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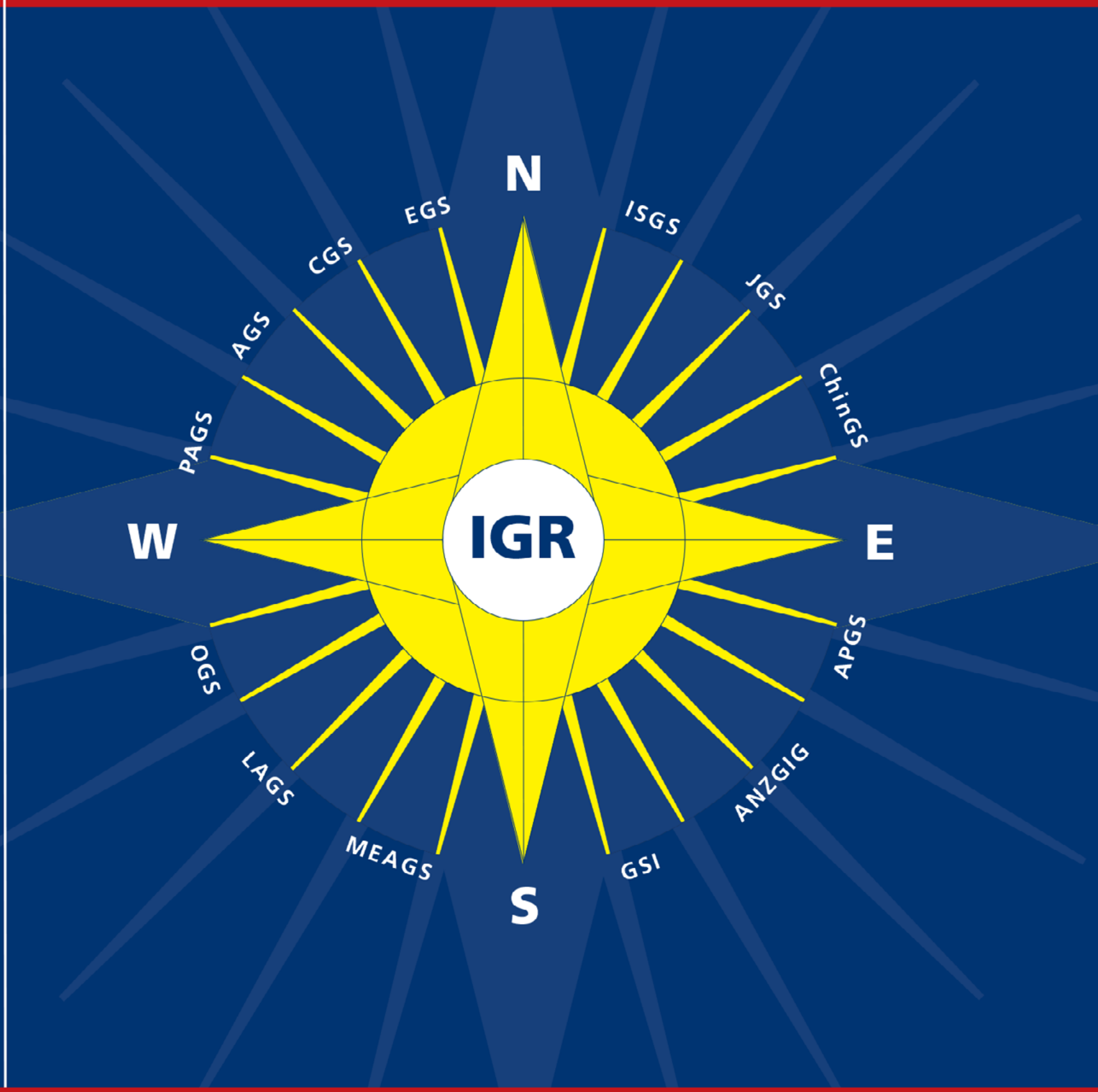

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From the WGA Executive Office

Dear readers,

Before glancing into the near future, I would like to express my appreciation to all those who have made the past 7th World Glaucoma Congress not only a wonderful experience but also a tremendous (educational) success.

This was greatly confirmed by the overwhelming number of delegates that came to Helsinki: a milestone in WGC attendance so far. The offered Wet Labs were the largest ever organized and were well received by both the delegates and industry.

Also, Finland and the city of Helsinki has clearly proven to be a wonderful congress destination! Delegates enjoyed visiting this compact, modern city filled with large parks, lakes and numerous islands; all in all a great unique character which derives from East and West.

The upcoming WGC-2019 will be hosted by Melbourne, Australia and is planned from March 27-30, 2019!

I also would like to ask your attention for the new **WGA#One** Management System. This platform replaces our current database management system and will improve and streamline the distribution of our WGA content and news to you.

Within the new database system you are able to manage your own profile and make any necessary updates 24/7. In order to make sure the database is correct, we are asking you to check and activate your profile.

If you did not yet receive a **WGA#One activation notice**, please contact the Executive Office for more details.

This is my last contribution to IGR in my role as Executive Vice President (EVP). As of January 1, 2018 Dr. Shan Lin has become EVP.

Thank you to our leadership, our members, our partners, our executive team and IGR Chief Editor, Prof Robert N. Weinreb, for your efforts on behalf of WGA. I wish Shan good luck and am confident that the WGA is in capable hands for the years to come!

Enjoy this issue of IGR!

Robert D. Fechtner, Executive Vice President

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WGA Consensus Series

Robert N. Weinreb

Introduction

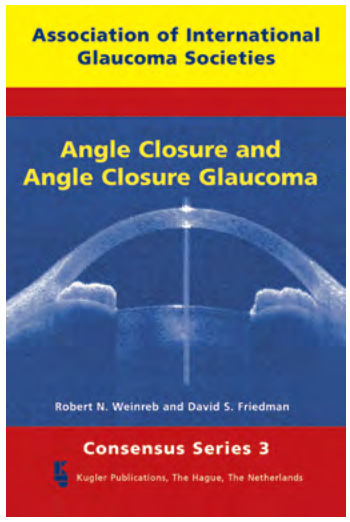
The Glaucoma Consensus Initiative of the World Glaucoma Association is based on the idea that the collective wisdom of a group is better than the opinion of a single expert. Assembling a sufficiently large and sufficiently diverse group of glaucoma specialists and scientists provides recommendations and insights that are likely to be superior to those of a single clinician. These recommendations and insights form the foundation for the Glaucoma Consensus Reports.

To prepare each of the 10 consensus reports, there were several months of active discussion via the Internet by more than 100 expert members of the various consensus committees. The preliminary documents were circulated to each of the member societies of the World Glaucoma Association, and additional comments were solicited. Participants were asked to review the international peer-reviewed literature, with special attention to the quality of available evidence. A Consensus Meeting attended by the experts and society representatives was then conducted. Consensus points were formulated and the report revised by the Consensus Panel following these discussions.

The clinical acumen and knowledge of numerous and diverse practitioners and scientists can be harnessed more efficiently and effectively than ever with the continued enhancements of inter-connected global communication. We can learn from each other by sharing, adapting and updating new information, and then agreeing on its significance. Linking networks of glaucoma specialists has tangible and ongoing important implications for, glaucoma clinical care, research and education on a global basis.

Consensus 3

Angle Closure and Angle Closure Glaucoma

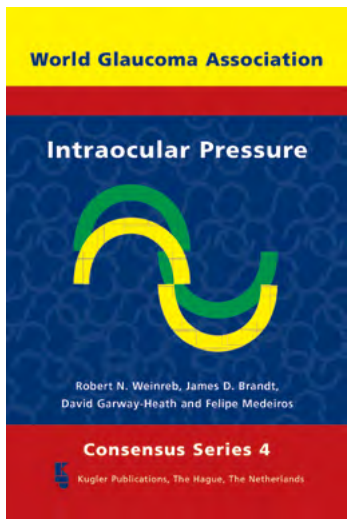


edited by: R.N. Weinreb and E.L. Greve
2006

Primary Angle-Closure Glaucoma is a leading cause of blindness throughout Asia, and may be more common in European-derived populations than previously recognized. Even though Open-Angle Glaucoma is more common than primary Angle Closure Glaucoma, it has been estimated that nearly half of all glaucoma blindness is due to Angle Closure Glaucoma because it tends to be more severe. Further, an aging population should increase the number of individuals affected by Angle Closure Glaucoma. Clearly, strategies need to be articulated to face this challenge.

Consensus 4

Intraocular Pressure



edited by: R.N. Weinreb and J.G. Crowston
2007

Intraocular Pressure is a topic that touches the essence of our subspecialty. Its measurement is a vital aspect of glaucoma diagnosis and treatment. For now, it is the only modifiable risk factor. Measurement of IOP is a relatively recent – one century – addition to our diagnostic armamentarium. Even though the measurement of IOP is relatively simple, it is by no means uncomplicated. The greatest limitation is probably the paucity of measurements that are obtained in practice.
Although continuous IOP measurement is on the horizon, it still is not ready for clinical practice.

Download Books

Through the courtesy of the **WGA** and **Kugler Publications**, you may now download the PDF files of Consensus 3 and 4 **free of charge** through your WGA#One account. Consensus 1 and 2 have previously been made available through IGR and are now also accessible through your WGA#One account.

Robert N. Weinreb
Consensus Initiative Chair
World Glaucoma Association

Consensus 3

Consensus 3 meeting participants

Consensus 4

Consensus 4 meeting participants

World Glaucoma Association

Diagnosis of Primary Open Angle Glaucoma

Robert N. Weinreb, David Garway-Heath, Christopher Leung,
Felipe Medeiros, Jeffrey Liebmann

Consensus Series - 10

Kugler Publications, Amsterdam, The Netherlands

Your Special Attention For

The connective tissue phenotype of glaucomatous cupping in the monkey eye - Clinical and research implications
Yang H, Reynaud J, Lockwood H, Williams G, Hardin C, Reyes L, Stowell C, Gardiner SK, Burgoyne CF
Progress in Retinal and Eye Research 2017; 59: 1-52
abstract no. 72651

Genetics of Glaucoma
Wiggs JL, Pasquale LR
Human Molecular Genetics 2017
abstract no. 73070

Primary Congenital and Developmental Glaucomas
Lewis C, Hedberg-Buenz A, DeLuca AP, Stone EM, Alward WLM, Fingert JH
Human Molecular Genetics 2017
abstract no. 73161

Discovery and Preclinical Development of Netarsudil, a Novel Ocular Hypotensive Agent for the Treatment of Glaucoma
Lin CW, Sherman B, Moore LA, Laethem CL, Lu DW, Pattabiraman PP, Rao PV, deLong MA, Kopczynski CC
Journal of Ocular Pharmacology and Therapeutics 2017
abstract no. 73280

Modulation of the immune system for the treatment of glaucoma
Bell K, Und Hohenstein-Blaul NVT, Teister J, Grus FH
Current Neuropharmacology 2017
abstract no. 73522

Aqueous shunts for glaucoma
Tseng VL, Coleman AL, Chang MY, Caprioli J
Cochrane Database of Systematic Reviews 2017; 7: CD004918
abstract no. 73565

World Glaucoma Association
The Global Glaucoma Network

Basic Course in Glaucoma

This course consists of 4 modules that address basic aspects of glaucoma diagnosis:

GONIOSCOPY
Anton Hommer, Tanuj Dada, Pooja Shah, Talvir Sidhu

Gonioscopy is an important diagnostic test in ophthalmology to correctly diagnose and properly treat each individual patient.
In this module, you will learn about the principles of Gonioscopy, its importance, the type of lenses and classification systems.

