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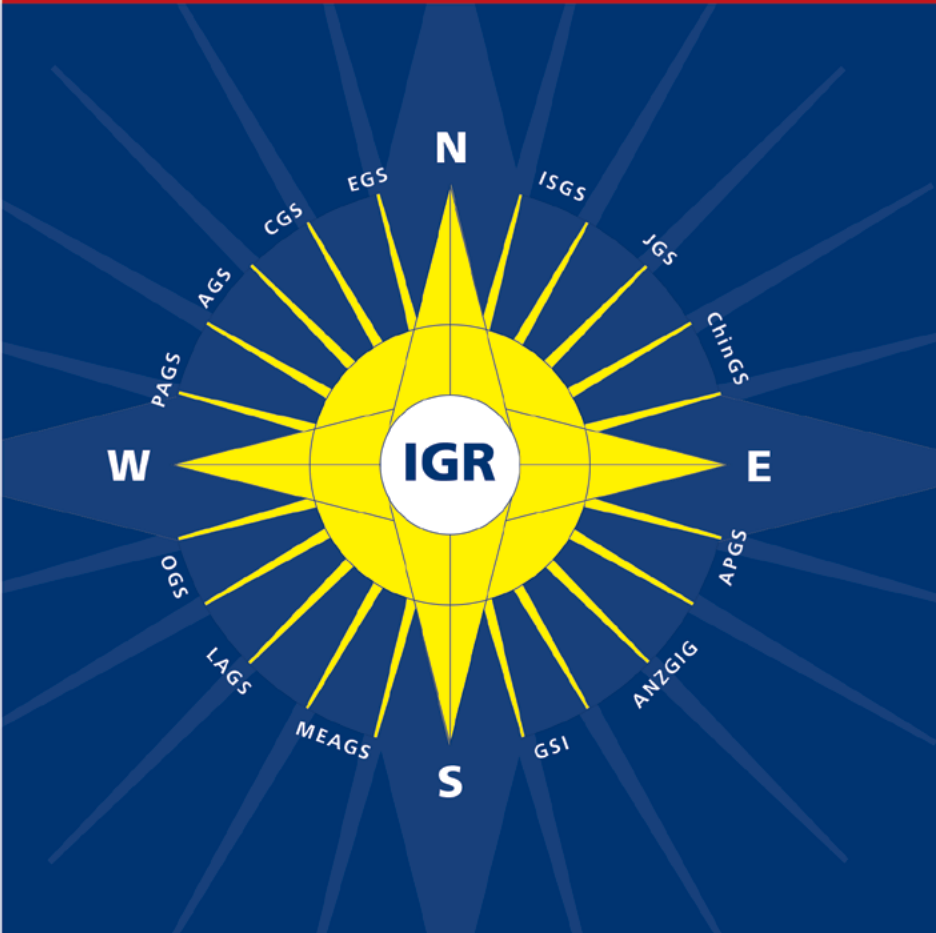
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From the WGA Executive Office

Dear IGR readers,

The World Glaucoma Association continues to expand our activities for the benefit of our members and our patients. The ICO-World Glaucoma Association Fellowship Program will expand the number of glaucoma fellowships from Sub-Saharan Africa to 10 for 2021, under the leadership of WGA Officer of External Affairs Dr. Neeru Gupta. In addition, the Global Outreach Committee, which is now under the leadership of Dr. Vijaya Lingham, is establishing observer fellowship programs in South Asia for selected fellows to train at sites in India and Nepal.

We are very proud to announce that the World Glaucoma Patient Association has officially joined the WGA and is now called the World Glaucoma Patient Committee. With Drs. Ivan Goldberg, Robert Ritch, and Ki Ho Park as the co-chairs, the WGPC will promote glaucoma awareness through activities including World Glaucoma Week, liaising with regional glaucoma patient associations/groups around the world, digital/social campaigns, and development of patient materials and symposia including the one held at the World Glaucoma Congress. The patient symposium at WGC-2019 in Melbourne was a very successful meeting with over 300 attendees from around the globe, and featured several prominent WGA members as speakers as well as a glaucoma patient who described how she copes with the disease.

The Program Planning Committee for WGC-2021 in Kyoto is co-chaired by Drs. Tina Wong and Arthur Sit. The PPC co-chairs have already kickstarted their planning with a teleconference reviewing the member feedback about the latest WGC (Melbourne) and using that information for the planning phase of WGC-2021.

Our Education Committee, chaired by Dr. Fabian Lerner, now has launched the Spanish version of the Glaucoma Patient education module, translated by Dr. Irene Copati. Feel free to direct your patients to this website (www.glaucomapatient.org) for patient education materials.





Get to know us!

Since February 2018 **Marije de Graaf** has been involved with the WGA as Operations Manager, working closely together with Irene Koomans, the WGA Executive General Manager.

The past one and a half years have been filled with learning moments about the WGA and our operations, our core purpose, values and goals, as well as the World Glaucoma Congress. As Operations Manager to the WGA, Marije is making sure all operational and administrative tasks related to the daily practices of the WGA run smoothly.

Marije is looking forward to optimizing our operations, and assisting in the elimination of glaucoma-related disability worldwide together with all our stakeholders.



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The effect of anti-vascular endothelial growth factor agents on intraocular pressure and glaucoma: A report by the American Academy of Ophthalmology

Hoguet A, Chen PP, Junk AK, Mruthyunjaya P, Nouri-Mahdavi K, Radhakrishnan S, Takusagawa HL, Chen TC

Ophthalmology 2019; 126: 611-622

abstract no. [79381](#)

The impact of disc hemorrhage studies on our understanding of glaucoma: A systematic review 50 years after the rediscovery of disc hemorrhage

Yamamoto T

Japanese Journal of Ophthalmology 2019; 63: 7-25

abstract no. [79392](#)

Stemming retinal regeneration with pluripotent stem cells

Jin ZB, Gao ML, Deng WL, Wu KC, Sugita S, Mandai M, Takahashi M

Progress in Retinal and Eye Research 2019; 69: 38-56

abstract no. [79469](#)

Conjunctival goblet cells, the overlooked cells in glaucoma treatment

Tiedemann D, Mouhammad ZA, Utheim TP, Dartt DA, Heegaard S, Petrovski G, Kolko M

Journal of Glaucoma 2019; 28: 325-333

abstract no. [79583](#)

Potential retinal biomarkers for dementia: What is new?

Cheung CY, Chan VTT, Mok VC, Chen C, Wong TY

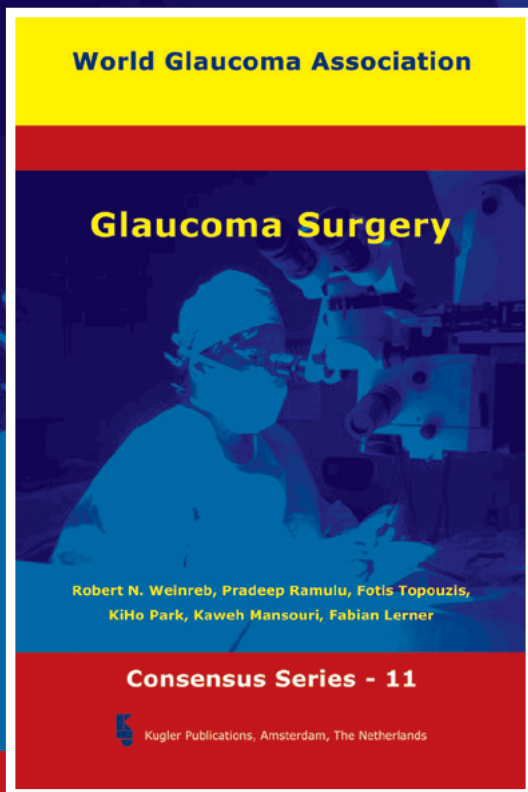
Current Opinion in Neurology 2019; 32: 82-91

abstract no. [79694](#)

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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

Basic Science

Glaucoma Pathophysiology



Comment by **Toru Nakazawa**, Sendai, Japan

79859 Differential effects of N-acetylcysteine on retinal degeneration in two mouse models of normal tension glaucoma; Sano H, Namekata K, Kimura A, Shitara H, Guo X, Harada C, Mitamura Y, Harada T; *Cell Death and Disease* 2019; 10: 75

The pathophysiology of glaucoma-induced retinal ganglion cell (RGC) death remains unclear. However, the suppression of oxidative stress may be an effective therapeutic strategy for the prevention of visual field loss.¹ N-acetylcysteine (NAC) is clinically used to treat paracetamol overdose and is relatively safe and well tolerated, with occasional mild side effects. NAC is cell permeable, serves as a precursor of cysteine and stimulates the synthesis of glutathione in neural cells.

