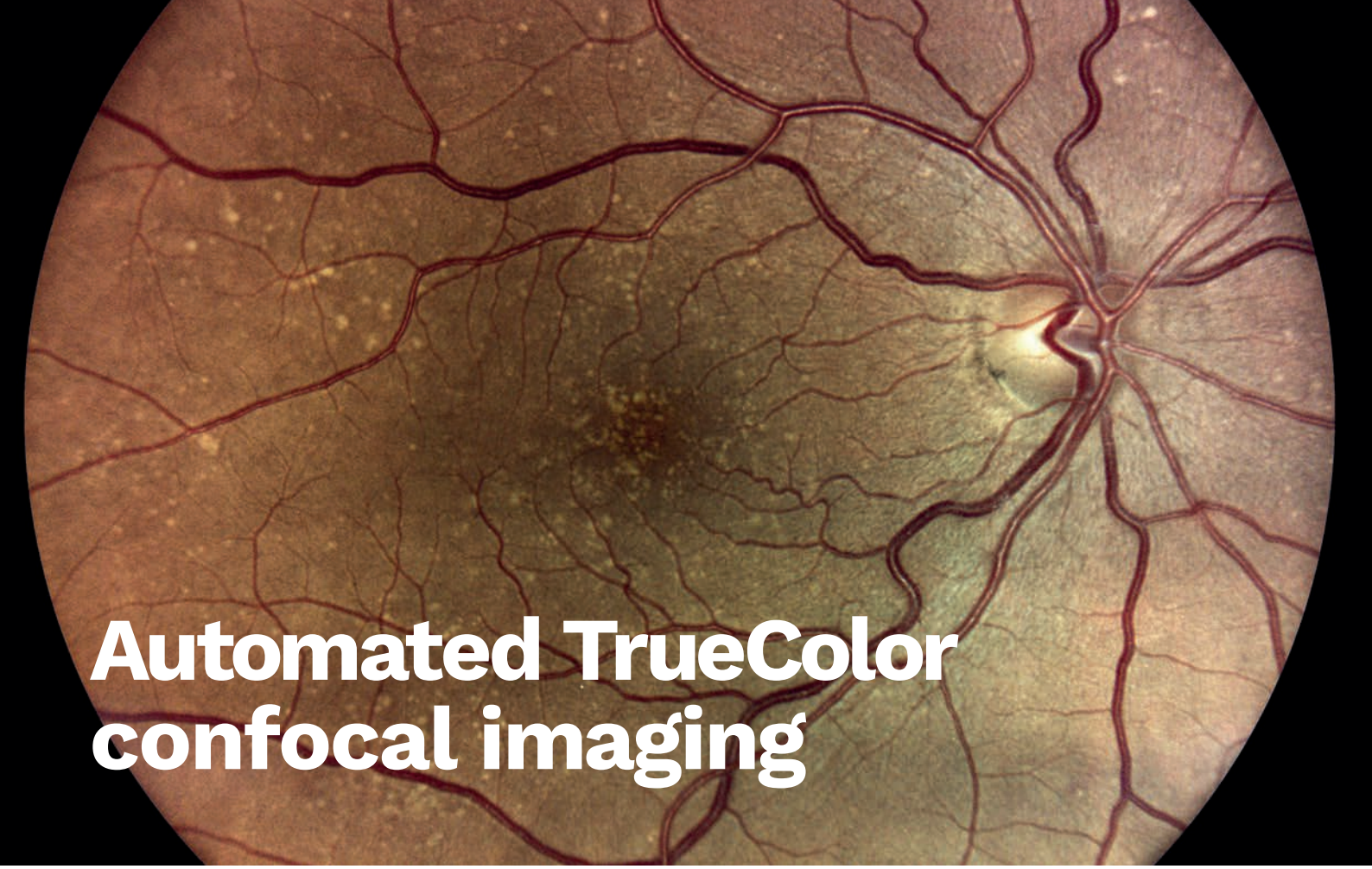
Now, I have even more appreciation for the importance of educating our patients about how vital appropriate monitoring of the condition is. One-on-one education with a patient is great, but it requires the patient to be in front of us. Another way is using online videos, such as my educational series. We should also be reaching out to patients via text or email to remind them of their appointments, as well as give them information about safe ways to visit the clinic. If they don't feel it is safe to come in, they should be offered a virtual visit. Patients have to be absolutely clear that refilling their medication should be their first priority, and it can be done with a simple phone call when they are close to running out.

Kaweh Mansouri, glaucoma specialist, Consultant Ophthalmologist at Montchoisi Clinique in Lausanne, Switzerland and Department of Ophthalmology, University of Colorado, Denver, USA

Various countries have had different strategies to cope with the COVID-19 pandemic as they have been affected differently. Of course, they also have a different density of ophthalmologists, and glaucoma specialists specifically. Switzerland has a high density of ophthalmologists, and we don't tend to rely on optometrists as heavily as ophthalmologists in some other countries, so we have not made much use of virtual clinics and asynchronous reviews. During the first lockdown, non-urgent glaucoma treatments were stopped – in our clinic, 95 percent of our glaucoma patients' care fell into this category. We asked patients not to come into the clinic for six to seven weeks, and then got to work on the backlog of cases. We extended our working hours and added Saturday clinics. After that, it was the "new normal" glaucoma management, which has meant that we see our elderly glaucoma patients more or less as often as we did before the pandemic began. It seems to me that visits take longer now, as patients have more trouble understanding what we are saying due to facemasks.