INTRAOCULAR PRESSURE
Emily P. Jones, Robert Kinast, David Simons, Steven L. Mansberger

Intraocular pressure (IOP) is the pressure of the fluid inside the eye.

Access Course

STANDARD AUTOMATED PERIMETRY
Anders Heijl, Balwantray Chauhan

Functional status in glaucoma is best evaluated with perimetry; Visual acuity is insufficient, since it usually remains normal until very late in the process of glaucomatous disease.

CLINICAL EXAMINATION OF THE OPTIC NERVE
Michael Coote, Jonathan Crowston

Examining the ONH is a key skill of ophthalmologists, optometrists and other eye care professionals.

All modules were written by world renowned experts in the field, and reviewed by members of the WGA Education Committee. They are intended for ophthalmologists and other eye-care providers.

All texts, pictures and videos were adapted to an online platform by a team of e-learning experts. This will allow you to have a pleasant learning experience. At the end of each module there is a multiple choice test that will auto correct once the exam is completed. You will also be able to download a Certificate of Completion.

WGC-2017 Highlights

Selections by Winnie Nolan

Effect of co-morbidity + glaucoma

▶ PLAY VIDEO

Simon Skalicky presented on the "**Effect of co-morbidity + glaucoma".** He discussed the impact of ocular surface disease and demonstrated that there is a reduction of Quality of Life with increasing number of eye drops in patients with glaucoma. Glaucoma patients with co-existing cataract report worsening activity limitation at all glaucoma severity levels and it is important for clinicians to consider cataract surgery and its benefits in glaucoma patients. Finally he reported the results of a randomized controlled trial of patient centered education and counseling in newly diagnosed glaucoma patients. This intervention resulted in lower self-reported anxiety levels compared with the control group who received standard management.

Measuring QOL in glaucoma studies

▶ PLAY VIDEO

*Ecosse Lamaroux's presentation "Measuring QOL in glaucoma studies" was given by **Mani Baskaran**.*

A case-control study using psychometric analysis attempted to measure the impact of glaucoma-related reduction in visual acuity and visual field on psychosocial functioning. The key findings of this study (which used the Glaucoma QOL 36 questionnaire) were that glaucoma patients report a 63% increase in anxiety, 71% lower self-image, 38% less emotional well-being and 32% reduced confidence in health care provision when compared with unaffected controls. Clinicians should be aware that visual acuity and visual field losses at different stages of glaucoma may negatively impact on patient's self-confidence and emotional well-being.

Patient reported outcomes

▶ PLAY VIDEO

Christof Hirneiss talked on **"Patient reported outcomes".** He discussed the need to develop better Patient reported outcomes (PROMS) for glaucoma, which would aid clinical decision-making. A study to assess clinical measurements as predictors of PROMS compared patient reported functioning (using the Glaucoma activity limitation 9 questionnaire) with visual field loss and glaucoma imaging. The mean defect on VF testing was the best predictor with a 2.4dB loss in visual field correlating with a significant reduction in the patient reported functioning scale.

Selections by Ingeborg Stalmans

Phaco with goniosynechiolysis: role and evidence

▶ PLAY VIDEO

Rahat Husain: Cataract surgery as a standalone procedure or combined with goniosynechiolysis when treating angle closure glaucoma has an intra-ocular pressure lowering effect. No statistically significant results in success nor in complications were noted. Only when performing subgroup analysis, a phaco-emulsification combined with goniosynechiolysis might have better results in patients with primary angle closure versus primary angle closure glaucoma.

Eagle and impact on angle closure management

▶ PLAY VIDEO

Augusto Azuara-Blanco: The EAGLE study compares clear lens extraction versus laser peripheral iridotomy as a treatment for primary angle closure and primary angle closure glaucoma. The results of the study indicate that a clear lens extraction should be considered as a first-line treatment for primary angle closure glaucoma and primary angle closure with increased intraocular pressure.

Role of MIGS in modern glaucoma surgery

▶ PLAY VIDEO

Ike Ahmed: Minimally Invasive Glaucoma Surgery (MIGS) is changing the view on surgical treatments in glaucoma by opening a wide range of options for mild to moderatwwe disease. Safety, control, predictability and rapid recovery are the basis for MIGS. The COMPASS trial showed combining the CyPass microstent provided additional benefit in combination with cataract surgery versus cataract surgery as a standalone that sustained through 2 years.

Phaco: an effective glaucoma treatment?

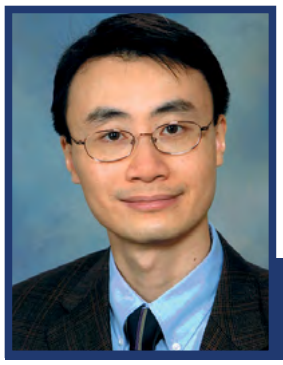
▶ PLAY VIDEO

Tina Wong: Cataract surgery can be an effective treatment for glaucoma with good patient selection. Intra-ocular pressure lowering effects are very significant in acute angle closure glaucoma, significant in primary angle closure glaucoma and modest in open angle glaucoma. The reduction in the amount of medications is minimal in open angle glaucoma, but very significant in primary angle closure glaucoma. Long term worsening of the pressure is significant in open angle glaucoma, modest in primary angle closure glaucoma and acute angle closure glaucoma.

Anti-VEGF in trabeculectomy

▶ PLAY VIDEO

Luis Pinto: The anti-VEGF bevacizumab has an impact on wound healing after glaucoma surgery. When administered intracameraly during trabeculectomy, the filtration bleb is less hyper vascularized and less additional interventions are required to meet the target IOP comparing with trabeculectomy without the use of bevacizumab.



Selections by Arthur Sit

In vivo imaging of the distal outflow system

▶ PLAY VIDEO

Alex Huang (United States): Dr. Alex Huang presented research on aqueous angiography (AA) with real-time aqueous humor outflow (AHO) imaging of live human patients during routine phacoemulsification. Fluorescent tracers, commonly used as capsular stains, were delivered into the anterior chamber and AHO was imaged using a FLEX module Heidelberg Spectralis. AA showed segmental AHO patterns with a nasal predilection. Pulsatile flow was seen with a new dynamic behavior where angiographic signal could spontaneously increase or decrease in distinct parts of the eye. Future application of this technique to glaucoma patients may enable a more targeted application of angle-based minimally invasive glaucoma surgery (MIGS).

Tree shrew - a rodent model for lamina cribosa

Brian Samuels (United States)

Dr. Brian Samuels presented research aimed at establishing a tree shrew (Tupaia belangeri) model of glaucoma to overcome limitations with the commonly used non-human primate (NHP) and rodent models of glaucoma. NHP have a collagenous load bearing lamina cribrosa (LC) that is ideal for optic nerve head biomechanics and other glaucoma studies, but they are expensive, and some centers have begun to restrict NHP research. Rodent models offer a platform to examine the genetic basis and molecular pathways involved in glaucoma pathogenesis. However, rodents have an astrocytic/glial lamina that is not load bearing, and some of the findings have not translated well to humans. In contrast, tree shrews are a para-primate a load bearing collagenous LC, they are less expensive than primates, and their genome has been fully sequenced, enabling the use of newer, advanced molecular techniques. Dr. Samuels reported that intracameral injection with magnetic microspheres causes sustained IOP elevation, associated with progressive LC bowing, reduction in retinal nerve fiber layer, and reduction in optic nerve axon count consistent with human glaucomatous changes. This novel tree shrew model of glaucoma appears to show significant promise as a tool for future glaucoma research studies.

Not featured as captured session.

24-hour IOP

▶ PLAY VIDEO

Kaweh Mansouri (Switzerland): Dr. Kaweh Mansouri presented on the complexities of 24-hour IOP, which is a dynamic parameter with an individual circadian rhythm, and technological advances in 24-hour IOP monitoring in humans. First was an implantable sensor (Implandata, Hannover, Germany; CE-marked) that is implanted into the ciliary sulcus and measures IOP directly. Several years of data are available for 22 patients and show that it is generally safe and provides reliable measurements. Second was the Triggerfish contact lens sensor (Sensimed, Lausanne, Switzerland; FDA approved), which measures changes of IOP and ocular biomechanics. Studies suggest that 24-hour IOP patterns may reflect the propensity of eyes for future glaucoma progression. Both approaches are promising and potentially complimentary. Longitudinal studies are needed to address their impact on clinical decision-making.

Trabecular meshwork biomechanics

▶ PLAY VIDEO

Darryl Overby (United Kingdom): Dr. Darryl Overby described how mechanical forces within the trabecular meshwork may act to modulate aqueous humour outflow resistance and thereby regulate IOP. As IOP increases, the trabecular meshwork distends, imposing biomechanical stretch on trabecular meshwork cells and shear stress on Schlemm's canal endothelium. These mechanical cues trigger the release of VEGF, nitric oxide and other factors that reduce outflow resistance and oppose the elevation in IOP. This mechanosensitive feedback loop allows the trabecular meshwork to sense and respond to IOP, modulating its own resistance to maintain IOP homeostasis. Increased trabecular meshwork stiffness, as occurs in glaucoma, disrupts this mechanosensory mechanism, leading to loss of IOP homeostasis and ocular hypertension.