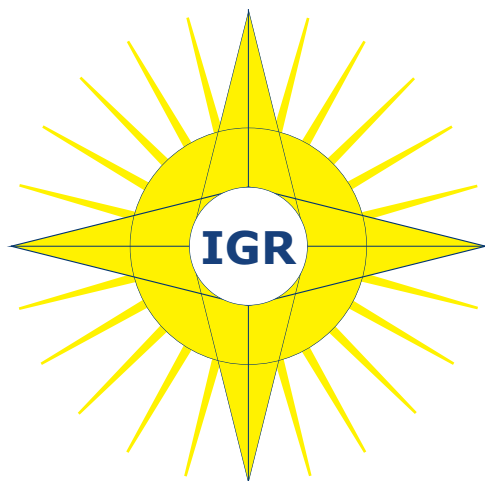
In this study, Sano *et al.* investigated the neuroprotective effect of the intraperitoneal administration of NAC (200 mg/kg, similar to the clinical dose) in two mouse models of normal-tension glaucoma. The authors previously developed these mouse models,² in which one of two genes was deleted: excitatory amino-acid carrier 1 (EAAC1, localized in the RGCs) or glutamate/aspartate transporter (GLAST, localized in the Muller glial cells). Intraperitoneal administration of NAC prevented RGC degeneration and visual impairment

in the EAAC1 knockout (KO) mice, but not in the GLAST KO mice. The treatment mechanism of NAC treatment in the EAAC1 KO mice was demonstrated to include the induction of glutathione in the retina and the suppression of oxidative stress and autophagy.

The plasma level of glutathione decreases in primary open-angle glaucoma, including NTG.³ In addition, mutations in optineurin, an adaptor protein that is involved in autophagy, are associated with glaucoma, suggesting that autophagy plays a role in the pathogenesis of glaucoma.⁴ Thus, these findings raise the intriguing possibility that **systemic administration of NAC may be effective for subtypes of glaucoma that are associated with increased oxidative stress.**

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Neuroprotection



Comment by **Ningli Wang**, Beijing, China

79745 Reduced Cerebrospinal Fluid Inflow to the Optic Nerve in Glaucoma; Mathieu E, Gupta N, Paczka-Giorgi LA, Zhou X, Ahari A, Lani R, Hanna J, Yücel YH; Investigative Ophthalmology and Visual Science 2018; 59: 5876-5884

There is significant evidence suggesting that the trans-lamina cribrosa pressure gradient (TLCPG) contributes to the glaucomatous optic neuropathy in primary open-angle glaucoma.¹ Moreover, many studies have confirmed that the circulation of cerebrospinal fluid (CSF) can be affected by the increase of the TLCPG, such as compartment syndrome², which may play crucial roles in nutrient delivery and clearance of metabolic waste of the optic nerve.

In this study, **Prof. Yücel and colleagues demonstrated that the CSF circulating around the optic nerve is not just in the subarachnoid space, but also enters the optic nerve itself via spaces surrounding blood vessels. Using a mouse model, they also found that CSF entry into the optic nerve is impaired in glaucoma.** What makes this study particularly important is that it is the first to confirm that circulation of CSF around the axons of the optic nerve can be affected due to an increase of the TLCPG.

Circulation of CSF around the axons of the optic nerve can be affected due to an increase of the TLCPG

This research has made a significant contribution in the way we understand TLCPG from the perspective of toxic damage. On the basis of this research, we can speculate that there is an accumulation of toxins in the impaired CSF which may induce optic nerve damage in glaucoma. More importantly, **this study has identified a potential new CSF-related mechanism in the pathogenesis of glaucoma.**

However, further study is still needed to elucidate the relationship between reduced CSF flow in the optic nerve and the accumulation of toxic metabolites in the optic nerve in glaucoma. If validated, it represents an important new target in the treatment of glaucoma.

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Clinical Examination Methods

Home-based Monitoring



Comment by **Andrew Tatham**, Edinburgh, UK

79572 Home-based visual field test for glaucoma screening comparison with Humphrey perimeter; Tsapakis S, Papaconstantinou D, Diagourtas A, Kandarakis S, Droutsas K, Andreanos K, Brouzas D; *Clinical Ophthalmology* 2018; 12: 2597-2606

Visual field testing is central to the diagnosis and monitoring of glaucoma. However, as perimetry is subject to considerable test-retest variability, a large number of tests are often needed to be confident that changes are genuine.¹ Novel technologies designed for use at home may improve access to testing whilst also providing improved statistical power by increasing the number of tests available. Previous authors have investigated the potential of self-tonometry,² home visual field testing³ and even home optical coherence tomography.⁴

In this paper, Tsapakis and colleagues introduce a supra-threshold visual field test and propose its use for home-based glaucoma screening. **The method, which uses a personal computer, involves presentation of stimuli on an LCD screen, with the patient registering a response by clicking a mouse button. Fifty-two test locations across the central 24 degrees were evaluated.** Novel aspects of the test include using a web camera as a photometer to measure room luminosity, the ability to automatically e-mail test results to the clinician, and a function to allow test results to be combined to improve accuracy, although exactly how this is done was not described.

ROC curves were used to evaluate the ability of the new test to classify individual test points as seen or not seen compared to Humphrey perimetry. **Area under the curves (AUCs) ranged from 0.762 to 0.837 depending on the threshold used. The Youden indices, which summarize the ROC curve, so giving a measure of effectiveness, ranged from 0.63 to 0.94 for sensitivity and from 0.73 to 0.49 for specificity.** The screening test was easy to use, quick, and did not require specialized equipment. However, **while home visual field testing may have an important role to play in future glaucoma care, this pilot study has significant limitations.** Only 10 patients were evaluated, and their clinical characteristics were not described. The study was also limited by lack of a control group and lack of clarity as to whether patients were able to operate the test without supervision. There is limited explanation of what training was provided and it is not clear whether testing was performed in patients' homes or in the clinic setting. Also, the test requires the patient to find the optimal distance of their eyes from the screen, by locating their own blind spot,

which many are likely to find difficult. There are also concerns regarding calibration of the LCD computer screen used to display stimuli, particularly given the variable quality of monitors and the proposal that patients use their own personal computer equipment.

To summarize, although home-based visual field testing is an attractive prospect, larger studies involving participants with a range of disease severities and including evaluation of ease of use, are needed before home-testing can be recommended for widespread practice.

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Rim Loss Quantification by Artificial Intelligence



Comment by **Kouroos Nouri-Mahdavi**, Los Angeles, CA, USA

79328 Macula vessel density and thickness in early primary open-angle glaucoma; Hou H, Moghimi S, Zangwill LM, Shoji T, Ghahari E, Pentead RC, Akagi T, Manalastas PIC, Weinreb RN; *American Journal of Ophthalmology* 2019; 199: 120-132

Hou *et al.* compared the performance of central macular OCT thickness measures to those of OCTA (vascular density) for detecting preperimetric glaucoma or early perimetric glaucoma (MD > -6 dB). Whether macular OCTA parameters can identify eyes with early glaucoma more effectively than macular thickness measures remains a controversial topic and data are scant especially in eyes with early glaucoma. In this manuscript, preperimetric glaucoma was defined as eyes with glaucomatous appearing optic nerve, in which the achromatic visual field still remained normal.