We have done more SLT procedures, as they don't require patients to be as dependent on medications, and we have done some virtual visits, which we had not done before, but – in my experience – they haven't amounted to more than 5 percent of all glaucoma appointments, and we only offer them to younger patients who have stable glaucoma.

To stratify risk properly, we need an objective and efficient AI system that will analyze centralized data – technology will help us greatly in the future. Innovative healthcare systems with digital centralized databases will get there quicker than others.



Automated TrueColor confocal imaging

iCare DRSplus

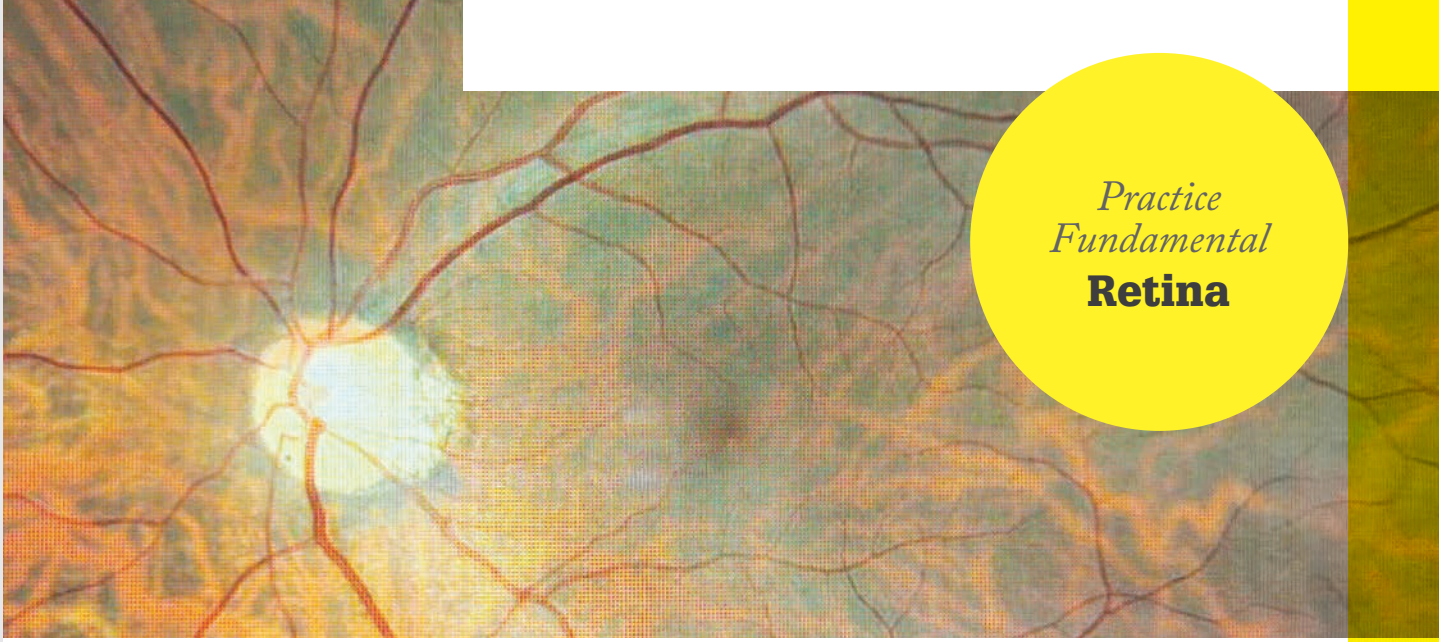
+ TrueColor confocal imaging
+ Ultra-high resolution
+ Fast image acquisition (16 s per eye)
+ No dilation (2.5 mm pupil size)

NEW! Remote Exam functionality allows you to acquire retinal images remotely, extending the distance between you and your patient.

DRSPLUS-007-AD-REV001 2021-04

More information:
info@icare-world.com
www.icare-world.com

For better perception icare



Positive Profiling. A cross institution and hospital clinical trial has identified a correlation between retinopathy of prematurity (ROP) in infants and their metabolic profile – potentially enabling earlier diagnosis and treatment. Both the current diagnosis and treatment for ROP are available after the eye damage is irreversible – the treatments themselves can also be dangerous. Metabolic profiling by mass spectrometry showed a strong correlation between the profile and retinal neovascularization seen in ROP. With this information, specific biomarkers can be identified not only for the diagnosis, but also for prevention of ROP.

Intelligent Diagnosis. Stargardt disease progression can vary massively, affecting different areas of the retina with inconsistent severity. This ultimately makes clinical trials for Stargardt therapeutics a minefield of patient selection and treatment outcomes – imagine deciding the better runner between Usain Bolt and Haile Gebrselassie? But researchers have developed an artificial intelligence based, deep learning method, that quantifies the loss of cells within the retina. Spectral-domain OCT images over five years (66 patients) determined that Stargardt patient loss in the ellipsoid zone of the retina was consistent and predictable over time – providing a benchmark for future trials.

Release the Kallikrein. Current therapies for diabetic macular edema (DME) consist of inhibiting vascular endothelial growth factor (VEGF) to curb disruption at the blood-retinal barrier – yet 20 to 40 percent of patients don't respond to treatment. A phase 1 clinical trial has shown that an alternative target, inhibition of the kallikrein-kinin system, is a viable therapeutic option for DME. Importantly the drug, THR-149, was safe and well tolerated, and improved BCVA. An exciting first in human result and promising for the future.