For more recorded sessions on past World Glaucoma Congresses, please visit: www.wga.one/wga/educational-portal

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Editor's Selection

With the multitude and variety of publications it seems almost impossible for the ophthalmologist to intelligently read all the relevant subspecialty literature. Even the dedicated glaucomatologist may have difficulty to absorb 1200+ yearly publications concerning his/her favorite subject. An approach to this confusing situation may be a critical selection and review of the world literature.

Robert N. Weinreb, Chief Editor

Glaucoma Screening

Screening High-Risk Populations

Comment by Rupert Bourne, Cambridge, UK

73164 Optimizing Glaucoma Screening in High-Risk Population: Design and 1-Year Findings of the Screening to Prevent (SToP) Glaucoma Study; Zhao D, Guallar E, Gajwani P, Swenor B, Crews J, Saaddine J, Mudie L, Varadaraj V, Friedman DS, American Journal of Ophthalmology 2017; 180: 18-28

The Screening to Prevent (SToP) Glaucoma study has designed and tested a community-based glaucoma screening strategy for high risk populations, in this case African-American men and women aged over 50 years. SToP Glaucoma aims to screen 9000 African-American men and women over 5 years, and in this paper the authors present the results of the first year of the program after recruiting 10%.

This work offers a fascinating insight into a high risk community and demonstrates knowledge of an unmet need within this population (42% knew they needed to see an eye doctor but hadn't) which was justified given the fact that a third of people in the sample saw less than 20/40 in at

least one eye, and 51% of those referred had glaucoma. Recruitment of participants was via local community organizations and faith organisations and focused on locations frequented by older adults.

Briefly, SToP consists of 2 visits, the first is a free screening visit lasting 10-20 minutes in a local community venue, and those who screen positive are offered a referral (definitive) examination visit at the Wilmer Eye Institute. The screening visit consists of presenting and best-corrected visual acuity, nonmydriatic fundus photography, and intraocular pressure measurement. Anyone with BCVA of worse than 20/40 is referred. A trained onsite technician evaluates the cup/disc ratio and checks the images for other retinal abnormalities and those with 0.7 ≤ CDR <0.9 and IOP < 23, with no known history of glaucoma, and no other reason for referral underwent frequency doubling perimetry.

A third of people in the sample saw less than 20/40 in at least one eye, and 51% of those referred had glaucoma

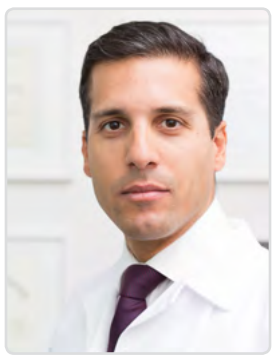
There are several components of this well-designed community program that are appealing:

1. The service component. Eg. e-tracking patients for onward care, providing free mail-in prescription glasses for those with solely uncorrected refractive error.
2. Mid-level non-medical personnel performed all tests at screening. Review of all the fundus images after the screening visit by a glaucoma specialist enhanced safety/quality.
3. Rapid screening methods without mydriasis also allowed diseases other than glaucoma to be detected at this first visit.

The authors plan to learn from this initial experience to increase attendance (from 43%) for the referral visit and scale the program to the greater Baltimore/Washington metropolitan area. Data on utilisation of eye care services after diagnosis by SToP and patient-reported outcome and experience measures of their care within SToP and their onward care within the local care system will be of interest.

Quality of Life

Effects of Visual Field Loss on Balance



Comment by Kaweh Mansouri and Neha Mihda, Lausanne, Switzerland

73175 The Association of Glaucomatous Visual Field Loss and Balance; de Luna RA, Mihailovic A, Nguyen AM, Friedman DS, Gitlin LN, Ramulu PY; Translational vision science & technology 2017; 6: 8

Maintaining a good quality of life in glaucoma patients is second to none. By 2050, the number of people with glaucoma worldwide is estimated to be 111.8 million[1]. Approximately 28-35% of people over 65 years suffer falls each year, causing a significant socio-economic damage.[2,3] One important risk factor for falls in the elderly is poor balance mechanism. Thus, this study by De Luna RA *et al.* attends to an important subject of geriatric health concern.

De Luna RA *et al.* in their work aimed to relate the effects of glaucomatous visual field loss on balance. They used a state-of-the-art OPAL kinematic system to quantify sway, jerk and visual dependence as measures of balance. The results revealed that with decreasing visual field sensitivity and increasing number of peripheral test points missed, increased sway and jerk was noted with eyes open on foam surface, greater jerk with eyes open on firm surface and increased sway and jerk in feet together position. They also observed that worse visual field sensitivity was significantly associated with lower visual dependence.

Balance was worse in glaucoma patients with greater VF damage

Balance or postural stability in humans is a complex mechanism with three prime elements - visual input, somatosensory input (proprioception) and the vestibular system.[4] Ageing is known to have a deleterious effects on balance control affecting all these mechanisms to some extent.[5] Elderly people depend more on their visual inputs for balance compared to the younger counterparts due to the declining proprioception, musculoskeletal strength and cognitive function. Visual field damage in such a scenario gives an additional blow to the already decrepit balance mechanism.[6] Previous studies have shown that in patients with glaucoma dependence on visual inputs decreases as visual field damage progresses. Proprioception becomes the more important in such scenarios. However, when a patient is subjected to conditions like standing on a foam surface, the proprioception inputs decrease, causing evident 'instability' in the 'stability mechanism'.[7,8]

A limitation of this study as stated by the author is that it is conducted in a defined prefixed milieu, not so similar to the environment at home, on roads or garden outside. A second limitation is that dynamic balance was not assessed. Thirdly, the study did not take into account the level of physical activity and cognitive function of these patients which could have some effect on balance.

As a step forward, studies should be designed which can simulate natural conditions and are able to assess postural instability while climbing the staircase or on a slippery surface. Efforts should be made to translate these results for the benefit of patients. Trials could be designed to see the effect of balance exercise on glaucoma patients in terms of fear of fall, number of falls, moving around independently and psychological impact.

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Macular Damage and Quality of Life

Comment by Andrew Tatham, Edinburgh, UK

73244 Association of Glaucoma-Related, Optical Coherence Tomography-Measured Macular Damage With Vision-Related Quality of Life; Prager AJ, Hood DC, Liebmann JM, De Moraes CG, Al-Aswad LA, Yu Q, Cioffi GA, Blumberg DM; JAMA ophthalmology 2017; 135: 783-788

Although measurements of glaucomatous structural damage using optical coherence tomography (OCT) are widely used to aid glaucoma diagnosis and assess rates of progression, the relationship between structural changes and vision-related quality of life (VRQoL) remains poorly understood. It is important to characterize this relationship to determine whether OCT measurements are related to visual disability and are valid surrogates of outcomes directly relevant to patients.

Recently, it has been shown that faster rates of retinal nerve fiber layer (RNFL) thinning, are associated with faster rates of decline in VRQoL, with loss of RNFL associated with worsening quality of life, even after adjusting for changes on visual field.[1] These findings provide evidence that measuring rates of change in RNFL is a valid marker of glaucoma-related disability.[1] In the current study, Prager and colleagues examined the relationship between macular structural changes and VRQoL. A growing body of evidence has shown the importance of damage to the macula in glaucoma, even at early stages,[2] and one would expect changes in the macula to be associated with change in VRQoL. A cross-sectional study was conducted including 107 patients. Quality of life was assessed using the 25-item National Eye Institute Visual Function Questionnaire (NEI VFQ-25), with OCT used to measure macular retinal ganglion cell and inner plexiform layer (RGC+IPL) thickness, and visual fields assessed using the 10-2 strategy. As both eyes of an individual are likely to contribute to VRQoL, binocular field sensitivities were calculated and an integrated maximum (and minimum) binocular RGC+IPL thickness derived by averaging the highest (or lowest) RGC+IPL thickness measurements from each of 6 sectors of each eye.

Surprisingly, there was no association between RGC+IPL thickness and VRQoL, which was unexpected given the importance of the macula for central visual function. It is also contrary to evidence that patients with worse central visual field report worse quality of life.[3] The negative result may be due to patients having similar average RGC+IPL thickness but differences in VRQoL due to different patterns of macular RGC+IPL loss. Lack of association may also be due to the complexity of quality of life assessment or to the cross-sectional study design. Contributors to quality of life such as socioeconomic status or comorbidities were not examined, and previous investigations into RNFL thickness and VRQoL showed a relationship in longitudinal but not

cross-sectional analyses.[1,4] To reduce the effect of inter-individual variation in perceptions of VRQoL, and to more fully elucidate the relationship between macular structural changes and quality of life, it is important the study is repeated using a longitudinal design.

Surprisingly, there was no association between RGC+IPL thickness and VRQoL

Despite the overall lack of association between GCL+IPL thickness and VRQoL, patients with widespread macular thinning were found to have worse VRQoL than those with focal damage. This suggests that glaucoma may have a greater impact on daily living in patients with diffuse compared to focal macular damage, however the reasons for this remain unclear. The authors should be commended for drawing attention to the need for studies to validate measurements obtained from imaging devices by elucidating their relationship to patient reported outcome measures.

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Anatomical Structures

Corneal Biomechanics

Comment by Cynthia Roberts, Columbus, OH, USA

72979 Comparison of Corneal Biomechanical Properties between Indian and Chinese Adults; Chua J, Nongpiur ME, Zhao W, Tham YC, Gupta P, Sabanayagam C, Aung T, Wong TY, Cheng CY; Ophthalmology 2017

It is important to investigate differences in corneal biomechanical properties between races in the context of multiple diseases, and the authors are commended for this detailed study.

The authors describe corneal hysteresis (CH) as an indicator of the viscous properties of the cornea, and corneal resistance factor (CRF) as an indicator of the elastic properties of the cornea. However, both CH and CRF are calculated as linear functions of the first applanation pressure (P1) in the loading phase, and second applanation pressure (P2) in the unloading phase of the Ocular Response Analyzer (ORA).[1] Therefore, both are viscoelastic parameters and highly correlated. The distinction is that CRF was designed to have maximum correlation with central corneal thickness (CCT).[2] This likely contributes to the result that **CH showed significant differences between Indian and Chinese populations, while CRF did not, when ocular parameters including CCT were included as co-variates.**

Both CH and CRF are viscoelastic parameters and highly correlated

Additional insight might be gained by analyzing the pressure and infrared (IR) signals produced by the ORA with each exam. For example, the magnitudes of the IR signal peaks have been shown to be associated with stiffness, such that the greater the magnitude of the peaks, the greater the corneal stiffness.[1] This might allow the conclusions to be extended beyond CH, to determining which group has the stiffer cornea.