The investigators used both absolute measured parameters and percent change from average normal values to fully explore potential differences in performance of the two structural measures. Overall the findings confirm some of prior published research that

OCTA measures do not necessarily perform better for detection of early glaucoma. One interesting finding was that in very early glaucoma, *i.e.*, in the preperimetric stage, a reduction in both OCT thickness and vascular density was observed in the central macula; however, thickness measurements continued to evolve and further thin out as glaucoma advanced whereas the reduction in vascular density slowed down as glaucoma progressed.

It is promising that the structure-structure correlations were reasonably strong in the early perimetric group ($R^2 = 31\text{-}32\%$). In the only example shown for a preperimetric glaucoma, the areas of decreased vascular density and reduced thickness were not very consistent. It would have been interesting to see how much central functional damage if anything would be observed on the 10-2 VFs. Glaucoma was defined based on disc and 24-2 VFs. As evidence of central loss can be variable in early glaucoma, this was likely a heterogeneous group of patients with variable levels of central damage and this might have led to an underperformance of both macular structural measures.

Overall, **the findings add to the currently available evidence that measuring OCTA derived vascular density is a potentially useful measure for detection of early glaucoma although by itself, it may not be superior to GCC thickness measures.** However, the potential additive value of OCTA measures beyond the GCC parameters is yet to be determined. Also, there is still significant variations in the imaging algorithms and post-acquisition processing of the OCTA images and therefore, the findings may not necessarily be generalizable to other OCTA devices at this point.



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Macular Findings in Early Glaucoma



Comment by **Gustavo de Moraes** and **Bruna Melchior Silva**, New York, NY, USA

79863 A Deep Learning Algorithm to Quantify Neuroretinal Rim Loss From Optic Disc Photographs; Thompson AC, Jammal AA, Medeiros FA; American Journal of Ophthalmology 2019; 201: 9-18

Fundus photography is one of the most common methods to assess the presence of glaucomatous optic neuropathy, although its interpretation by human graders is highly subjective and studies have shown modest reproducibility and interrater reliability.¹ However, the interest in fundus photographs has increased due to recent studies that have demonstrated the ability of deep learning algorithms (DLA) to provide accurate analysis of retinal diseases based on them.² Moreover, fundus photographs are relatively inexpensive and largely available worldwide, which make their use particularly promising for community screening.

In this study, Thompson *et al.* developed a novel DLA that has been trained on using the Bruch's membrane opening minimum rim width (BMO-MRW) from spectral domain (SD) OCT to detect glaucomatous optic neuropathy on fundus photographs and to quantitatively predict the amount of neuroretinal tissue. Studies have suggested that BMO-MRW is an accurate parameter for differentiating glaucomatous from healthy eyes and has good correlation with visual field (VF) loss.³ Moreover, this objective parameter can minimize human mistakes that frequently happen when subjectively assessing the limits of the optic nerve and estimating the amount of neural tissue that exits the globe.

The study included 9,282 pairs of optic disc photographs and SDOCT scans from 927 eyes of 490 subjects, divided into normal, suspect and glaucomatous. In the independent test set, the mean DLA BMO-MRW predictions of global rim area had a strong correlation with the observed values of actual SDOCT BMO-MRW ($r=0.88$, $p<0.001$). They also evaluated the relationship between the predicted values of sectorial BMO-MRW and the corresponding sectorial VF sensitivities according to the Garway-Heath structure-function map, which had similar strength to those observed for the actual SDOCT BMO-MRW measurements. The global BMO-MRW predictions were also significantly associated with VF MD ($r=0.49$, $p<0.01$).

Quantification of neuroretinal damage from fundus photographs ... could potentially reduce the rates of undiagnosed glaucoma worldwide

This is an important study for the objective quantification of neuroretinal damage from fundus photographs, which could potentially reduce the rates of undiagnosed glaucoma worldwide. Moreover, by overcoming issues related with the reproducibility of subjective disc photo evaluation, it could be useful to improve estimates of structural progression based on photos.

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Ocular Hemodynamics



Comment by **Makoto Araie**, Tokyo, Japan

80085 Ocular hemodynamics in acute nonarteritic anterior ischemic optic neuropathy compared with normal tension glaucoma; Kuerten D, Fuest M, Bienert M, Walter P, Plange N; *Journal of Glaucoma* 2019; 28: 334-340

It has been assumed that blood velocity of retrobulbar vessels {ophthalmic artery (OA), posterior ciliary artery (PCA) and central retinal artery (CRA)} and resistance indexes (RI), a parameter indicating down-stream resistance of the questioned vessel, could be estimated *in vivo* using color Doppler imaging (CDI). However, a formula for calculating RI which has more clinical implications in evaluating peripheral circulatory conditions was rheologically over-simplified and could be affected by factors other than mere peripheral vascular resistance. In spite of these limitations, previous prospective or retrospective longitudinal studies reported that **higher RI values in the OA and/or PCA or slower blood velocity in the OA, CRA and/or PCA were associated with progression of primary open-angle glaucoma (POAG).**

PCA hemodynamics of NTG eyes were already similarly affected as in the NAION eyes

The results of the authors' study to characterize retrobulbar hemodynamics in eyes shortly after the onset of non-arteritic anterior ischemic optic neuropathy (NAION) in comparison with that of chronic POAG with normal pressure (normal-tension glaucoma, NTG) are of clinical interest. In spite of a clear inter-group difference in the frequency of cardiovascular risk factors and time period the onset, **no significant difference was seen in the PCA CDI parameters between the NAION and NTG group.** The authors' second explanation for this rather unexpected finding that PCA hemodynamics of NTG eyes were already similarly affected as in the NAION eyes seems more reasonable than other explanations provided. On the other hand, significantly worse CDI parameter values, i.e., higher OA RI and slower CRA blood velocities in the NAION eyes than in the NTG eyes, are rather easier to understand. The NAION eyes had much worse overall visual field damage and had a significantly higher systemic blood pressure which is well known to be associated with a smaller central retinal arteriole equivalent (CRAE) value, i.e., more constricted retinal arteries. These factors would result in worse CRA CDI parameters and thus OA (= CRA+PCA) CDI parameter. Because of a large user dependency of CDI measurements and lack of an age-matched normal control group, however, it would be difficult to draw any conclusions regarding CRA or OA CDI parameter values in NTG eyes. The authors' result showed that in eyes with NAION shortly after the onset, central retinal arterial hemodynamics were thought to be significantly disturbed in spite of the supposed pathogenesis of NAION that disturbance of PCA perfusion was mainly responsible for its onset.

Forms of Glaucoma

Health Economics of Exfoliation Glaucoma



Comment by **Tony Realini**, Morgantown, WV, USA

80016 A Comparison of resource use and costs of caring for patients with exfoliation syndrome glaucoma versus primary open-angle glaucoma; Rath S, Andrews C, Greenfield DS, Stein JD; American Journal of Ophthalmology 2019; 200: 100-109

Rathi and colleagues have conducted a retrospective study evaluating resource utilization and costs of therapy in eyes with primary open-angle glaucoma (POAG) and exfoliation glaucoma (XFG). Drawing from a data set including a 20% representative sample of Medicare beneficiaries between 2008-2014, they estimated the total two-year costs of care as well as rates of specific services (office visits, surgery, etc.) performed in both existing (prevalent) and new (incident) cases. Costs to care for patients with XFG were significantly greater than for POAG, as were the frequency of office visits, cataract surgery, and glaucoma surgery; this was true in both incident and prevalent cases. These findings are not surprising – it is generally accepted that XFG is a more aggressive form of glaucoma than POAG and would thus require more aggressive (*i.e.*, more expensive) care. The significance of this study, however, transcends its specific findings. As the authors point out, the US healthcare system is ripe for a revamp of its reimbursement model, and one possible replacement for the current fee-for-service model is a bundled payment approach in which the reimbursement for care will be a standard annual amount based on diagnosis and severity. Rathi and colleagues rightly point out that the devil is in the details: what constitutes a diagnosis? Their broader point is that a bundled payment approach will only be viable if diagnosis has the appropriate level of granularity.