Injection Rejection. Aqueous protein biomarkers indicate whether wet age-related macular degeneration (AMD) patients can reduce their injection treatment burden – 30 percent of whom may be able to stop the injections altogether. This study follows the development of new anti-VEGF intraocular therapeutics designed to reduce the frequency of injections – currently these are bi-monthly, indefinite, and are potentially unsustainable given the rise of wet AMD in our aging population. The proteomic analysis established that a principal component of drusen, ApoB100, is increased in patients who are treated and may benefit from less frequent injections.

See references online.

IN OTHER NEWS

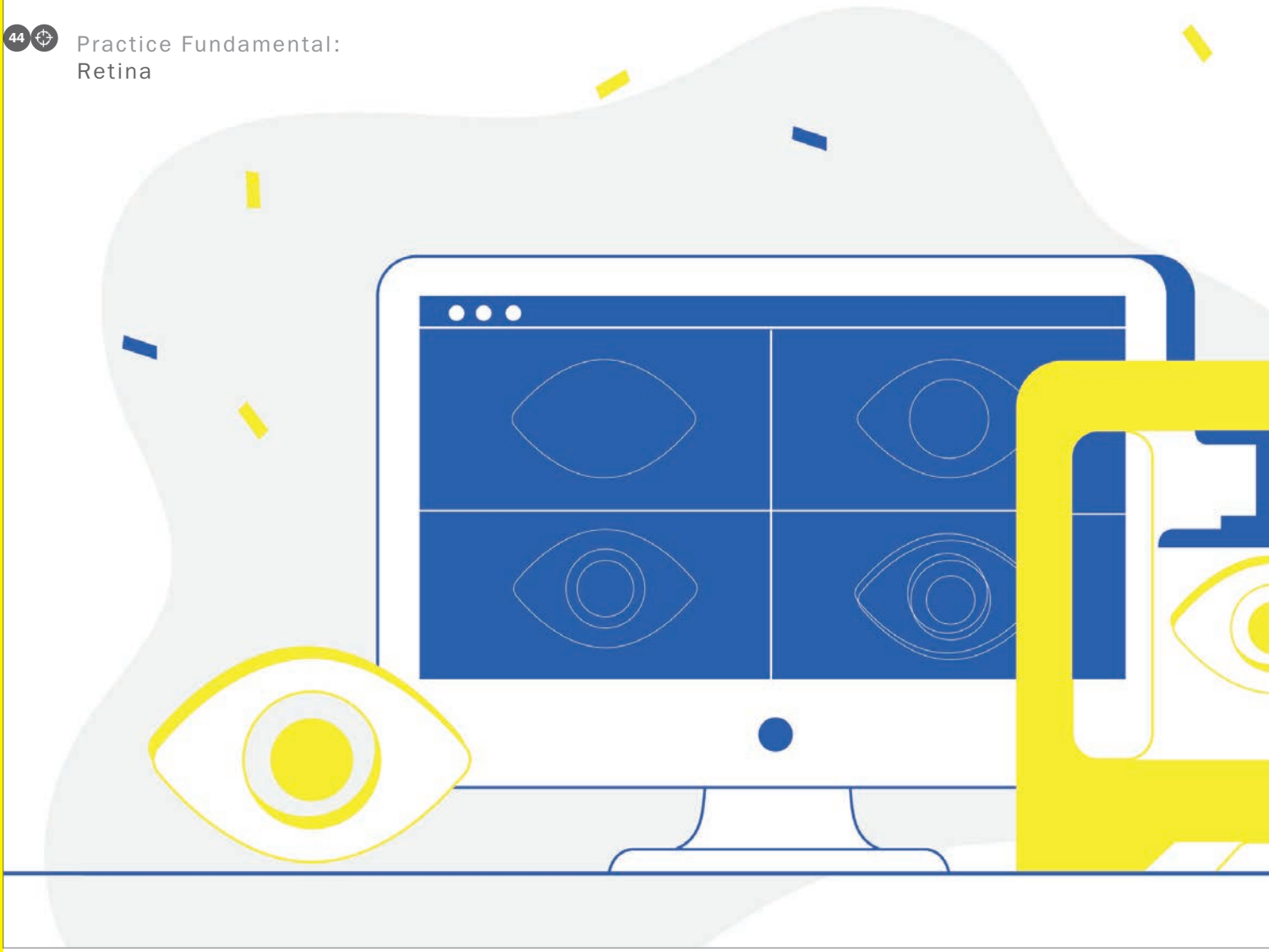
COVID-19 weak spot. *Single cell sequencing of human retina and choroid show low vulnerability to SARS-CoV-2 infection at the retina, but choroidal vasculature is the posterior segment's Achilles heel.*

Plugging up the hole. *A retrospective cohort study shows that human amniotic membrane has a 91 percent success rate at closing macular holes.*

Changing the sheets. *Transplantation of a retinal cell sheet grown from genetically modified human embryonic stem cells has better functionality and grafting – is the next stop human testing?*

Corona case. *A case study found anterior ischemic optic neuropathy to be another ocular manifestation that can occur following COVID-19 infection.*

Better safe than sorry. *Concurrent diabetic retinopathy and arteriovenous nicking can indicate coronary microcirculation dysfunction.*



The Retina Blueprint

Taking retinal tissue research from the bench to the bedside with decellularized extracellular matrix bioinks and 3D cell printing

By Jongmin Kim and Dong-Woo Cho

Why is AMD – the most common cause of blindness – still without any effective treatment? There are various reasons, but a significant issue is the lack of an effective research platform in drug development that drives translation from bench to bedside.