Interestingly, the authors report that Body Mass Index (BMI) is significantly greater in the Indian population than the Chinese. It has been reported that BMI is positively correlated with intracranial pressure (ICP).[3] Thus, the lower BMI in the Chinese population might also indicate a lower ICP, which is an additional risk factor for glaucoma,[4] and might also contribute to its prevalence in the Chinese despite lower IOP and higher CCT, compared to Indian persons.

It would valuable to extend our knowledge base with similar studies on other racial groups, as well as incorporate newer technology to clinically evaluate corneal biomechanics.

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Choroidal Thickness and Neuroretinal Parameters

Comment by Tae-Woo Kim, Bundang-gu, Seongnam, Korea

72982 Serial Changes in Lamina Cribrosa Depth and Neuroretinal Parameters in Glaucoma: Impact of Choroidal Thickness; Vianna JR, Lanoe VR, Quach J, Sharpe GP, Hutchison DM, Belliveau AC, Shuba LM, Nicolela MT, Chauhan BC; Ophthalmology 2017

Since the glaucoma involves deformation of the lamina cribrosa (LC), evaluation of the LC may provide additional information for diagnose and managing glaucoma. Degree of LC deformation has been assessed by measuring the LC depth, which was defined as the distance between the Bruch's membrane opening (BMO) level and the anterior laminar surface. **Vianna et al. demonstrated that the LC depth measurement was influenced by choroidal thickness.** It is of note that the significant choroidal thinning occurred in 89% of the included patients. It indicates that the influence choroidal thinning on the measurement of LC depth is not an issue that is limited to some patients but relevant to almost all patients.

The magnitude of deformation of any material is defined as the difference between its original and current status. Lamina cribrosa is contiguous with peripapillary anterior sclera not choroid. Therefore, it is reasonable to assess the LC deformation from the anterior scleral plane level. BMO has been used as the reference plane probably because it is easily identified even in moderate quality image. LC depth measured from BMO is the sum of actual deformation and choroidal thickness. As long as the choroidal thickness is a constant value, such measurement would be acceptable. However, the choroidal thickness is not a constant value. Vianna *et al.* nicely pointed out this important issue. Since the choroidal thickness is varying among subjects, this idea is applied not only into the serial measurement in the same individual but also relevant with the interindividual comparison.

Visualizing the Collector Channel Entrance

Comment by Murray Johnstone, Seattle, WA, USA

72921 Imaging collector channel entrance with a new intraocular micro-probe swept-source optical coherence tomography; Xin C, Chen X, Li M, Shi Y, Wang H, Wang R, Wang N; Acta Ophthalmologica 2017

The authors of this report describe a new intraocular OCT probe capable of imaging the outflow system from either the anterior chamber or from within Schlemm's canal. **Their report demonstrates the ability to identify the collector channels in the distal aqueous outflow pathways** from either of the two locations.

The approach employs several technological advances, eliminating the issues of scleral light scattering and shadowing from the limbal vasculature that occurs with current commercial systems. Advances include: 1) small catheter size permitting positioning near the tissue, 2) a 1310 nm vs. the typical 810 nm light source permitting better tissue penetration, 3) a high scan rate (50 kHz) within a very thin probe (0.25 mm), and 4) swept source OCT implementation improving detection sensitivity over the imaging depth.

A commercial version of such a microprobe would have the potential to much more efficiently target the collector channels of the distal outflow system, a capability not available previously. Both accurate localization and assessment of functional properties of the distal outflow channels have the potential to substantially improve success rates of MIGS such as stents.

Current limitations to *in vivo* applications result from both structure and time resolution limits imposed by the frame rate and small size of the probe (0.25 mm). Fortunately, the authors suggest an increase in probe size, for example to the size of a 3-mm corneal incision, should provide the ability to achieve the required resolution. Since many MIGS surgeons do cataract surgery involving incisions approximating 3 mm, the more substantial probe size is unlikely to be a deterrent to use of a bigger probe.

The availability of a substantial increase in the probe dimensions, together with rapid advances in the development of light sources for swept source OCT, suggests OCT innovators will overcome current probe limitations soon. One of the most exciting aspects of this report is the demonstration of the rapid advances in OCT technology and its miniaturization that are quickly transforming our field.

Visualizing the Collector Channel Entrance

Comment by Sung-Chul Park, New York, NY, USA

72921 Imaging collector channel entrance with a new intraocular micro-probe swept-source optical coherence tomography; Xin C, Chen X, Li M, Shi Y, Wang H, Wang R, Wang N; Acta Ophthalmologica 2017

Xin *et al.'s* case report demonstrated the use of a novel swept-source optical coherence tomography (OCT) probe to visualize collector channel entrances *ex vivo*. Their side-viewing OCT probe (outer diameter, 0.15 mm) was contained within a biocompatible fluorinated ethylene-propylene tube (outer diameter, 0.25 mm). **When inserted into the Schlemm's canal of a human cadaver eye, the probe provided a cross-sectional OCT image of collector channel entrances. When placed next to the trabecular meshwork in the anterior chamber, the OCT probe visualized both Schlemm's canal and collector channel entrances.**

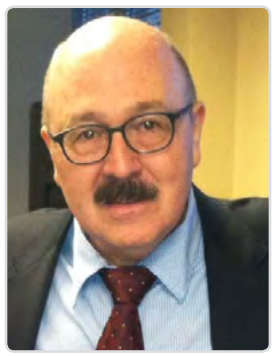
In newer glaucoma surgeries targeting the iridocorneal angle and Schlemm's canal, real-time intraoperative evaluation of the Schlemm's canal and collector channels using this OCT probe may be helpful in selecting the target area to improve surgical outcomes. Visualization of Schlemm's canal and collector channel entrances from the anterior chamber may be most useful clinically, as it makes the OCT probe much easier to use and decreases surgical time substantially compared to inserting the probe into Schlemm's canal. Additionally, as the authors mentioned, this OCT probe can potentially be used to evaluate *in vivo* dynamic structural changes in the Schlemm's canal and collector channels in response to intraocular pressure changes.

The outer diameter (0.25 mm) of this novel OCT probe is the same as that of a canaloplasty catheter (iTrack™, iScience Interventional, Menlo Park, CA). Therefore, the OCT probe can potentially achieve a similar effect as canaloplasty when inserted into the Schlemm's canal for visualization of the conventional aqueous outflow pathway. However, if it is inserted into Schlemm's canal, it will likely alter the anatomy of surrounding microstructures including collector channels and their entrances.

Since this is a prototype device, better resolution and clearer visualization with increased signal-to-noise ratio are needed for future clinical application of this technology. The authors are also encouraged to provide more *in vivo* quantitative data regarding human aqueous outflow pathway in dynamic settings in the future.

Basic Science

Pathophysiology



Comment by Hanspeter Killer, Basel, Switzerland

73583 Elevated IOP alters the space-time profiles in the center and surround of both ON and OFF RGCs in mouse; Sabharwal J, Seilheimer RL, Tao X, Cowan CS, Frankfort BJ, Wu SM; Proceedings of the National Academy of Sciences of the United States of America 2017

Sabharwal *et al.* used mice to elaborate on the effect of elevated intraocular pressure (IOP) on the space–time profiles in the center and surround of both ON and OFF retinal ganglion cells. IOP elevation was produced by applying a microbead occlusion model. To record the ganglion cell activity a multielectrode array was used that allowed the simultaneous recording form a large population of retinal ganglion cells and to compare them to mice without elevated IOP. **The researchers found a IOP induced reduction of the firing rate to light offset for OFF and ON-OFF retinal ganglion cell receptive field center size and linked this to a pressure induced dysfunction in the inner retinal circuitry, especially on the ON cross – over pathways**. The speculate that this might be due to an IOP–induced alteration of the retinal ganglion cell dendrites in the OFF lamina.

Given that IOP acts as a scalar force, namely unidirectional, **this could identify cells types that seem to be more sensitive to pressure induced damage** (previous literature found a higher pressure sensitivity of motion sensitive magno ganglion cells).

The authors suggest that their findings may provide a basis for a new functional tests that could pick up early glaucomatous damage based on such findings.

The authors suggest that their findings may provide a basis for a new functional tests

There is however one question that needs to be solved. Mice are mostly night active while humans are mostly day active. This difference may be crucial in the evaluation of space time behavior. Therefore, care needs to be taken when the results in mice are transferred to humans.

A Mouse Model for assessing ONH Damage

Comment by Richard Libby, Rochester NY, USA

72863 A mouse ocular explant model that enables the study of living optic nerve head events after acute and chronic intraocular pressure elevation: Focusing on retinal ganglion cell axons and mitochondria; Kimball EC, Pease ME, Steinhart MR, Oglesby EN, Pitha I, Nguyen C, Quigley HA; Experimental Eye Research 2017; 160: 106-115

The optic nerve head (ONH) is a critical site of injury to retinal ganglion cell axons in glaucoma. The ONH consists of multiple cell types, including astrocytes and microglia, and retinal ganglion cell axons. After a glaucomatous injury, it is important to understand dynamic intracellular events in the ONH and how the different cell types interact over time. To date, it has been very difficult to study the *in vivo* biology of the ONH, limiting our ability to understand critical pathophysiological changes that occur with time. To overcome this limitation, Kimball and colleagues developed a mouse organ culture system specifically designed to interrogate the ONH and retinal ganglion cell axons *in situ*. In this manuscript, using mouse genetic tools, they ask important questions about mitochondrial biology that are relevant to glaucoma. To do this they compare mitochondrial dynamics in retinal ganglion cell axons in and around the ONH between normotensive eyes and eyes subjected to elevated intraocular pressure. They found that **mitochondrial size, movement and density were all significantly different in the ocular hypertensive eyes compared to the control eyes.** These data further implicate mitochondrial biology in glaucomatous neurodegeneration. A very significant aspect of this manuscript is the development of a much-needed model system that can provide critical feedback concerning cellular responses in the ONH in real time in a tractable, animal model of glaucoma. Going forward this model system could be used to ask additional important questions about ONH and retinal ganglion cell axon biology after glaucoma-relevant injuries. For example, the system could be used in conjunction with pharmaceutical or genetic manipulations to critically test hypotheses about glaucomatous neurodegeneration. Furthermore, it could be used to elucidate the precise timing of events relevant to axonal injury in microdomains of the ONH. I am looking forward to future studies from this group and others that exploit this technology to probe key aspects of glaucomatous pathophysiology.