There were significant differences in costs of care between specific forms of glaucoma (POAG vs PXF)

A diagnosis of 'glaucoma' may be inadequate to estimate annual care costs with the necessary precision for such a system to work; in this case, there were significant differences in costs of care between specific forms of glaucoma (POAG vs PXF). It follows that costs may vary with other forms of glaucoma as well, including pigmentary glaucoma, steroid-induced glaucoma, traumatic glaucoma, etc. Rathi and colleagues are to be congratulated for making this broader point and beginning the process of clarifying realistic care costs for the various forms of glaucoma in advance of any potential reimbursement policy changes.

Glaucoma and Epiretinal Membranes



Comment by **Min Hee Suh**, Busan, South Korea

79817 Cross-sectional imaging analysis of epiretinal membrane involvement in unilateral open-angle glaucoma severity; Sakimoto S, Okazaki T, Usui S, Ishibashi T, Oura Y, Nishida K, Miki A, Kawasaki R, Matsushita K, Sakaguchi H, Nishida K; Investigative Ophthalmology and Visual Science 2018; 59: 5745-5751

Epiretinal membrane (ERM) is a fibrocellular tissue proliferation on the inner limiting membrane (ILM) leading to various changes in the retinal architecture. **In this study, Sakimoto *et al.* reported that ERM can be a potential risk factor for unilateral severity in eyes with POAG. The proposed mechanism is mechanical stress and vascular insult to the inner retina induced by the ERM leading to thinning of the retinal nerve fiber layer (RNFL) and subsequent glaucomatous damage.**

While this is an interesting theory, it needs to be confirmed by longitudinal studies investigating the temporal relationship between the ERM and RNFL change. In a recent study,¹ RNFL was found to be thickened after the development of ERM. However, it is possible that although RNFL was thickened right after the development of an ERM, and persistent mechanical and vascular insult on the inner retinae results in eventual thinning of the RNFL.^{2,3} Whether or not persistent traction from an ERM accelerates glaucomatous damage of retinal ganglion cell axons remains to be elucidated. As well, it may be helpful to assess the changes in the superficial retinal layer microvasculature in glaucomatous eyes with ERM by using optical coherence tomography angiography (OCT-A).

Nevertheless, the results of this study represent a good start in understanding the influence of ERM on the glaucomatous optic neuropathy. Further prospective longitudinal studies examining the RNFL changes before and after the development of the ERM in glaucoma patients are warranted.

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Progression

Rate of progression Post-surgery



Comment by **Florent Aptel**, Lyon, France

79498 Relationship between the rate of change in lamina cribrosa depth and the rate of retinal nerve fiber layer thinning following glaucoma surgery; Krzyzanowska-Berkowska P, Czajor K, Helemejko I, Iskander DR; PLoS ONE 2018; 13: e0206040

The authors investigated the relationships between the lamina cribrosa depth and lamina cribrosa depth rate of change over time, and the RNFL thickness change over time, during the first years following a filtering surgery in 29 subjects with glaucoma (16 underwent trabeculectomy and 13 deep sclerectomy). RNFL thickness and lamina cribrosa depth were estimated from Spectralis OCT scans of the optic nerve head. The patients were followed 12-29 months after the surgery. A significant IOP decrease was achieved after the surgery (from 24.0 ± 8.9 mmHg preoperatively to 12.7 ± 4.4 mmHg at the last follow-up). **A significant decrease of the lamina cribrosa depth was found (from 465.3 ± 136.4 μ m preoperatively to 342.8 ± 90.3 μ m at the last follow-up).**

They did not find a lot of RNFL thickness change over time. The average RNFL thickness was 59.3 ± 15.8 μ m pre-operatively, 64.9 ± 19.8 μ m at one month, 58.9 ± 19.0 μ m at three months, 56.4 ± 15.6 μ m at six months and 55.0 ± 14.0 μ m at the last follow-up.

The RNFL thickness and lamina cribrosa depth were not significantly correlated at the last follow-up. They did not find a unique relationship between the rate of change in lamina cribrosa depth and the rate of retinal nerve fiber layer thinning during the different periods of the follow-up.

This study confirms the significant and sustained reduction of the lamina cribrosa depth after a filtering surgery

I think that this study confirms the significant and sustained reduction of the lamina cribrosa depth after a filtering surgery. It also confirms the significant increase of the RNFL thickness (swelling?) one month after surgery and a return to the initial value after three to six months.

Regarding the relationship between the lamina cribrosa and RNFL thickness rate of change over time, it is likely that the results are influenced by the study period. During the first months after the surgery the RNFL increases. After three to six months the RNFL gradually decreases. Further studies could evaluate the long-term change of RNFL thickness and

lamina cribosa depth (e.g., over a three to five years period excluding the first six months of follow-up). Also, **this study includes patients that underwent both penetrating and non-penetrating filtering surgeries. The magnitude of the IOP reduction could differ, and thus impact the results.**



Comment by **Steve Mansberger**, Portland, OR, USA

79844 Cataract surgery and rate of visual field progression in primary open-angle glaucoma; Kim JH, Rabiolo A, Morales E, Fatehi N, Lee WS, Yu F, Afifi AA, Nouri-Mahdavi K, Caprioli J; American Journal of Ophthalmology 2019; 201: 19-30

This study compares the rates of visual loss before and after cataract surgery. **While intra-ocular pressure parameters improved, surprisingly, cataract surgery was associated with increasing visual field loss.** Previous papers have quantified the effect of cataract vs. glaucoma on the visual field. Overall, they suggest generalized loss with cataract, focal loss with glaucoma, and unmasking of mild visual field loss with cataract surgery.

The current manuscript uses a previously published pointwise exponential model to determine the independent effect of cataract vs glaucoma on visual field decay. Their model fits the mathematical behavior of individual perimetry test locations and separates into slow components and fast components. The model demonstrates cataract surgery altering the slow component, which indicates that increasing cataract creates slow decay of the visual field. In converse, glaucoma creates fast decay.

This innovative study and analysis of visual field decay is important, and could help clinicians determine whether their patient's cataract or glaucoma is creating their visual complaints. One important caveat is that patients with cataract and glaucoma may have visual dysfunction from both conditions progressing simultaneously, and several previous studies suggest slow and fast rates of glaucoma decay.

Patients with progressive glaucoma may be interested in cataract surgery when compared to traditional glaucoma surgery because it is less invasive and has mild IOP lowering effect. Therefore, this population may be enriched with glaucoma patients with current progression, which are likely to have future glaucomatous progression. Table 3 shows significant slow decay even after cataract surgery. Is this related to posterior capsular opacification or another reason? Finally, **if the hypothesis is that cataract surgery slows the apparent rate of glaucomatous visual field decay, the study should consider controlling for factors known to be associated with visual field progression to determine whether cataract surgery is still significant such as preoperative IOP, age, previous disc**

hemorrhage, and baseline mean deviation of the visual field (MD). In summary, this innovative study helps distinguish between different mechanisms of visual field loss and that cataract surgery may not be protective against glaucomatous progression.

Progression Factors in NTG



Comment by **Louis Pasquale**, New York, NY, USA

80071 Factors associated with progression of Japanese open-angle glaucoma with lower normal intraocular pressure; Sakata R, Yoshitomi T, Iwase A, Matsumoto C, Higashide T, Shirakashi M, Aihara M, Sugiyama K, Araie M; Ophthalmology 2018

Sakata *et al* should be congratulated for providing a five-year perspective on the natural history of untreated open-angle glaucoma with average intraocular pressure (IOP) of 12 mmHg in 76 eyes of 76 patients. This IOP level should not be associated with considerable trabecular meshwork dysfunction. Interestingly, in follow-up the mean IOP in these patients did not increase; nor were there IOP differences between subjects who did and did not progress.