Boot camp blues

Before entering the clinical stages of research, drug candidates (recruits) must pass boot camp – more formally known as in vitro and animal testing. Unfortunately, traditional cell culture and animal experiments do not reflect the exact condition of human organs, which causes many recruits to drop out of the pipeline.

Our aim is to improve the process by making a human tissue testing platform. By being able to more accurately mimic function in a living and breathing human, several serious problems could be resolved.

Our approach is to use a combination of decellularized extracellular matrix (dECM) and 3D cell printing technology to better create a working human model in the lab (1). The dECM – a hydrogel rich in extracellular matrix components from the actual tissue – acts as a "bioink" when mixed with the cells – enabling superior cell maturation compared with conventional bioink. Furthermore, the latest 3D cell printing technology facilitates the fabrication of complex and functional multicellular tissue structures.

We have expertise in both of these technologies. Recently, we developed the retina dECM (RdECM) bioink, and printed a retina using 3D cell printing technology. In cultured retinas, cells not only proliferate well, but also express retinal-related markers that were not shown in previous in

vitro studies. Our aim is to use the platform for drug development to treat AMD (and eventually other diseases), ultimately helping blind patients around the world.

Impact on the visual field

So where does our developed retina lead us? Functional retinas are in demand not only for development and testing of new drugs but also for transplantation – and our 3D printed retina could be used in both cases.

But we don't want to stop developing the model. We have plans to improve upon our retina tissue model by introducing other components of the eye, including the retinal pigment epithelium (RPE) and choroid. The integration of more components makes the tissue more complex, bringing it yet another step closer to the healthy functioning retinas that most of us are lucky to have – and thus producing even better tissue for transplantation and drug testing.

Jongmin Kim, Department of Mechanical Engineering, Pohang University of Science and Technology (POSTECH), Pohang, South Korea.
Dong-Woo Cho, Department of Mechanical Engineering, Pohang University of Science and Technology (POSTECH), Pohang, South Korea.

Reference

1. *J Kim et al., "Maturation and Protection Effect of Retinal Tissue-Derived Bioink for 3D Cell Printing Technology," Pharmaceutics, 13, 934 (2021). PMID: 34201702.*

DECM – EVERYTHING IN ITS PLACE

Our key concept is "the right thing in the right place." The more natural functions that can be obtained result in tissue that is more similar to the real tissue environment. The eye in general – and the retina in particular – have complex structures made up of different cells and ECM materials. However, traditional technologies cannot reproduce the 3D structure and ECM environment of the organ. dECM bioinks and 3D cell printing technology help overcome these limitations. And as 3D printing technology constantly advances, so too does 3D cell printing, enabling us to recreate the complex structure of human organs in an increasingly accurate way.

Our work with dECM has led us to develop various types of tissue alternatives and in vitro models using 3D cell printing and dECM bioinks – finding the advantages and disadvantages to each. The dECM bioinks are rich in ECM materials related to tissue-specific microenvironments and help cells mature with their natural functions. By using more advanced bioinks, 3D cell printing technology is able to create models that better replicate the real tissue; for example, by facilitating proper intercommunication between each cell type and between the cells and the ECM – both of which are crucial to effective and realistic tissue functions.

One element that we add to the bioink is collagen. This is crucial to enable the crosslinking and solidification of dECM based bioinks, and without collagen the RdECM, in particular, will not form a suitable 3D structure. We actually chose collagen because it is widely used for 3D tissue engineering and very conventional. Collagen is well known to be biocompatible with cells and the crosslinking capabilities make it a good companion for our dECM bioinks – enabling the formation of a 3D structure whilst also reinforcing the physical properties that are necessary for 3D printing.

Although our major focus has been the development of retinal tissue, we have developed or are currently developing other alternative tissues using our dECM and 3D cell printing processes – including brain, heart, liver, skin, and even the cornea and Bruch's membrane of the eye.

The nature of our tissue engineering process – using decellularized tissues of the same tissue origin to create a dECM bioink – is something that can be applied easily to many tissue types. As our work into other 3D cell printing other tissues grows, we can potentially expand this process to aid transplantation and research studies throughout the body.

Accurate Results, Improved Outcomes

Four experts explain how using the ANTERION imaging platform for anterior segment diagnostics helps improve patients' outcomes – based on case studies and clinical trial data

The European Society of Cataract and Refractive Surgeons (ESCRS) 2021 Congress hosted a symposium for ophthalmic surgeons titled "ANTERION – Better Solutions by Accuracy. Anterior Segment Diagnostics and Biometry," featuring four distinguished experts: Oliver Findl, Kjell Gunnar Gundersen, Bjørn Gjerdrum, and Damien Gatinel, who presented results from their clinics. The meeting was chaired by Findl, who thanked the organizers, Heidelberg Engineering, and graciously welcomed the audience gathered in the room – many of whom were attending their first in-person ophthalmic event since the start of the COVID-19 pandemic – and those in front of computer screens, connecting virtually.

Oliver Findl: ANTERION – Validated Precision and Accuracy

Findl's opening presentation began with an overview of Heidelberg Engineering's ANTERION – a multimodal imaging platform optimized for a wide range of applications in the anterior segment, with functionalities, or "apps," such as the Cornea App, the Cataract App, the Metrics App, and the Imaging App. As Findl explained, the platform boasts a wavelength of 1300 nm, a scan rate of 50,000 Hz, axial resolution of 10 microns, and it produces B-scans with the length of 16.5 mm length and depth of 14 mm, meaning that the entire anterior segment is displayed within the image frame. It also provides A-scans for the axial eye length (AL), required for biometry purposes. Corneal topography of the platform takes 65 B-scans with 9 mm length. Corneal tomography is also offered; it's important to remember that topography and tomography differ in excluding or including the posterior corneal surface, respectively, and tomography is ANTERION's exceptional strength. The AL measurement automatically detects the retinal pigment epithelial peak – the most relevant parameter for measuring of AL.