Mitochondrial-mediated Neuroprotection

Comment by Miriam Kolko, Roskilde, Denmark

73163 Topical Coenzyme Q10 demonstrates mitochondrial-mediated neuroprotection in a rodent model of ocular hypertension; Davis BM, Tian K, Pahlitzsch M, Brenton J, Ravindran N, Butt G, Malaguarnera G, Normando EM, Guo L, Cordeiro MF; Mitochondrion 2017

In the present study, the authors elucidate the potential neuroprotective role of coenzyme Q10 (coQ10). CoQ10 is known as an antioxidant. Moreover, coQ10 carries electrons between complex I and III and complex II and III in the oxidative phosphorylation. Since emerging studies have related mitochondrial dysfunction and glaucomatous loss of retinal ganglion cells (RGCs), it is likely that treatments to support the electron transport and thereby increase ATP production and reduce the production of reactive oxygen species (ROS) may rescue the RGCs and their axons.

The study provides supportive evidence of CoQ10/TPGS as a neuroprotective treatment and emphasizes a great potential of the "Detection of apoptosing retinal cells"

Since previous studies have proven better delivery of coQ10 when combined with the vitamin E derivative D-α-Tocopherol polyethylene glycol 1000 succinate (TPGS), the authors used this combined treatment to investigate the neuroprotective properties of coQ10. The authors reported that topically instilled CoQ10/TPGS micelles were delivered in neuroprotective concentrations to the retina. In order to investigate the protective efficacy of CoQ10/TPGS, the authors used primary murine retinal mixed cultures and the immortalized retinal photoreceptor cell line (RGC5). Moreover, an *in vivo* Morrison's model of ocular hypertension was used. To induce mitochondrial impairment cells were exposed to DMSO and paraquat. Whereas both DMSO and paraquat induce oxidative stress, paraquat has furthermore been shown to reduce complex I activities. **In both mixed murine retinal cultures, RGC5 and in the ocular hypertension model, the authors reported neuroprotective effects of CoQ10/TPGS**.

While the results are interesting and supporting previous findings of CoQ10 as a possible neuroprotective agent, an important consideration is how generalizable the results are to glaucoma. Moreover, the particular impact of the oxidative phosphorylation complexes and/or ROS production in the pathophysiology of glaucoma is still debated and future studies would benefit from more stringent measurements of the various complex activities compared to ROS production in response to CoQ10/TPGS. In spite of the need for extended studies to investigate the potential use of CoQ10/TPGS to prevent progressive glaucomatous RGC loss, the study provides

supportive evidence of CoQ10/TPGS as a neuroprotective treatment and emphasizes a great potential of the "Detection of apoptosing retinal cells", DARC technique as a tool to monitor the efficacy of potential neuroprotective treatments.

Neuroprotection - role of astrocyte reactivity

Comment by Peng Tee Khaw, London, UK

72868 Optic nerve astrocyte reactivity protects function in experimental glaucoma and other nerve injuries; Sun D, Moore S, Jakobs TC; Journal of Experimental Medicine 2017; 214: 1411-1430

Although there have been some criticisms of the use of the mouse and rat model for raised intra-ocular pressure in the model of glaucoma, in part because the mouse and rat lack the lamina cribosa found in the primate optic nerve. Nonetheless these models have proved very useful. In particular, raising the pressure in these eyes appears to cause a similar cycle of axonal and subsequent ganglion cell body death seen in primary glaucoma. Given that there are two major cell types in the rat and mouse optic nerve head *i.e.* the astrocytes which form a living cellular lamina and the ganglion cell axons which run through the optic canal intimately in contact with the astrocytes, this suggests that the disruption of the astrocytic axonal relationship is a fundamental part of the diseases we call glaucoma.

In this paper the authors have concentrated on a signal transducer and activator of transcription 3 (STAT3) which is a cellular transcription factor. The molecule has various functions. Within the nervous system it is a regulator of astrocyte reactivity and glial scar formation in the brain and spinal cord. Astrocytes in the nervous system all express STAT3 and activation of this molecule increases after events such as trauma and inflammation and also in elevated intraocular pressure in the rat. In the brain and spinal cord the expression of STAT3 attenuates the amount of damage after injury.

Using a knock-out model, the authors investigated the changes in STAT3 expression was associated with cellular phenotype and damage to the axon in a model of raised pressure in the mouse created by microbead injection.

pSTAT3 was upregulated in reactive astrocytes within the glial lamina. Retinal astrocytes did not show upregulation of pSTAT3.

Interestingly, there was some activation of STAT3 in some of the retinal Müller cells that have been postulated to carry out similar support functions to the retinal nerve fibre layer in the retina. With injury due to raised pressure, hypertrophy and reaction of the astrocytes are noted

and the reactive astrocytes also expressed glial fibrillary acidic protein. The damage to astrocytes resulted in the expulsion of various biomarkers of activation in the glial lamina of the mice, while a knockout of STAT3 did not show a similar phenotypic reaction.

Lack of reactive astrocytes was associated with significantly greater ganglion cell loss. In addition, using the positive scotopic threshold response (or pSTR) the mice with the STAT3 knockout showed 20% to 30% greater reduction in the amplitude of the pSTR reflecting ganglion cell dysfunction.

What the study shows, at least in this model, is that **STAT3 appears to be an important component of the reaction of the astrocytes to raise pressure**. The lack of STAT3 is associated with greater damage to the axons and ganglion cells. This also continues to confirm the intimate relationship between the astrocyte and the axon in that the reactivity or otherwise at the astrocyte is potentially extremely important in modifying damage to the axon and subsequently the ganglion cell body.

The intimate relationship between the astrocyte and axon is clearly going to be one of the keys to fully understanding and treating this enigmatic group of diseases known as glaucoma

There is also commentary about the fact that a single transient elevation of pressure to about 30mmHg for just a few hours can cause very long term damage, confirming the findings of other authors. Again raising the discussion about the primary mechanisms of long term continued damage to the axons appear to be related to long term cellular changes initiated by barotrauma in the form of raised intraocular pressure. This also suggests that the **intimate relation between the astrocyte and axon is clearly going to be one of the keys to fully understanding and treating this enigmatic group of diseases known as glaucoma**.

Diet may aggravate Optic Nerve Injury

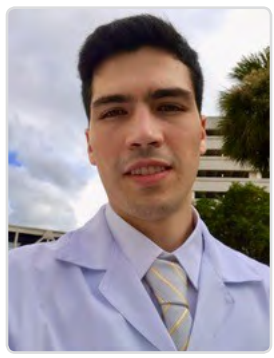
Comment by Louis Pasquale, Boston, MA, USA

73574 A short term high-fat high-sucrose diet in mice impairs optic nerve recovery after injury and this is not reversed by exercise; Chrysostomou V, van Wijngaarden P, Steinberg GR, Crowston JG; Experimental Eye Research 2017; 162: 104-109

Saturated fatty acids and sugar-sweetened beverages are major components of the Western diet, a nutritional consumption pattern associated with several adverse health outcomes. Chrysostomou and colleagues placed mice on a high-fat, high-sucrose (HFS) diet for 6 weeks and found no changes in retinal ganglion cell (RGC) function as measured by electroretinography (ERG) and no changes in intraocular pressure (IOP) compared to a control diet containing a lower content of fat and sucrose. Then IOP was raised to ~50mmHg for 30 minutes via cannulation of the anterior chamber. This IOP elevation did not cause structural changes in the retina but did result in reduced positive scotopic threshold response (pSTR) amplitudes, responses that localize to the RGC layer. **At one week after exposure to elevated IOP, pSTR amplitudes recovered to near normal in mice on the control diet but remained reduced in mice on the HFS diet. This vulnerability to RGC dysfunction was not rescued with an exercise regimen** consisting of 60 minutes of swimming, 5 days per week for 1 week after induction of elevated IOP. More significant IOP insults resulting or longer periods of exercise were not tested. The authors note that the HSF diet did not produce statistically significant changes in body mass index or serum glucose levels. **They hypothesize that the HSF diet induces oxidative stress in neuronal cells** and provide evidence for increased glial fibrillary acidic protein immunoreactivity in the RGC layer of mice fed the HFS diet after IOP elevation compared to mice on the control diet who also had similar exposure to elevated IOP. The authors discuss other mechanisms but do not provide data to address them. Overall, these data provide another reason to curtail intakes of foods high in saturated fats and sucrose.

Clinical Examination Methods

24-h IOP Variations under Treatment

Comment by Tomas Grippo New Haven, CT, USA and Facundo G. Sanchez, Buenos Aires, Argentina

73171 Twenty-Four-Hour Variation of Intraocular Pressure in Primary Open-Angle Glaucoma Treated with Triple Eye Drops; Itoh Y, Nakamoto K, Horiguchi H, Ogawa S, Noro T, Sato M, Nakano T, Tsuneoka H, Yasuda N; Journal of Ophthalmology 2017; 2017: 4398494

Yoshinori *et al.* performed a prospective study to evaluate the 24-hour intraocular pressure (IOP) variation in 74 eyes of 74 patients with moderate primary open-angle glaucoma treated with triple eye drops (beta-blockers, prostaglandin analogs and carbonic anhydrase inhibitors). Measurements were perfomed in the sitting position at all time points (10:00, 13:00, 16:00, 19:00, 22:00, 1:00, 3:00, and 7:00) using Goldmann applanation tonometry. Statistical analysis included subdividing the patients into diurnal and nocturnal based on IOP peak-time during the 24-hour period. **They found that peak IOP occurred at 1:00, and was significantly different than the trough IOP at 7:00 ($p<0.05$). Sixty eyes (62.5%) did not have peak IOP during office hours.** Patients were also subdivided into high-myopic and low/non-myopic eyes based on spherical equivalent. Low/non-myopic eyes showed a significant IOP rise during the night (especially in those with a spherical equivalent of −2D or less). However, the origin of the refractive error (*i.e.* lenticular vs axial) was not described, which makes interpretation of this finding difficult.

Additional limitations of this study are related to the considerable variation in glaucoma eye drops used, which may affect the 24-hour IOP patterns. As well, the IOP measurement technique involved waking patients and placing them in a sitting position, which does not match the normal physiologic position during sleep, potentially affecting IOP readings.

Nevertheless, this study contributes to our understanding of the impact of triple hypotensive therapy on the 24-hour IOP pattern. It demonstrated that even under triple therapy, most patients will have their peak IOP outside office hours (night time), similarly to what Liu *et al.* observed in untreated glaucoma eyes (in the habitual positions).[1] As well, some variables, such as refractive error, may help identify patients that are more likely to have nocturnal IOP peaks.