Lower baseline IOP in open angle glaucoma produces comparable progression rates to other untreated normal tension glaucoma patients with baseline IOP that was 4-5 mm Hg higher

In their work, Sakata *et al.* employ carefully crafted structural and functional definitions of disease progression. Among the participants with baseline age of 53 years, there was considerable cupping (mean vertical cup-disc ratio (CDR) = 0.85), although the average mean deviation was 2.8 decibels. Patients with hard-to-read myopic or dysmorphic discs were not included in the study. Importantly, they find that the rate of progression was 66% at five years. The authors estimate that the average slope of progression on visual field was -0.33 decibels/year. Assuming no other intercurrent disease and a continued linear progression rate, most of these subjects would have advanced functional loss (MD worse than -12 decibels) and some would be visually disabled after three decades. **The authors find IOP fluctuation, baseline CDR, and history of disc hemorrhage as potential risk factors for progression based on multivariable analysis.**

The study was small and did not include patients with diabetes and hypertension. Systemic blood pressure was not considered as a possible risk factor for disease progression. Only two of 90 patients reported a history of migraines and no patient reported Raynaud's

phenomenon. **This work underscores that a lower baseline IOP in open angle glaucoma produces comparable progression rates to other untreated normal tension glaucoma patients with baseline IOP that was 4-5 mm Hg higher^{1,2}** and that disc hemorrhage remains an important biomarker for glaucomatous progression.

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24-hour IOP monitoring and Progression



Comment by **Tanuj Dada**, New Delhi, India

77177 Association between 24-hour intraocular pressure monitored with contact lens sensor and visual field progression in older adults with glaucoma; De Moraes CG, Mansouri K, Liebmann JM, Ritch R; *JAMA ophthalmology* 2018; 136: 779-785

This is an important publication by Carlos Gustavo De Moraes *et al.* which suggests an association between functional (visual field-VF) progression and changes in the curvature of the corneoscleral junction as measured by the 24-hour contact lens sensor (CLS) based on retrospective visual field data analysis. **The authors suggest that a single CLS session can help in risk stratification of glaucoma patients.** Although a number of CLS variables had an association with fast VF progression and the mean peak ratio while awake was the best variable and for every 10-U increase in this ratio, the mean rate of MD change was 0.02 dB/y faster on average. There are some important issues that need to be highlighted regarding this technology and its clinical utility as a diagnostic tool.

1. There is no doubt that a 24-hour monitoring of IOP is ideal and a dream for most glaucoma specialists. The CLS addresses this option remotely by measuring physical changes in ocular dimensions that **may** correlate well with IOP, although a few studies have shown a poor correlation. The CLS generates electric signals based on volumetric changes and these in turn depend on the biomechanical properties of the eye such as the scleral stiffness. Therefore we are actually measuring how ocular tissues respond to mechanical pressure based on their biomechanical properties and this is a very different and complex

issue which requires further understanding before we incorporate it in risk stratification of glaucoma patients. **The reader should thus be clear that the CLS is by no means a 24-hour IOP sensor.**

2. The next important question is: does this study impact our current decision-making capability when treating glaucoma patients? The answer is a big NO. Although the study has reported a CLS-VF association, it does not have predictive capability and getting a high CLS value across any parameter does not indicate that the patient will be a future fast progressor. This will require a prospective visual field analysis for progression.

The next important question is: does this study impact our current decision-making capability when treating glaucoma patients?

3. Let us assume that the study was prospectively done and CLS variables were predictive of fast progression on a single day. **We know that diurnal IOP curves vary from day to day and therefore an association between the two on a single day may not be there on the next day.** Furthermore, our decisions on escalating medical therapy or performing surgery are now based on robust OCT structural parameters in early glaucoma and visual field parameters at an advanced stage. Would we be willing to modify treatment decisions based on CLS variables? (e.g., high CLS variable values in eyes with no structural/functional progression on follow-up).

4. On a more philosophical note, I prefer simplicity. To introduce a new technology to the armamentarium of glaucoma investigations will complicate matters for both the physician and the patient with 'RED' disease (false positive) scenarios, risk of un-necessary therapy and additional expenditure. In the current scenario, we have new and expensive technologies looking for indications to best fit in, when actually they may not be required at all.

5. Finally, I commend the authors on highlighting this new association and **encourage future prospective studies on this topic looking at CLS variables in treatment naive eyes, incorporating corneal hysteresis and scleral rigidity parameters and prospective evaluation of both structural (OCT-RNFL, GCC) and functional (visual field - VFI) parameters for progression.**



Comment by **John Liu**, La Jolla, CA, USA

77177 Association between 24-hour intraocular pressure monitored with contact lens sensor and visual field progression in older adults with glaucoma; De Moraes CG, Mansouri K, Liebmann JM, Ritch R; JAMA ophthalmology 2018; 136: 779-785

Development of contact lens based 24-hour intraocular pressure (IOP) monitoring device (Triggerfish: Sensimed AG) may provide a new tool to evaluate glaucoma risk factors. This contact lens sensor does not measure IOP itself, but the sensor collects electronic output signals associated with tissue volumetric changes in the corneoscleral region. Therefore, data are related to IOP change as well as tissue biomechanical properties reflecting how they are altered by the IOP change. The present multicenter, retrospective cohort study using a relatively large sample of 445 treated open-angle glaucoma patients aimed to isolate principal components of 24-hour IOP-related pattern correlated with the rate of visual field progression within a time frame of about five years. Results indicated, in addition to the mean peak ratio (related to the output signal height and time to reach the height) during the wake period, a few components during the sleep period (number of long peaks, variation of bursts ocular pulse frequency, and variation of bursts ocular pulse amplitude) were also correlated.

Most critically, **the newly identified sensor signal variables from a single 24-hour time period showed overall a better statistical correlation with the rate of glaucoma progression than the current clinical standard, the mean of multiple office-hour Goldmann IOP readings taken over years.** It should be noted that both the newly discovered principal components from the contact lens sensor output signals and the traditional Goldmann IOP readings can only explain 20-30% of the visual field progression in statistical terms as articulated by the authors. Confirmed in the present study, an important advantage of using the contact lens sensor to study glaucoma progression is the short period time of 24 hours. Clinical research involving a single or multiple 24-hour time period are likely easier to manage than a clinical research involving several years' data collection. For this reason, major confounding factors discussed by the authors in the article can be evaluated by repeated contact lens sensor recordings; for example the confounding factors related to IOP-lowering treatments during the follow-up years. Applying similar statistical analyses in a study that collects contact lens sensor output signals from a group of patients prior to and after IOP-lowering glaucoma medications may identify those components related to tissue biomechanical properties independent from the reduction of IOP. Components associated with a specific IOP-lowering medication in the 24-hour signal outputs from the sensor may also be evaluated. These potential studies are straightforward, and the requirement of study time is relatively short compared to the collection of Goldmann IOP

readings over years. It is reasonable to expect from these studies additional independent components in the 24-hour signal pattern generated by the contact lens sensor that are associated with glaucoma progression. **These independent components or a combination of these independent components plus the traditional Goldmann IOP readings may show us more insights for the unexplained 70-80% of disease progression in open-angle glaucoma patients.**

Medical Treatment

Patient Reminders to Increase Treatment Adherence



Comment by **Sally Baxter**, La Jolla, CA, USA

79746 Association of an Electronic Health Record-linked glaucoma medical reminder with patient satisfaction; Varadaraj V, Friedman DS, Boland MV; JAMA ophthalmology 2019; 137(3): 240-245

Glaucoma medication adherence remains an ongoing challenge. Here, the authors used the electronic health record (EHR) patient portal to send patients dosing reminders for glaucoma medications. Participants underwent a baseline assessment of their risk of non-adherence (from 0% to 100% using a validated instrument), with high risk defined as $\geq 50\%$. When configuring reminders, they selected the medication(s), mode of reminder delivery (i.e., voice call vs. text), and the timing of reminders. Patient satisfaction with the system and likelihood of ongoing use were measured three months later.