Findl then presented the results of the Agreement Study, which compared two SS-OCT biometry devices: the IOL Master 700 (Carl Zeiss Meditec AG) and the ANTERION (1). Comparable metrics assessed included: AL, anterior chamber depth (ACD), lens thickness (LT), and keratometry. 389 eyes of 209 patients with age-related cataracts were measured using both devices and found very similar measurements of AL, keratometry, ACD, and LT, with very few outliers. As Findl noted, any differences were found not to be clinically relevant when performing an IOL power calculation.

Findl then went on to share results of another study, designed to determine repeatability. The study used the same two SS-OCT biometers, as well as the OLCR Lensar LS900 (Haag-Streit AG) and measured 50 eyes of 50 patients. It found that all the devices included presented high repeatability, with the two SS-OCT devices outperforming the OLCR device, which showed a larger number of outliers (2).

Agreement Study results (1)

"The mean absolute difference between the keratometry data of the two devices was 0.04 ± 0.05 mm (7.80 ± 0.26 mm for biometer A and 7.82 ± 0.26 mm for biometer B; $P < .0001$) for the steep keratometry readings and 0.04 ± 0.04 mm (7.63 ± 0.26 mm and 7.65 ± 0.25 mm; $P < .0001$) for the flat keratometry readings. For ACD and LT, the mean absolute difference was 0.07 ± 0.04 mm and 0.07 ± 0.04 mm. The mean absolute difference for AL was 0.02 ± 0.03 mm (23.55 ± 1.18 mm for biometer A and 23.54 ± 1.18 mm for biometer B; $P < .0001$)." (1)

Biometer A = IOLMaster 700
Biometer B = ANTERION

ANTERION® is Heidelberg Engineering's platform optimized for the anterior segment. The multi-disciplinary device aims to improve the day-to-day routines in cataract and refractive surgery as well as cornea and glaucoma diagnostics.

The study also assessed pre- and post-op AL, measuring 50 eyes of 50 patients suffering from cataracts, using the IOL Master 700 and the ANTERION. Based on the evaluation of pre-and post-op changes to AL measurements, it turned out that the difference for both devices (0.08 mm for the IOL Master 700 and 0.07 mm for the ANTERION) was statistically significant, but not clinically relevant. A small correlation between cataract grades and AL measurement difference was found.

The final comparison presented by Findl looked at higher order aberrations (HOAs) in patients scheduled for cataract surgery using an SD-OCT with Placido system (CSO, MS-39) with the ANTERION. It found very little to no difference in HOAs. As Findl concluded, the ANTERION showed very high reproducibility of results, with measurements similar to those of the IOL Master 700.

Kjell Gunnar Gundersen: ANTERION Biometry in Normal and in Difficult Eyes – Clinical Experience and Case Presentations

Gundersen began by reminding the audience that in modern refractive surgery, obtaining accurate biometry measurements is mandatory in all cases – normal and irregular. He went on to show the results of a pilot study that examined refractive results 5-6 weeks post-op in 41 eyes of 21 patients. Gundersen and colleagues found that the ANTERION returned the lowest predictive error – both arithmetic and absolute – and a clear trend was visible even within the small cohort.

Gundersen commented on the epidemiology of astigmatism and noted that with 45 percent of patients presenting with corneal astigmatism over 1 D, every second IOL implanted should or could be a toric IOL. His clinic conducted a study looking at low toric (T2) cylinder lenses implanted, and found that post-op refractive cylinder and the uncorrected contrast sensitivity were significantly better when toric lenses were used. Gundersen then went on to present special cases in which ANTERION had proven particularly useful.

OCT images of the same eye before and after cataract surgery, including selected measurement overlays for anterior chamber angles, spur-to-spur distance and lens vault.

Case 1

- The right eye of a 62-year-old male patient with post-LASIK keratitis
- Laser regularization and scarring
- Asymmetric astigmatism axis and power
- Pre-laser vision correction (LVC) refraction: -+5.00-1.75x45, VA 1.0
- Pre-cataract refraction: -+7.00-1.50x15, VA 0.8
- Autorefractive: +10-2.0x55
- Preoperative clinical challenges: anisometropia, reflections, and headache

A thorough biometry work-up was done, arriving at a "conservative" IOL choice. When the predictive spherical and cylindrical errors were checked, the sphere was close to perfect, but the cylinder was still a challenge. In week 5 post-op, the patient's VA was 0.8, with fewer side effects and anisometropia.