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24-h IOP Monitoring: Effect of Body Posture

Comment by John Liu, La Jolla, California, USA

72600 Twenty-four hour intraocular pressure monitoring with the SENSIMED Triggerfish contact lens: effect of body posture during sleep; Beltran-Agulló L, Buys YM, Jahan F, Shapiro CM, Flanagan JG, Cheng J, Trope GE; British Journal of Ophthalmology 2017

When patients slept with a 30-degree head-up wedge pillow, intraocular pressure (IOP) readings taken every two hours were significantly lower compared to a flat sleep body position. In the current study, investigators used the Sensimed Triggerfish contact lens sensor to monitor the related IOP change pattern in 12 patients with progressive glaucoma. The new results surprisingly did not corroborate the anticipated IOP elevation during the sleep period or the IOP-lowering effect due to the head-up sleep body position. The authors noticed a significant baseline drift upward. However, the correlation between the sensor output signals and the Goldmann IOP readings, taken before the contact lens fitting and after the removal of contact lens, was absent. These observations cast doubt on the use of this contact lens sensor to evaluate individual IOP changes in glaucoma patients. For all the study participants except one, polysomnography showed obstructive sleep apnea. It is known that obstructive sleep apnea reduces the nocturnal IOP elevation. Without the anticipated nocturnal IOP elevation, variation of experimental data could overshadow a small IOP-lowering effect and the frequently observed baseline drift became relatively prominent. Since the sensor is embedded in silicone material, not hydrogel, it is impossible to determine the corresponding applanation IOP over the contact lens. By design, the sensor software uses the first output signal as the set point for baseline. Physiological environment when the sensor first lands on the corneal-conjunctival surface and when the sensor has been sitting on the corneal-conjunctival surface for 24 hours may be very different.

The new results surprisingly did not corroborate the anticipated IOP elevation during the sleep period or the IOP-lowering effect due to the head-up sleep body position

For example, time-dependent changes in the sensor temperature and the tightness of fit associated with circular conjunctival pressure mark may contribute to the 24-hour baseline drift. There is no evidence that these confounding factors have been appropriately addressed in the senor's engineering design. While the current study cautions the use of this new technology beyond the indication of determining 24-hour IOP peak timing, the study affirms that more research is needed to develop the contact-lens based IOP sensor as a clinically useful tool for glaucoma management.

Diurnal IOP Patterns in Healthy Subjects

Comment by Tony Realini, Morgantown, West Virginia, USA

72758 Long-term Reliability of Diurnal Intraocular Pressure Patterns in Healthy Asians; Chun YS, Park IK, Shin KU, Kim JM; Korean Journal of Ophthalmology 2017; 31: 132-137

Chun and colleagues have recently reported a study evaluating the repeatability of diurnal intraocular pressure (IOP) patterns in heathy Asian subjects without glaucoma. In this study, IOP was measured using Goldmann applanation tonometry every 2 hours from 9AM to 11PM on two days separated by 8 weeks. At each visit, IOP mean, peak, trough and fluctuation (assessed both as peak minus trough and as standard deviation of all measurements). **Using the intra-class correlation coefficient as a measure of agreement, the investigators found excellent agreement of diurnal summary parameters and IOP at individual time points between these two sessions.** They concluded, "These findings suggest that IOP measurements at standardized times of the day will be useful for assessing the effectiveness of glaucoma therapy." As our group and others have demonstrated, the significant spontaneous variability of IOP over time can confound the accurate assessment of therapeutic efficacy in glaucoma management. I applaud the authors for their carefully designed and analyzed study addressing this important topic. I caution readers, however, to consider whether some elements of the study design and the data themselves may weaken support for the stated conclusions of the analysis. The study was conducted in healthy subjects without glaucoma. Assuming that IOP regulation in healthy and glaucomatous eyes is comparable is problematic. The trabecular meshwork (TM) is integral to IOP regulation, and in contrast to the presumed healthy TM in the subjects in this study, patients with glaucoma are known to have trabecular dysfunction that likely alters IOP regulation in glaucomatous eyes. More importantly, this study was conducted in Asian eyes, known to have very low IOP levels. **In this study, the mean IOP was 12.2 mmHg at each visit, and peak and trough values averaged only 1 mmHg above or below the mean, respectively, yielding IOP fluctuations on the order of 2-3 mmHg by the peak minus trough method and only 1 mmHg using the standard deviation method**. Such minimal fluctuations bias toward higher agreement: if values don't change much, they will agree by default. It remains my belief that assessment of therapeutic efficacy of glaucoma treatment should be based on the difference between several pre-treatment IOP measurements and several on-treatment IOP measurements, to better distinguish the signal from the noise.

Diurnal IOP Patterns in POAG and PACG

Comment by Andrew Tatham, Edinburgh, UK

72705 Comparison of self-measured diurnal intraocular pressure profiles using rebound tonometry between primary angle closure glaucoma and primary open angle glaucoma patients; Tan S, Baig N, Hansapinyo L, Jhanji V, Wei S, Tham CC; PLoS ONE 2017; 12: e0173905

It is well established that intraocular pressure (IOP) fluctuates, with sleep laboratory studies showing peak IOP often occurs during the nocturnal period.[1] The ability to obtain a greater number of IOP measurements, including outside office hours, is likely to improve understanding of the role of IOP as the major risk factor for glaucoma, and improve ability to determine the efficacy of IOP-lowering treatments.

Tan and colleagues taught 31 patients with primary angle closure glaucoma (PACG) and 22 with primary open angle glaucoma (POAG) to perform self-tonometry using the iCare ONE rebound tonometer (RBT) (iCare Finland, Oy, Finland). This device uses a probe which makes 6 rapid consecutive contacts with the central cornea and records the mean measurement as the IOP. Patients measured their own IOP in the sitting position 5 times per day at 4 hourly intervals from 8am to midnight for 7 days. At least 3 successful measurements were required at each time point and the mean IOP at each time point over the 7 days was calculated for each subject to provide an individual's 'diurnal IOP profile'.

Overall IOP was highest at 8 am and tended to drop during the day to reach a low at midnight, with similar patterns of IOP fluctuation seen in eyes with PACG and POAG. IOP was significantly higher at 8am compared to 8pm and midnight for both groups; however, **the range of IOP fluctuation was modest with a median range of 2.3mmHg in eyes with PACG and 3.2 mmHg in POAG. It is, however, important to emphasize that patients were medically treated and eyes with PACG had received prior laser iridotomies**; one would expect IOP fluctuation may be greater in untreated patients. There were other subtle differences between groups: eyes with POAG were noted to have slightly greater IOP fluctuation and eyes with PACG had higher trough IOP. However, there was no significant difference in average or peak IOP between groups. The RBT showed good agreement with Goldmann applanation tonometry with a mean underestimation of only 0.15 ± 0.65 mmHg.

The differences between POAG and PACG may have been due variation in number and type of medication or differences in the effect of dilation status on IOP. An interesting finding was that **eyes with POAG tended to have higher IOP during the day but at midnight IOP was significantly higher in eyes with PACG**. The authors hypothesize that this may be due to nocturnal pupil dilation causing impaired aqueous humour outflow at night in PACG.

Although the significance of IOP fluctuation for glaucoma progression is yet to be determined, this study supports others in showing self-tonometry is feasible and can be used to improve understanding of IOP fluctuations in patients' ambient environment.[2] A limitation is that although RBT allows a great number of IOP measurements, it does not record IOP continuously. Only 5 measurements were taken each day and no measurements were taken between midnight and 8 am, meaning the true timing of peak IOP and magnitude of fluctuation remains uncertain. Nevertheless, the days of ophthalmologists relying on single IOP measurements to set treatment targets and assess response to treatment may be near an end.

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Reliability of Visual Fields

Comment by Chris Johnson, Iowa City, IA , USA

73414 Evidence-based Criteria for Assessment of Visual Field Reliability; Yohannan J, Wang J, Brown J, Chauhan BC, Boland MV, Friedman DS, Ramulu PY; Ophthalmology 2017

Perimetry and visual field testing are diagnostic test procedures that are typically employed to evaluate the status of peripheral visual function in patients with glaucoma or who are at risk of developing glaucoma. Because this is a test that requires subjective responses to stimuli presented at key locations in the peripheral visual field, the reliability of the test results is an important factor for the practitioner to assess in order to determine how much importance to assign to the perimetric findings.

> Fixation losses did not influence MD values to any appreciable extent, but false positives elevated MD, and increasing amounts of false negatives and test time decreased MD values

The impact of reliability criteria on sensitivity measures and summary statistics is crucial for proper interpretation of these test results. Methods of monitoring the accuracy of steady fixation through gaze tracking (monitoring the location of the corneal reflex in relation to the edges of the pupil) and fixation losses (responses to a stimulus presented to the blind spot) provide a means of determining the level of cooperation demonstrated by the patient during a visual

field examination. Additionally, catch trials in the form of false positives (responses when no stimulus is presented, or responses that fall outside of a predetermined time window in relation to the stimulus presentation) and false negatives (lack of responses to a stimulus presented at a higher intensity than a previously determined threshold at locations with normal or near-normal sensitivity) provide information about the consistency of the response properties of the patient. As indicated by the authors, the normal "cutoffs" for these values were determined through population studies that provided a distribution of results. Moreover, the criteria were binary (reliable versus unreliable) rather than continuous. In this investigation, the authors evaluated visual fields from a very large population of patients and used a multilevel model of longitudinal data to determine the influence of false positives, false negatives, fixation losses and test time on visual field mean deviation (MD) which is often used as an indicator of visual field status in glaucoma. It was found that fixation losses did not influence MD values to any appreciable extent, but false positives elevated MD, and increasing amounts of false negatives and test time decreased MD values. These evidence-based results provide important information for eye care specialists that rely on visual field testing for monitoring glaucoma patients and those at risk of developing glaucoma. In this view, the authors are to be congratulated for providing a well-constructed evaluation of visual field reliability and their influences on test results.