Of 147 patients approached, 100 participated. Most (64%) were men; more than half (51%) were white. **Self-reported adherence exceeded 90% in both participants and non-participants.** Only nine (9%) participants were high risk for nonadherence. **Most (74%) participants found the reminders to be useful**, while 15% were neutral, and 11% found them not useful. About half (47%) of the patients reported they were very likely or likely to continue using these reminders, while 11% were neutral and another 42% said they were unlikely to continue use.

47% of the patients reported they were very likely or likely to continue using these reminders

Overall, this EHR-linked automated reminder system was well-received in the study. However, several issues require further consideration. Firstly, there was no objective measure of whether the patients dispensed the medication when reminded. Possible

strategies to address this include sensors embedded in medication packaging and video recognition technology to verify patient consumption. Secondly, **the participants were majority white males with high baseline adherence**. EHR-linked reminders should also be studied in patients with high risk of non-adherence with greater representation of women and minorities, who carry a disproportionate burden of glaucoma blindness. Thirdly, more extended follow-up would enable observation of the long-term effects on patient behavior. Patients may also develop the 'alert fatigue' that has limited the efficacy of many EHR-based clinical decision support tools designed to influence physician behavior.¹ Finally, while EHRs have become widespread, use of EHR-based patient portals is still not as high as expected.²

This study is an excellent starting point and highlights the need for ongoing work to develop methods for facilitating patient engagement, particularly for high-risk patients, to address this important problem of glaucoma medication adherence.

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Anton Hommer, Tanuj Dada, Pooja Shah, Talvir Sidhu

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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.

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WGA Consensus Series



Robert N. Weinreb

The topic for the eleventh World Glaucoma Association Consensus was glaucoma surgery. Global experts were invited and assembled by our international co-chairs, beginning in September 2018, to participate in an online discussion of glaucoma surgery. Consensus was reached for each of the five sections on key issues relating to indications, performance, monitoring, and reporting of glaucoma surgeries.

The results of these thoughtful discussions then were summarized with preliminary consensus statements for each of the sections. The draft of the Consensus Report, including the preliminary consensus statements, was distributed to the societies and partners for comments prior to the Consensus Meeting, which took place in Melbourne on Tuesday March 26, 2019. At this time, relevant stakeholders engaged in a stimulating, educational, and thought-provoking session that reviewed and revised the consensus statements.

Once again, the collective wisdom of the crowd superseded time and time again the opinion of any single expert. The Consensus Report then was finalized by the Consensus co-chairs, participants, and editor.

Robert N. Weinreb, Consensus Chair





Consensus 11 - Consensus Points

SUMMARY CONSENSUS POINTS

Section 1 - Guidelines for clinical surgical trials and outcome measures

1. The benefits and risks of any new glaucoma surgical procedure should be considered in relation to established and accepted interventions to lower intraocular pressure (IOP).
2. The randomized controlled clinical trial is the most valid approach to evaluate the safety, efficacy, and effectiveness of a new glaucoma procedure.

Comments:

- Good study design reduces the potential for bias, and combined with good reporting increases confidence in the conclusions of trials. Hypotheses and both primary and secondary outcomes (including safety measures and statistical methods) should be determined before initiation of a study to optimize reporting of outcomes.
3. Studies should characterize patients who were study eligible but not enrolled, and state the reasons for not enrolling.
 4. Conflicts of interest, including financial links to a product/company, should be routinely disclosed due to the potential influence on reported outcomes.
 5. Low IOP by itself should not necessarily be considered as a complication or a criterion for failure.

Comments:

- If low IOP is associated with structural changes in the eye and/or worse vision, it should be considered as a complication.
6. Pre- and postoperative washout (off medication) IOP curves are a robust method to define the IOP-lowering effects associated with a procedure, while avoiding confounding effects from medication use.

Comments:

- Medication washouts may not be possible in eyes with moderate to advanced disease.
 - Non-compliance with preoperative medications or addition of ineffective medications prior to surgery may make medication reduction from surgery appear artificially high.
7. Consideration should be given to setting eye-specific IOP goals for operated eyes and reporting success of the procedure in achieving these goals (overall, and in analyses stratified by IOP goal).

Comments:

- The target IOP needs to be defined and articulated prior to initiating the study for each individual.
- IOP goals may be stated as a percentage reduction or a “target pressure.”
- Reporting success for specific IOP thresholds can lead to misclassification of success or failure if the treating physician is not seeking to achieve that IOP threshold with surgery and during the postoperative period.

- Decisions regarding if and when IOP-lowering medications are reintroduced after surgery should be determined by protocol, and not left purely to the discretion of the treating physician.
 - Tables and figures that integrate IOP and medication usage can be used to better describe IOP outcomes (see Fig. 1).
8. Visual field damage, visual acuity loss, and change in quality of life are definitive outcomes in glaucoma surgery. Nevertheless, IOP remains an important endpoint.
Comments:
- Changes in IOP can be readily measured and are particularly useful for judging success in studies of shorter duration.
 - Following patients for visual field changes after surgery is desirable.
9. Utilizing consistent criteria for surgical success and definitions of postoperative complications and reoperations across clinical studies and trials is encouraged, so that outcomes across varied studies can be compared and/or combined.
Comments:
- In addition, scatterplots of preoperative vs postoperative IOP allow comparison among studies.
 - Consideration should be given to make individual patient data available for meta-analyses and systematic reviews.
10. Infrequent complications that severely affect visual acuity may not affect mean visual acuity significantly, but strongly affect doctor and patient perceptions of the surgery.
Comments:
- Average changes in acuity are not always useful in capturing the risks of an operation.
 - Monitoring large numbers of operations for uncommon, catastrophic events is more likely to pick up these complications than clinical trials.
11. Study methods should be explicit with regard to whether presented IOP data include eyes that have been censored, and how IOP data are handled in the event of loss to follow-up, failure for IOP reasons, and reoperations.

Future needs

All clinical research studies of treatment outcomes in glaucoma should collect patient-centered outcome data. More work is required to identify the ideal measures (e.g. patient-reported outcome measures; PROMS) to be used for this purpose. Further work needs to be done to determine if structural measures of the optic disc, macula, and retinal nerve fiber layer are suitable for determining surgical outcomes. More work is required to develop a consensus regarding which complications occurring after glaucoma surgery are minor or severe.

Comments:

- Classification of severity should take into account the typical visual declines occurring in the context of the complication, the risk of the complication to the patient's sight, and the effect of the complication on the patient (*i.e.* their preoperative human function, inconvenience, anxiety, and discomfort).