Case 2

- A male patient of 63 years with stable keratoconus
- The central part of his left eye more affected by keratoconus than the center of this right eye:
- OD: 41.85, astigmatism 5.98 @137, AL 24.82
- OS: 46.32, astigmatism 9.61 @39, AL 24.60
- Stable refraction pre-cataract
- Pre-cataract refraction
- OD: -4.00-2.50x455 VA 0.7
- OS: -1.25-0.50x45 VA 0.6

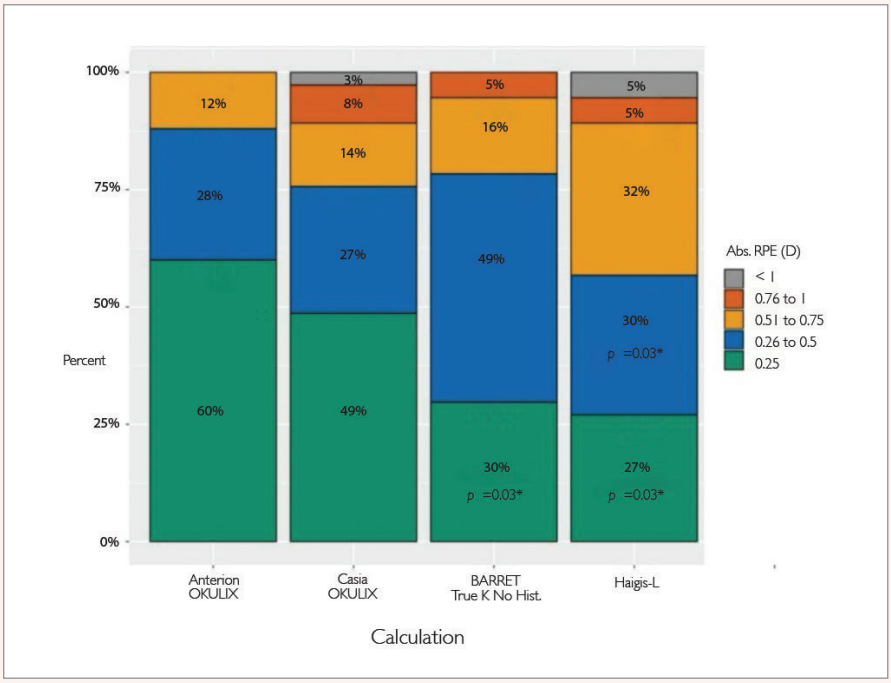
Multiple biometry measurements were done, and IOLs were implanted for a large astigmatism correction (OD: +15.00 D, cylinder +7.50 D, OS: +14.00 D, cylinder +10.00 D). Following the surgery, the right eye turned out to be slightly undercorrected, and the left eye was slightly overcorrected. The spherical component was – again – close to perfect, but the toric component posed more difficulty. Five weeks post-op, the patient "had never seen better," he was uncorrected in bright light, reading well with a simple "plus" lens.

Gundersen summarized his findings from irregular cases, pointing out that patients' expectations have to be realistic, corneal surface needs to be optimized, thorough biometry should be performed, and access to a wide range of toric IOLs is very important. All this should be accompanied by the surgeon's wealth of experience dealing with similar cases.

Gundersen has found ANTERION to be the only instrument that can acquire all measurements for ray tracing in one setting, which results in fewer measurement errors. In his experience, it's ready for any modern, fifth generation biometric formula, useful in an increasing number of cases, as well as

Refractive predictability study results (3)

"The best ray tracing combination resulted in an arithmetic prediction error statistically significantly lower than that achieved with the best formula calculation (Barret True-K, no-history) (-0.13 D and -0.32 D, respectively, adjusted p = 0.01), while the Barret TK NH had the lowest SD. The absolute prediction error was 0.26 D and 0.35 D for ANTERION-OKULIX and Barret TK NH, respectively, but this was not statistically significantly different. The ANTERION-OKULIX calculation also had the highest percentage of eyes within ±0.25, compared to both formulas and within ±0.50 and ±0.75 compared to the Haigis-L (p = 0.03)." (3)



Absolute refractive prediction error compared between different IOL calculation methods in patients with a history of previous myopic laser vision correction. The combination ANTERION + OKULIX showed the highest percentage of eyes within ± 0.25 D, and all eyes within ± 0.75 D (3).

clinically and scientifically reliable. He can see even more potential for integrating ANTERION with imaging systems; image averaging of a minimum of three images could reduce the variability; access to epithelial maps, and objective dry eye assessment.

Bjørn Gjerdrum: ANTERION Biometry and Ray Tracing IOL Calculation for post-LASIK Patients

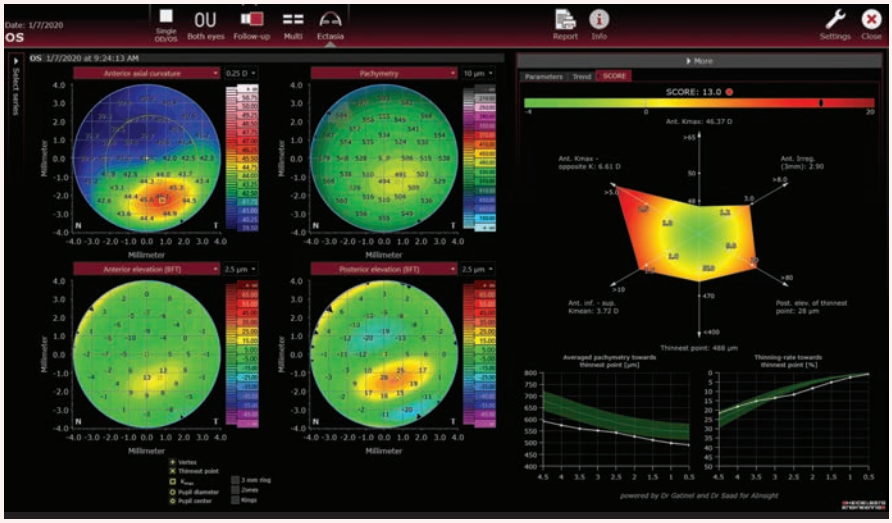
Gjerdrum opened with a comment on the challenge of obtaining accurate post-LVC calculation, which often makes traditional formulas unusable, due to keratometric index errors, ELP errors, and radius/instrument errors. Therefore, special post-LVC formulas have been developed, taking into account historic, pre-LVC data, or no-history formulas based on regressions to predict true corneal power, using assumed posterior or total corneal power. They are all theoretical formulas that use paraxial assumptions, which are not accurate for the human eye.