Parapapillary Atrophy Zones

Comment by Marcello Nicolela, Halifax, Nova Scotia, Canada

72865 Measurements of the parapapillary atrophy zones in en face optical coherence tomography images; Miki A, Ikuno Y, Weinreb RN, Yokoyama J, Asai T, Usui S, Nishida K; PLoS ONE 2017; 12: e0175347

Diagnosing glaucoma in myopic eyes can be challenging, particularly in eyes with significant optic nerve tilt and pronounced peripapillary atrophy (PPA). Modern imaging and visual field tests aren't of great benefit in helping this diagnosis, as myopia alone can cause OCT abnormalities and visual field defects. Recent studies have demonstrated that what was traditionally described as beta type of PPA (a hypopigmented atrophic area bordering the edges of the optic disc), can be distinguished in two distinct subtypes, based on OCT findings: the OCT defined beta type, where RPE is absent but Bruch's membrane is present, and the gamma type, where both RPE and Bruch's membrane are absent. Some authors reported that beta type of PPA has greater association with glaucoma and gamma type has greater association with myopia.

Miki *et al.* reported on a new method of assessing PPA in SS-OCT images, by performing en face measurement, therefore eliminating the possible measurement error of projecting the PPA borders identified at the level of the RPE / Bruch's membrane into the red-free images.

Their study confirmed previous finding that **beta PPA was associated with glaucoma and age, whereas gamma zone was associated with myopia.** Their new method of measuring PPA is elegant, but it would be useful to compare with measurements of PPA done more traditionally on red free images, to evaluate the magnitude of the difference between the two methods. One problem of their study is that the control individuals were not myopic. In order to truly evaluate the relevance of OCT defined PPA types in identifying glaucomatous damage in myopic individuals, a myopic control group should be included, allowing for a more realistic evaluation of the diagnostic accuracy of the subtypes of PPA defined by OCT.

Inner Retinal Changes in Glaucoma

Comment by Ki Ho Park, Seoul, South Korea

73162 Ganglion Cell-Inner Plexiform Layer Change Detected by Optical Coherence Tomography Indicates Progression in Advanced Glaucoma; Shin JW, Sung KR, Lee GC, Durbin MK, Cheng D; Ophthalmology 2017

The authors examined the performance of Guided Progression Analysis (GPA) in spectral-domain optical coherence tomography (OCT) for detection of progressive thinning of the ganglion cell inner plexiform layer (GCIPL) and retinal nerve fiber layer (RNFL) in glaucoma. Glaucomatous eyes were classified into mild (mean deviation [MD],> -6 dB) or moderate-to-advanced (MD, <-6 dB) groups by the severity of their VF defects.

The eyes with progressive GCIPL thinning had a higher probability of VF progression than did the eyes without progressive GCIPL thinning, regardless of glaucoma severity. In addition, the rate of change in the average GCIPL thickness was significantly higher in progressors than in non-progressors, regardless of glaucoma severity. The paper has value as the first to demonstrate the usefulness of GCIPL GPA as a new approach to the detection of glaucoma progression.

GCIPL GPA was more useful than RNFL GPA for detection of progression in the moderate-to-advanced stages of glaucoma. This result seems quite reasonable, because about one-half of the total retinal ganglion cells are concentrated in the macular region where GCIPL analysis is performed and where VF change occurs in the advanced stage of glaucoma. By contrast, as the average RNFL thickness reflects the entirety of retinal ganglion cells, it might be less sensitive for detection of VF changes in moderate-to-advanced glaucoma.

In the final part of their discussion, the authors declared that "the significantly higher rate of change in the average GCIPL thickness in progressors may imply that progressive GCIPL thinning beyond the extent of age-related loss could be used as a biomarker for predicting glaucoma progression." However, the term "prediction" should be used very cautiously, because the

current study did not demonstrate any GCIPL GPA utility for prediction of future VF progression but rather, and only, better GCIPL GPA performance than RNFL GPA in differentiating VF progression in cases of moderate-to-advanced glaucoma.

Morphological changes and Visual Field Progression

Comment by Brad Fortune, Portland, OR, USA

72739 Impact of Rates of Change of Lamina Cribrosa and Optic Nerve Head Surface Depths on Visual Field Progression in Glaucoma; Wu Z, Lin C, Crowther M, Mak H, Yu M, Leung CK; Investigative Ophthalmology and Visual Science 2017; 58: 1825-1833

The promise of using OCT to image deeper optic nerve head (ONH) structures such as the lamina cribrosa in order to detect change and predict future glaucoma progression becomes increasingly clear with results of meaningful studies such as the one by Wu and colleagues. This study used OCT scans to measure two ONH parameters: the anterior lamina cribrosa surface depth (ALSCD) and ONH surface depth (ONHSD), each relative to two different internal reference planes: one defined by the pair of Bruch's Membrane Opening (BMO) points in each OCT B-scan, the other defined by the choroid-sclera interface (CSI) detected just adjacent to the ONH. The latter is arguably more stable with regard to fluctuations of choroidal thickness, which have been shown to influence the axial position of the BMO plane. Wu and colleagues used trend analysis to determine rates of change for these 4 OCT parameters of ONH structure in a large cohort of glaucoma patients and used elegant statistical modeling to determine if those rates had any influence on the likelihood of visual field progression (as determined by EMGT criteria for standard automated perimetry). The investigators found that:

"The risk of development of VF progression increased by 6.4% (BMO-based measurements) to 7.4% (CSI-based measurements) for each micrometer per year increase in the rate of change of ALCSD, and by 10.9% (BMO-based measurements) and 9.3% (CSI-based measurements) for each micrometer per year increase in the rate of change of ONHSD after controlling for the covariates." And they concluded ultimately that this: *"finding underscores the importance of monitoring the ALCSD and ONHSD for risk assessment of VF progression in glaucoma patients."*

This study reports compelling evidence that the anterior lamina cribrosa surface and the optic nerve head surface measured by OCT provide biomarkers capable of predicting subsequent visual field progression in glaucoma

In their Discussion section, the authors also consider other important findings from their study such as that older age was associated with a slower rate of change of ALCSD and ONHSD (*i.e.*, less rapid increase in the depth of either surface, confirming similar observations previously predicted and published by others) but also that higher IOP during follow-up was associated with a faster rate of change of both parameters (*i.e.*, a more rapid increase in the depth of either surface). The authors rely on their complete set of findings to synthesize the reasonable suggestion that **lowering IOP (particularly in those eyes exhibiting a rapid increase of ALCSD and ONHSD) should reduce the rate of change as well as the risk of subsequent visual field progression.**

The strengths of the study by Wu and colleagues include that it was based on a large cohort (146 eyes of 95 glaucoma patients) and long duration of regular, frequent (every 4 months) follow-up scans; to quote: "The mean follow-up duration was 6.5 years (range, 5.0–7.4 years) and the mean number of follow-up visits for each patient was 17.3 (range, 8–21 visits)." Further, the investigators applied elegant statistical models to control for baseline variables including baseline age, baseline axial length, baseline central corneal thickness, baseline ALCSD/ONHSD and IOP during follow-up. It is also reassuring that they found positive results despite using an ONH scan pattern that consisted of only 6 radial B-scans. Their measurements to derive the ONH parameters ALCSD and ONHSD were generally very careful, for example, using a spatially weighted average to adjust for sampling density inherent to a radial scan pattern.

However, in this regard, there are also a few caveats to consider for future studies of this kind. First, the investigators performed their measurement in B-scan images scaled as 1:1 pixel (*i.e.*, "square pixels"), then applied the instrument's estimates for pixel size to report (and presumably analyze) depth measurements of the ALC and ONH surfaces relative to each reference plane. These depth measurements were made perpendicular to the reference plane, but the orientation of that plane would change once the correct scaling is applied to the images (*i.e.* if the images were scaled 1:1 µm instead of 1:1 pixel) for all cases in which the reference plane was not perfectly parallel to the image frame. This means the "normal" to the reference plane would also have a different orientation and thus intersect the surface of interest (such as the lamina cribrosa) at a different point, which could lead to errors especially in eyes with highly curved surfaces. Another related limitation is that all measurements were two dimensional (made within each B-scan) rather than three-dimensional. It is not likely that the results of the study would change with these improvements, more precise measurements, but it is worth the endeavor for future studies.

Another question arises about results not reported in this fine paper. Figure 2 showed Venn Diagrams to document the agreement between the two different parameters (ONHSD and ALCSD) for each reference plane, which was generally quite good, reassuring. But it also would be important to know whether there was also good agreement *between the two different reference planes* (*within* each parameter). That is because if the choroid thins and causes the BMO to move posteriorly – but not the ONH tissue/surface – then the parameter ONHSD would decrease relative to the BMO but not the CSI reference plane; similarly, the ALCSD would not change for CSI but would decrease for BMO reference plane. In any case, it was reassuring to see at least good agreement for the two different parameters when the same reference plane was used for each.

In summary, this study reports compelling evidence that the anterior lamina cribrosa surface and the optic nerve head surface measured by OCT provide biomarkers capable of predicting subsequent visual field progression in glaucoma.

Morphological changes and Visual Field Progression

Comment by Jost Jonas, Heidelberg, Germany

73046 β-Zone Parapapillary Atrophy and Rates of Glaucomatous Visual Field Progression: African Descent and Glaucoma Evaluation Study; De Moraes CG, Murphy JT, Kaplan CM, Reimann JJ, Skaat A, Blumberg DM, Al-Aswad L, Cioffi GA, Girkin CA, Medeiros FA, Weinreb RN, Zangwill L, Liebmann JM; JAMA ophthalmology 2017; 135: 617-623

In the study by de Moraes and colleagues, larger parapapillary beta zone at baseline (but not the enlargement of beta zone during the study period) was correlated with faster progression of glaucomatous perimetric defects.[1] This process was more evident for patients of European descent than for patients of African descent. In a parallel manner, in a group of individuals with ocular hypertension, larger beta zone at baseline (but not the enlargement of beta zone during the study period) was associated with faster development of perimetric defects, without marked inter-ethnic differences. The findings show the importance of parapapillary beta zone as parameter (of second ranking order) for the diagnosis of glaucomatous optic neuropathy. It confirms previous hospital-based and population-based, cross-sectional and longitudinal, studies and adds to the current knowledge the information about potential inter-ethnic differences in the association between beta zone and glaucoma progression.