Section 2 - Techniques

A. Trabeculectomy

1. The prognosis of filtering surgery is related to the preoperative condition of the conjunctiva, cornea, and lid margin.
Comments:
 - The discontinuation of antiglaucomatous drugs to reduce hyperemia and inflammation could improve the preoperative condition of the conjunctiva. One may consider substituting with oral medications to reduce intraocular pressure (IOP) temporarily.
 - The treatment of significant lid margin disease, blepharitis, and ocular surface disease can help improve surgical outcomes.
 - The use of topical steroids in the preoperative period may enhance the condition of the conjunctiva.
2. Similar efficacy of trabeculectomy surgery with respect to bleb failure or IOP control was observed in both fornix-based and limbal-based conjunctival incision.
3. Mitomycin C (MMC) and 5-fluorouracil (5-FU) reduce conjunctival scarring.
Comments:
 - There is inconclusive evidence whether anti-VEGF (vascular endothelial growth factor) drugs also reduce conjunctival scarring.
 - There is inconclusive evidence whether the delivery method (intraoperative sponge vs subconjunctival injection) of antimetabolites affects outcomes.
 - Of the many factors that can affect success rate, the data are inconclusive in regard to dose, exposure times, and treated surface area.
4. Although thickness of the flap might influence outflow resistance, the optimal size and shape has not been determined.
5. Evidence seems to suggest that phacotrabeculectomy is less effective in reducing IOP than trabeculectomy alone in open angle glaucoma.
Comments:
 - Phacoemulsification after trabeculectomy increases the likelihood of bleb failure.
 - In open-angle glaucoma, trabeculectomy in pseudophakic eyes has a higher risk of failure than in phakic eyes. Results after clear corneal cataract surgery may be better than after a conjunctival incision.
 - It is unclear if results are enhanced with a longer time frame between procedures.
6. Postoperative bleb needling with antimetabolites (5-FU or MMC) is an important part of trabeculectomy.
Comments:
 - Antimetabolites (5-FU or MMC) can be applied peri- and postoperatively by subconjunctival injection.
 - Both 5-FU and MMC may induce complications.

B. Nonpenetrating surgery

7. Although deep sclerectomy, viscocanalostomy, and canaloplasty appear to be safer than trabeculectomy, these methods are generally less effective than trabeculectomy.

Comments:

- The use of antimetabolites and space-maintainers enhances surgical results.
- Postoperative YAG-laser goniopuncture is often needed for IOP control.

C. Glaucoma drainage devices (GDD)

8. The Baerveldt implant may be associated with better long-term IOP control than the Ahmed implant, but the latter is associated with fewer serious complications.

Comments:

- Glaucoma drainage tubes may be inserted through a partial-thickness scleral flap or tunnel, or covered with a donor graft patch, in order to prevent tube exposure or tube migration.
- There is no evidence to suggest that a better long-term survival of GDD surgery is dependent on the type of graft material or the use of antimetabolites.
- Nonvalved implants require the creation of mechanisms that will restrict flow to prevent postoperative hypotony. Intraluminal stents and occlusion sutures around the tube are frequently used to avoid this complication.
- The Molteno implant is an alternative GDD.

D. Minimally invasive glaucoma surgery (MIGS)

9. *Trabecular outflow*

Trabecular meshwork/Schlemm's canal microbypass stents (iStent, iStent Inject, Hydrus) are best used for open-angle glaucoma patients with IOP targets in the mid-teens and higher.

Comments:

- Randomized controlled trials (RCTs) show a slightly higher IOP-lowering effect and/or medication reduction of combined phacoemulsification with trabecular meshwork/Schlemm's canal microbypass stents than phacoemulsification alone for up to two years.
- Stand-alone stent procedures have shown IOP lowering and medication reduction.
- An RCT demonstrated a higher IOP-lowering effect of stand-alone Hydrus compared to iStent.

10. Ab interno trabeculotomy (AIT) can achieve average IOPs in the mid to high teens and can be performed in open-angle glaucoma.

11. AIT can be used to reduce both IOP and the need for IOP-lowering medications.

Comments:

- Devices that can be used for AIT include the Trabectome, the Kahook Dual Blade, gonioscopy-assisted transluminal trabeculotomy (GATT), and the Goniotome.
- RCTs are needed to compare outcomes of AIT to other MIGS procedures, trabeculectomy, GDDs, and other surgical procedures.

12. *CyPass*

Because of increased rates of endothelial cell loss, the CyPass was voluntarily withdrawn from the market and further implantation is not advised at present.

Comments:

- Patients who have had a CyPass implanted should be monitored for signs of corneal decompensation.
- If there are clinical signs of corneal decompensation developing, the implant should be considered for trimming flush with the iris root/scleral spur or explanation, with a discussion of the risks and benefits of intervention.

13. *Ab interno subconjunctival outflow*

The XEN gel stent is a procedure that can achieve IOPs in the low to mid teens.

Comments:

- Although off-label, creating an ab interno bleb with a gel stent may benefit from the use of a subconjunctival antimetabolite.
- In cases of excessive subconjunctival fibrosis, needling or open revision may be needed to improve the overall success of the procedure.
- The intraoperative complications of the procedure are low across trials, although severe postoperative complications, such as hypotony maculopathy and endophthalmitis, can occur.
- To date, it is unclear whether failed primary XEN gel stent surgery affects subsequent trabeculectomy outcomes negatively.
- Results of an ongoing RCT comparing the XEN gel stent to trabeculectomy are not yet available.

14. *Ab interno subconjunctival outflow*

Ab externo subconjunctival outflow procedures (Preserflo microshunt) have the potential to achieve IOPs in the low to mid teens.

Comments:

- Results of an ongoing RCT comparing the Preserflo microshunt to trabeculectomy are not yet available.
- Results of ab externo XEN gel stents are not yet available.

15. *General statements for MIGS*

To date, accumulating short-term studies support some MIGS procedures as an alternative in patients with mild to moderate glaucoma.

Comments:

- High quality randomized clinical trial data with long follow-up durations are needed.

16. *General statements for MIGS*

RCT data comparing MIGS procedures to each other and to other treatment modalities, in all stages of disease, are needed.

Comments:

- Cost-effective analysis is needed.

17. *General statements for MIGS*

Data from non-Caucasian populations are also needed.

E. Laser trabeculoplasty

18. Laser trabeculoplasty may be a viable option for achieving additional lowering of IOP and/or delaying the time of surgery in patients on medical therapy or not using medical therapy.
19. Laser trabeculoplasty may be considered as first-line therapy.

Comments:

- In selective laser trabeculoplasty (SLT), the initial power of 0.5-0.7 mJ is titrated upwards till fine bubbles are just seen.
- In primary open-angle glaucoma (POAG) eyes, 360° of angle should be treated in one or two sessions.
- A check of IOP at least one hour following treatment is recommended to detect and treat, if indicated, postoperative IOP spikes.
- Peak IOP lowering typically occurs at least one to two months following the procedure.

F. Cyclodestructive procedures

20. While effective at lowering IOP, these procedures typically have limited use in early disease.

Comments:

- While cycloablative interventions were traditionally used for refractory glaucoma or as a surgery of last resort, these procedures often can be considered for use earlier in the surgical management of glaucoma.
- Endocyclophotocoagulation in combination with lens extraction may help open the angle in patients with plateau iris syndrome, by shrinking the ciliary body and its processes away from the posterior iris and angle structures.
- RCTs are needed to compare cyclodestructive procedures to other surgical techniques.

G. Goniosynechialysis (GSL)

21. Early (e.g. within six months of acute attack of angle closure) GSL in combination with cataract surgery may be effective in eyes with synechial angle closure.

Section 3 - Approach to primary open-angle glaucoma

A. When to consider a surgical approach

1. *Overview of nonsurgical options*

Medical treatment is the most common initial intervention to lower intraocular pressure (IOP) and is effective for the majority of patients with primary open-angle glaucoma (POAG).

2. *Overview of nonsurgical options*

Monotherapy is the initial treatment in most patients. Laser trabeculoplasty can be considered as the initial treatment in POAG patients.

Comments:

- Prostaglandins are currently the most effective topical medications for decreasing IOP.

- With intolerance, poor efficacy, or patient preference, another agent should be substituted.
- If monotherapy is effective but the IOP target is not reached, a second or a third drop from a different class of medications can be added.
- Preservative-free eye drops should be considered in POAG patients with pre-existing ocular surface disease or intolerance to preservatives.

3. *Overview of nonsurgical options*

In the absence of useful vision, the goal of treatment in POAG is to maintain patient comfort with the minimum necessary treatment.

4. *Laser trabeculoplasty*

Laser trabeculoplasty can be considered as an initial treatment for ocular hypertensive and mild to moderate glaucoma (as opposed to medications).