Ray tracing IOL calculations, on the other hand, are exact calculations based on Snell's law, using single rays going through each refractive surface at varying radial distances. These calculations use no paraxial assumptions, but the accuracy is dependent on the available input data: the amount, and the accuracy of it.

Gjerdrum presented results of a study comparing the refractive precision of ray tracing IOL calculations (done using the ANTERION and Tomey Casia SS-1000) with post-LVC formulas (done using Haag-Streit Lenstar 900) in 37 eyes of 20 patients who had undergone LVC for myopia (3). 65 percent of patients had toric IOLs implanted. Patients were examined two to three months after surgery, and the main outcome metric – refractive prediction error – was measured as the post-op refraction minus the predicted refraction. The study found that ray tracing based on the ANTERION platform OCT data gave results similar or better than those based on post-LVC formulas. ANTERION in combination with OKULIX (a ray tracing calculation software integrated on the ANTERION platform) had the best arithmetic mean RPE, lowest "range," and 60 percent of the results were within ±0.25 D. Gjerdrum noted that this was also the only calculation that had all eyes within three quarters of a diopter. He concluded pointing out that the main advantage of ray tracing is that it takes individual measurements and is independent of ocular history, so it should be suitable for any eyes.

Damien Gatinel: ANTERION – Screening subclinical corneal ectasia with SCORE Analyzer

Gatinel, presenting the work he did with Alain Saad from the Anterior Segment and Refractive Surgery Department, Rothschild Foundation, Paris, France, began by reminding the audience that post-LASIK keratectasia is one of the most devastating complications of LASIK, and a bugbear of all refractive surgeons, despite its low incidence. Even though many approaches are available, surgeons are still trying to improve their detection



ANTERION Ectasia Display showing customizable corneal maps and "SCORE". The SCORE tab presents the SCORE value, a radar map and pachymetry diagrams (powered by Dr Gatinel and Dr Saad). The SCORE value consists of different parameters that describe the magnitude of corneal steepening, thinning and asymmetry to assist clinicians in detecting and monitoring ectatic changes. *The image shows investigational software that is currently under development.

methods. The "comfort level" or "threshold" for LASIK varies from one surgeon to another, and can be subjective. "Therefore," he said, "a simple, efficient, yet objective risk assessment system is required."

Gatinel illustrated subjectivity in the field by presenting a study that aimed to evaluate the variability of experts' subjective corneal topography map classification (4). Eleven corneal topography experts were asked to rank corneas according to the Ectasia Risk Scoring System depending on preoperative axial curvature maps using Scheimpflug imaging obtained with the Pentacam HR (Oculus) and clinical parameters. The study found significant variability among experts in subjective classifications within the same scale, and significant variability for each expert when working with different scales.

Using an example of two eyes of a keratoconus patient, and an observation by Stephen D. Klyce, Gatinel notes that where one eye is affected, the other eye – which has no clinical findings except for some topographical changes, should be considered forme fruste. Gatinel sees those eyes as good subjects for a training system to detect abnormalities, and commented that they should be monitored until they become suspect.

Around 10 years ago, Gatinel and Saad developed a scoring system for detecting corneas susceptible to ectasia, the SCORE Analyzer (5, 6, 7, 8, 9). Based on this system, a similar SCORE Development system was developed for the ANTERION. Gatinel and Saad analyzed all variables available from the ANTERION and added some additional criteria (such as inferior/superior keratometry, steepest/opposite keratometry, averaged pachymetry, and pachymetry thinning rate). Those metrics were then combined in a linear discriminant function, and multiplied by a coefficient, to achieve the required score that would separate the forme fruste from the normal corneas. As a result, Gatinel and Saad have been able to detect 75 percent of suspicious corneas – although Gatinel notes that the remaining 25 percent of eyes might not end up being affected by keratoconus, especially when there is no eye rubbing involved.

Conclusion

Heidelberg Engineering's ANTERION multimodal imaging platform optimized for the anterior segment, which uses high-resolution SS-OCT, is regularly used by experts in the anterior segment field, in clinics around the world. Independent evaluations conducted by surgeons in their practices confirm that comprehensive measurements provided by the platform are invaluable in transforming cataract and refractive surgery, and cornea diagnostics. As Gundersen comments, modern cataract and refractive surgery cannot exist without accurate biometry measurements, and ANTERION is the platform of choice for accuracy, which gives better solutions to surgeons, and – ultimately – benefits their patients.