> The findings show the importance of parapapillary beta zone as parameter (of second ranking order) for the diagnosis of glaucomatous optic neuropathy

As any well conducted study, the investigation by de Moraes *et al.* has some limitations. The European descent group and the African descent group differed in some parameters at baseline. Beta zone at baseline was larger in the African descent group than in the European descent group, corresponding to the (statistically?) larger perimetric defect in the African descent group (-3.29 ± 5.2dB versus -2.25 ± 3.7 dB). It is in agreement with previous cross-sectional studies reporting on a correlation between larger size of beta zone and more marked glaucomatous optic nerve damage. The question arises whether the inter-ethnic difference in beta zone (and perimetric defect) at baseline might have influenced the inter-ethnic difference in the association of baseline beta zone and glaucoma progression. Also, both ethnic groups likely differed

in disc size since the optic disc is larger (and central corneal is thinner) in African descendants than in European descendants.[2] It leads to the question whether the detection of beta zone at baseline and the detection of beta enlargement in the follow-up might have been influenced by differences in disc size between both ethnic groups. Another limitation of the study was the assessment of beta zone on optic disc photographs instead on optical coherence tomographic (OCT) images. Since the background pigmentation of the fundus may influence the ophthalmoscopical delineation of beta zone from alpha zone, the inter-ethnic difference in the fundus background pigmentation might have influenced the assessment of differences in beta zone between both ethnic groups. This potential bias could have been avoided by using OCT images. More importantly, as also pointed out by the authors, OCT images would have allowed the differentiation between a newly defined beta zone characterized by parapapillary Bruch's membrane denuded of retinal pigment epithelium, and a gamma zone without Bruch's membrane.[4] Although both zones, the newly defined beta zone and gamma zone, share similarities in their ophthalmoscopical appearance with a visible sclera and visible choroidal vessels, the difference between both zones is that in the newly defined beta zone, Haller's layer and Sattler's layer of the choroid are still more or less present and the choriocapillaris is occluded. In gamma zone however, in association with the lack of Bruch's membrane, the major elements of the choroid are absent, except for some large feeder vessels. Recent studies have suggested that the newly defined beta zone was associated mainly with glaucoma and not, or only to a minor degree, with axial myopic elongation.[2] In contrast, gamma zone was correlated mainly with axial elongation and not, or only to a minor degree, with glaucomatous optic neuropathy. Differentiating the old beta zone into the newly defined beta zone and gamma zone could therefore have increased the specificity of measured beta zone for glaucoma and could have augmented the diagnostic precision of the measured beta zone for the diagnosis of glaucoma.

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Morphology and Function in Myopic Eyes with Glaucoma


Comment by Claudio Perez and Shan Lin, San Francisco, CA, USA

73167 Multiple Temporal Lamina Cribrosa Defects in Myopic Eyes with Glaucoma and Their Association with Visual Field Defects; Sawada Y, Araie M, Ishikawa M, Yoshitomi T; Ophthalmology 2017

The relation between myopia and primary open angle glaucoma (POAG) has been shown in many studies; nevertheless, it is often difficult to differentiate between early stage glaucoma and non-glaucomatous anatomy of the myopic optic disc, and it is also challenging to define progression of glaucomatous changes in myopic eyes.[1] Therefore, new diagnostic tools for detecting glaucoma in the myopic population is an important issue. Using the enhanced depth imaging feature of spectral-domain optical coherence tomography (SD-OCT), the cross-sectional study by Sawada *et al.* compared the number and location of large pores (diameter 60-100 mm) and lamina cribosa (LC) defects (diameter ³ 100 mm) between eyes with and without open angle glaucoma in a myopic population. They described the novel finding of **multiple LC defects at the temporal periphery in myopic eyes with normal tension glaucoma (NTG) and POAG, and showed their association with glaucomatous visual field (VF) loss in both severity and location.** The number of temporal LC defects and tilt angle of the optic disc were associated with the presence of paracentral scotomas, whereas the number of inferior and superior LC defects and torsion direction of the optic disc were associated with the presence of superior and inferior VF defects. Myopic eyes without glaucoma exhibited multiple large pores at the temporal periphery of the LC; and the authors suggested that large pores in myopic eyes with more tilted disc may evolve into LC defects, proposing this finding as a unique mechanism that causes VF defects in myopic eyes with glaucoma. This theory may be plausible, because previous studies have shown that LC localized structural changes in glaucoma have been manifested early in the disease process.[2] Nevertheless, it is important to note that these interesting findings are in the context of a cross-sectional study. Therefore, it is still inconclusive about whether these LC defects may contribute as risk factors to glaucomatous defects or are the result of glaucomatous damage in myopic eyes.

The authors suggested that large pores in myopic eyes with more tilted disc may evolve into LC defects, proposing this finding as a unique mechanism that causes VF defects in myopic eyes with glaucoma

It should be noted that this study was done in a population of Japanese patients, where NTG is a much more frequent disease.[3] That aspect may explain the mean untreated IOP of 19.7 mmHg in the glaucoma group and the higher prevalence of paracentral scotoma defects in that glaucoma

population (almost 50%). Since the authors used a Humphrey Visual Field 24-2 SITA-standard strategy to detect paracentral scotoma defects, they may have under-diagnosed up to 35% of those types of glaucomatous defects in glaucoma suspects with normal 24-2 VF.[4]

The study by Sawada *et al.* shows a more temporal distribution of LC defects in glaucomatous myopic tilted optic discs in comparison with the more superior and inferior distribution in glaucomatous non-myopic eyes.[5] Many of the *in vivo* LC imaging studies have been conducted in Asian glaucoma populations.[2] Considering the high prevalence of myopia, tilted disc and other anatomic optic nerve head features more prevalent in (and perhaps relatively specific to) this region, the results may not be extrapolated to other ethnicities including those of Caucasian, Hispanic or African descent. For example, it has been published that young Asian myopic patients with tilted disc can present with non-progressive (presumably, non-glaucomatous) stable visual field defects.[6] In the future, it would be interesting to evaluate if a similar group of non-progressive young patients have associated LC defects or not.

In conclusion, the improvements in OCT technology have led to interesting findings in relation to *in vivo* LC imaging within the optic nerve. These findings may help to improve the diagnosis and management of glaucoma. It would be of special interest for future upcoming prospective studies to evaluate if LC defects precede VF or retinal nerve fiber layer defects, and thus a structural risk factor for early glaucoma diagnosis and for detecting glaucoma progression.

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Glaucoma and Systemic Diseases

Vascular Diseases and Glaucoma


Comment by Ingeborg Stalmans and Luis Abegão Pinto

73417 Vascular and metabolic comorbidities in open-angle glaucoma with low- and high-teen intraocular pressure: a cross-sectional study from South Korea; Lee SH, Kim GA, Lee W, Bae HW, Seong GJ, Kim CY; Acta Ophthalmologica 2017

Understanding why glaucoma develops in patients with otherwise normal intraocular pressure (IOP) has been the focus of research for decades now. While vascular-related variables have long been associated with disease, data from epidemiological studies has been scarce in providing evidence for this relationship (and hopefully determining how those parameters affect the disease).

Lee *et al.* have presented a cross-sectional study of subjects from a Korean National Health Survey (2008–2012). Patients had undergone a detailed ophthalmological examination, including fundus picture, two IOP measurements and a Frequency Doubling Technology (FDT), from which a Glaucoma diagnosis was retrieved. In addition to demographic parameters, systemic parameters such as blood pressure, diabetes mellitus and cholesterol levels as well as vascular-related symptoms such as migraine or Raynaud were registered. With over 14.000 subjects included, one interesting feature of the study was the stratification of glaucoma patients by IOP (between high teens and low teens). Their multivariate analysis suggested that unlike their higher IOP counterparts, **glaucoma patients with IOP < 15mmHg were positively associated with arterial hypertension, hyperlipidemia, ischemic heart conditions and stroke.** Interestingly, this study could not determine whether DM was in fact related to glaucoma or not, possibly as a number of confounding factors exist in understanding the complex relation between diabetic induced vascular problems and this neurodegenerative disease. In spite of some limitations inherent to these type of cross sectional studies, this paper provides further support the concept of an underlying vascular phenotype in these patients who develop glaucoma despite an apparent low IOP status.

Surgical Treatment

Selective Laser trabeculoplasty


Comment by Cindy Hutnik and James J. Armstrong, London, ON, Canada

73329 Selective laser trabeculoplasty as replacement therapy in medically controlled glaucoma patients; De Keyser M, De Belder M, De Belder J, De Groot V; Acta Ophthalmologica 2017

The use of topical anti-glaucoma medications can cause a major deterioration in patient quality of life.[1,2] Therefore, compliance with medical therapy has become an important issue and an increasing impediment to long-term vision health.[3,4] De Keyser *et al.* hypothesized that selective laser trabeculoplasty (SLT) could be used to replace established, and otherwise effective topical medical therapy in patients with primary open angle glaucoma (POAG) or ocular hypertension (OHT).

This prospective randomized non-blinded interventional trial included 208 eyes with POAG and 36 eyes with OHT. Patients were on a mean of 1.5 medications at baseline and there was no medication washout period. Significantly more patients in the SLT group were on prostaglandin analogues and/or alpha-mimetics. However, mean number of medications per patient was not significantly different and several studies have shown that the class of pre-laser glaucoma medications has no effect on SLT outcome.[5,6] Therefore, the importance of this potential confounding influence is questionable.

SLT was performed using a Q-switched Nd:YAG laser with 532nm wavelength over 360 degrees. Full ophthalmological examination was performed at baseline, 1hr, 1 week and 1, 3, 6, 12 and 18 months post-op. After SLT, glaucoma medications were continued until IOP was more than 2 mmHg below the patient's target pressure, at which point medications were stopped one by one. Complete success was the total discontinuation of all medications, partial success was defined as a reduction in number of medications from baseline while maintaining target pressure. IOP control and medication use were compared to a control group that did not receive SLT and continued their pre-existing medical therapy normally.

Patients were able to discontinue a mean of 1.15 and 1.21 medications 12 and 18 months after SLT, respectively. Of 143 patients on a mean of 1.5 medications, 77% were able to totally discontinue medical therapy after SLT. By 18 months, 74% of patients were able to discontinue medical treatment. These findings, which support the work of others,[7] further strengthen the role SLT in the treatment paradigm as a means to reduce patient medication burden without compromising IOP. This, in turn, may translate into greater success in managing glaucoma over the long-term.

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News flashes

- ★ Balance was worse in glaucoma patients with greater VF damage
- ★ No association between RGC+IPL thickness and VRQoL
- ★ Evidence of CoQ10/TPGS as a neuroprotective treatment and emphasizes a great potential of the “Detection of apoptosing retinal cells”
- ★ The intimate relationship between the astrocyte and axon is clearly going to be one of the keys to fully understanding and treating
- ★ Fixation losses did not influence MD values to any appreciable extent, but false positives elevated MD, and increasing amounts of false negatives and test time decreased MD values
- ★ Large pores in myopic eyes with more tilted disc may evolve into LC defects

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