References

1. *AD Fişuş et al., "Comparison of 2 swept-source optical coherence tomography-based biometry devices," J Cataract Refract Surg, 47, 87 (2021). PMID: 32769752.*
2. *AD Fişuş et al., "Repeatability of 2 swept-source OCT biometers and 1 optical low-coherence reflectometry biometer," J Cataract Refract Surg, 47, 1302 (2021). PMID: 33770018.*
3. *B Gjerdrum et al., "Refractive precision of ray tracing IOL calculations based on OCT data versus traditional IOL calculation formulas based in reflectometry in patients with a history of laser vision correction for myopia," Clin Ophthalmol, 15, 845 (2021). PMID: 33664562.*
4. *IC Ramos et al., "Variability of subjective classifications of corneal topography maps from LASIK candidates," J Refract Surg, 29, 770 (2013). PMID: 23980708.*
5. *A Saad, D Gatinel, "Topographic and tomographic properties of forme fruste keratoconus corneas," Invest Ophtalmol Vis Sci, 51, 5546 (2010). PMID: 20554609.*
6. *A Saad et al., "Retrospective testing of a new method for detecting ectasia-susceptible corneas," J Cataract Refract Surg, 37, 1907 (2011). PMID: 21930050.*
7. *D Gatinel, A Saad, "The challenges of the detection of subclinical keratoconus at its earliest stage," Int J Keratoco Ectatic Corneal Dis 1, 36 (2012).*
8. *A Saad, D Gatinel, "Association of corneal indices for the detection of ectasia-susceptible corneas," J Refract Surg, 28, 166 (2012). PMID: 22373030.*
9. *C Chan et al., "Validation of an objective scoring system for forme fruste keratoconus detection and post-LASIK ectasia risk assessment in Asian eyes," Cornea, 34, 996 (2015). PMID: 26165793.*

One in a Million

Sitting Down With… Gladys Atto, ophthalmologist at Moroto Regional Referral Hospital, Moroto, Uganda

You're one of only 45 ophthalmologists in Uganda – a country of over 45 million people – and the only one in your region, Karamoja. What are the reasons for this shortage and is the situation improving?

Students are not motivated enough to go into ophthalmology and other sub-specialties such as otolaryngology or dermatology, as they are seen as focusing on very small parts of medicine. Money is a big driver and candidates imagine that these paths will not be profitable.

What I see as a major concern is the unequal distribution of ophthalmologists across Uganda, where we have around 14 reginal referral hospitals. If each one of them had an ophthalmologist, we would have an equitable distribution of them, but many of them are concentrated in urban areas, which attract most of ophthalmic specialists. Getting ophthalmologists into rural areas like the one I work in is a huge issue. People feel that such areas don't have enough amenities and don't provide opportunities to progress in their careers.

Why did you decide to practice in Karamoja?

The area where I grew up, around 450 km from Karamoja, only has one ophthalmologist, but for me, having even one specialist in a region makes such a big difference. When people know that there is a specialist in their regional hospital, even if it's 100 km away, it gives them hope. But in Karamoja, there were no ophthalmologists, and patients who needed eye care felt hopeless and helpless. I knew that the burden of disease was high in the region and there were no ophthalmic surgeries taking place here, except for those performed occasionally by visiting doctors, with no proper follow ups. Trachoma is still endemic here and that tells you how high the need for eye care services is.

I could really see the potential of this place and the need for an ophthalmologist willing to practice here. When I was applying for a Sightsavers scholarship, interviewers asked me where I wanted to work. I replied that I wanted to work in Karamoja and they thought I was only saying that to be guaranteed the sponsorship, but I had already got in touch with the local hospital director and had an agreement that that's where I would work after finishing my education. Now, my mission is to make sure other ophthalmic specialists come to work here, so everywhere I go, I talk about how proud I am of my job, I wear the best local clothes, and really try to impress people and let them know how wonderful the region is. Karamoja is one of those remote places that you have to see to find out more about it and want to stay.

What made you choose ophthalmology?

Becoming a doctor was my dream already in my childhood. My primary school teachers used to say that I talked that much I would become a lawyer – like the great Ugandan role model, Julia Sebutinde who serves on the International Court of Justice. I was adamant I would become a doctor instead!

When I was doing my internship in Uganda, it was a very rigorous process. What I found out was that I didn't enjoy general medicine as much as I had previously. Seeing patients with chronic diseases that would not get better was really bringing me down. I found that eye care gave me an opportunity to focus on a small part of the body, which really suited me. I'm generally very focused on detail and ophthalmology – especially ophthalmic surgery – is so great for that!

Tell me about your mentors…

My first eye care mentor was John Onyango, who is now the Head of Department of Ophthalmology at Mbarara University of Science and Technology in Western Uganda. When he taught me at medical school, he would walk into the classroom without any notes or books – everything was in his head. The way he would talk about ophthalmology and the shortage of eye care specialists in the country was truly inspiring. When I was about to start my internship, he called me and reminded me that I did so well in ophthalmology that I should think of following this path – and offered to continue to teach me. I am very grateful that he did that. During my ophthalmology residency, my course coordinator was Simon Arunga. He was instrumental in teaching me surgical skills. Then, when I went to the London School of Hygiene and Tropical Medicine in the UK, my supervisor was Allen Foster. He had been an impressive figure with so many publications under his name, and yet suddenly he was calling me personally to talk about my research! He still checks on me regularly to make sure I'm applying the skills he taught me. There have been many other important people I have crossed paths with in my career so far – I feel very privileged.

"I knew that the burden of disease was high in the region and there were no ophthalmic surgeries taking place here, except for those performed occasionally by visiting doctors."

Makes a **Complex** Process **Simple**, Automatic and Reliable

- Axial Length
- Scheimpflug Tomography
- Refraction
- Retroillumination
- Total Wavefront

Pentacam® AXL Wave

You position the patient. The new **full sequence measuring assistant** handles the rest.

Thanks to the newly developed measurement workflow and the automatic quality check, you are always on the safe side. Optimized workflows, satisfied patients, and the best possible clinical results: always achieved quickly, reliably, and without long training.

No risk, just fun –
the new Pentacam® AXL Wave

www.pentacam.com/axl-wave

20 YEARS OF Pentacam®

OCULUS®