Comments:

- The LiGHT trial showed that in patients with ocular hypertension or mild to moderate glaucoma:
 - Selective laser trabeculoplasty (SLT) can achieve target IOP control without medications in nearly 75% of eyes after three years of follow-up.
 - SLT can achieve target IOP better than topical medications, and reduce the need for further glaucoma surgery.

5. *Overview of IOP-lowering effect of cataract surgery*

Cataract surgery is not recommended as a sole treatment to decrease IOP in POAG when there is evidence or high risk of disease progression.

Comments:

- Cataract surgery in POAG has been shown to provide, for some patients, IOP reduction of 2-4 mmHg for as long as two years.

6A. *The decision to operate*

The decision to operate relies on the evidence of disease progression or high risk of progression.

Comments:

- There is no consensus upon the level of visual field or structural (optic disc, retinal nerve fiber layer, etc.) loss that would necessitate a surgical approach in POAG.
- Baseline testing should be readjusted following a treatment intervention.
- Attention should also be paid to test-location-specific changes, particularly in visual field defects that threaten fixation.
- Surgery should be considered in a patient who already is in an advanced state of glaucoma by the time of presentation.

6B. *The decision to operate*

Consideration for surgery also should be given to patients who are poorly adherent to medical treatment, intolerant of their medications, or unable to access their medications.

7. *The decision to operate*

Standard automated perimetry and progression analysis tools for both structure and function may be less reliable in cases of advanced visual field loss.

8. *Signing up a patient for surgery*
Surgical options in POAG should take into account several factors, including: age; baseline IOP; stage of the disease; rate of progression; lens status and need for cataract surgery; compliance with treatment; success rate of each intervention and expected time to possible failure; as well as availability for postoperative follow-up.
9. *Signing up a patient for surgery*
Once relevant topics regarding surgical intervention have been properly addressed, it is mandatory to obtain consent before any procedure is performed.
Comments:
 - All necessary information needs to be provided in a comprehensive and well-understood language to the patient, who needs to understand well the potential risk and intended benefit of the surgery.

B. Procedure selection for primary surgery in POAG

10. *Severity of disease/IOP goal*
A comprehensive, preoperative assessment should be performed in order to select the most appropriate surgical procedure for each individual patient.
11. *Severity of disease/IOP goal*
In general, incisional surgery or tube shunts are the preferred treatment options for advanced POAG.
Comments:
 - The predictability, safety, and/or long-term IOP lowering of all surgical techniques need to be considered when selecting the procedure.
12. *Severity of disease/IOP goal*
Fast rates of progression and highly elevated preoperative IOP levels may require procedures that are more effective in achieving lower IOP goals, even in early stages of the disease.
13. *Unlikely to take IOP-lowering medicines*
Medication intolerance, unaffordability, nonadherence, and poor access to medical treatment may necessitate surgical intervention.
14. *Cost of procedure*
The affordability of procedures to the patient should be considered when selecting amongst surgical options.
15. *Need for follow-up/likelihood of success on first operation*
Attentive, early, postoperative care is important for enhancing surgical outcomes, particularly for those procedures involving subconjunctival blebs.
16. *Need for follow-up/likelihood of success on first operation*
The selection of the first glaucoma surgical procedure may impact the results of further interventions, if needed.
17. *Speed of recovery/other-eye visual status*
Trabeculectomy remains the reference standard for moderate to severe glaucoma to which other procedures should be compared.
18. *Speed of recovery/other-eye visual status*
Careful preoperative decisions and attentive postoperative care decrease the likelihood of complications.

19. *Ethnicity/race*

There is limited information about the impact of ethnicity/race on the outcomes of different surgical procedures.

Comments:

- Individuals of African descent have more conjunctival scarring when compared to individuals of European descent.

20. *Age extremes*

Trabeculectomy may be less effective in younger POAG patients (i.e. those with juvenile open-angle glaucoma [JOAG]).

Comments:

- Studies evaluating the safety and efficacy of minimally invasive glaucoma surgery (MIGS) procedures in JOAG are sparse.

21. *Lens status*

Lens status has an important part in the decision making process, not just in whether to perform combined surgery, but by impacting the success of the operation.

22. *Other comorbid ocular disease (e.g. dry eye, diabetic retinopathy, scleral buckle, prior pars plana vitrectomy, penetrating keratoplasty/Descemet-stripping endothelial keratoplasty or other corneal surgery, high myopia)*

Tube shunts can be effective in situations where the success rate and safety of trabeculectomy is more limited (e.g. prior intraocular surgery or prior failed trabeculectomy).

23. *Other comorbid ocular disease (e.g. dry eye, diabetic retinopathy, scleral buckle, prior pars plana vitrectomy, penetrating keratoplasty/Descemet-stripping endothelial keratoplasty or other corneal surgery, high myopia)*

Tube shunts are often performed if the eye has extensive conjunctival involvement with a scleral buckle.

Comments:

- If the buckle is placed quite posteriorly, trabeculectomy also may be a reasonable approach.
- Small-gauge vitrectomy may not preclude a trabeculectomy.

24. *Other comorbid ocular disease (e.g. dry eye, diabetic retinopathy, scleral buckle, prior pars plana vitrectomy, penetrating keratoplasty/Descemet-stripping endothelial keratoplasty or other corneal surgery, high myopia)*

Highly myopic individuals are more likely to have hypotony maculopathy after trabeculectomy/shunt and have a higher risk of additional vision loss compared to emmetropes.

25. *Complicating systemic factors*

In consultation with the internist or general medical doctor, the risks and benefits of discontinuing antiplatelet or anticoagulant agents needs to be considered for each patient.

Comments:

- If safe, many surgeons discontinue antiplatelet or anticoagulant therapy.

C. Procedure selection in eyes with prior surgery

26. *Prior cataract surgery*
Glaucoma drainage devices (GDDs), trabeculectomy, and many other less invasive surgeries may be considered as alternative options for surgery in eyes with unscarred conjunctiva after clear corneal phacoemulsification.
27. *Prior cataract surgery*
Well-healed, conjunctival-sparing cataract surgery has limited implications on the success of glaucoma surgery.
28. *Prior glaucoma surgery*
The choice of second glaucoma surgery should be individualized to the patient and is influenced by several factors, including prior surgical procedure, degree of conjunctival scarring, target IOP, corneal endothelial status, and visual potential.
29. *Prior glaucoma surgery*
GDDs are an option in eyes with previous incisional glaucoma surgery.
30. *Conjunctival scarring from past surgery or other causes*
Trabeculectomy is a surgical option in eyes which have previously undergone ophthalmic surgeries not associated with conjunctival scarring and which require a low target IOP.
31. *Conjunctival scarring from past surgery or other causes*
Ophthalmic surgeries associated with conjunctival scarring increase the risk of failure for filtration surgery. GDDs remain an option in most eyes with conjunctival surgery, even when superior conjunctiva is scarred.
32. *History of prior or ongoing complications in same/contralateral eye*
If glaucoma surgery is associated with a sight-threatening complication in one eye, it increases the risk of the same complication occurring in the fellow eye and impacts the prognosis.
Comments:
 - Patients need to be counselled about these situations and alternative surgical procedures may be warranted in such situations.

D. General (non-surgery-specific) postoperative recommendations

33. It remains unclear what steroid regimen (potency, frequency, and duration) is required to optimize glaucoma surgery outcomes.
Comments:
 - Steroid response can also occur after glaucoma surgery.
34. Both mitomycin C (MMC) and 5-fluorouracil (5-FU) can improve IOP lowering in trabeculectomy bleb-related procedures vs placebo, at the cost of an increased rate of complications.
35. The benefit of antiscarring agents in tube surgery remains to be determined.
36. Surgical IOP-lowering procedures have an early critical phase, during which observation by the ophthalmic surgeon is recommended.
37. Many incisional surgical procedures for glaucoma can result in refractive changes.
Comments:
 - Cataract progression is a frequent late complication of filtering surgery, and perhaps other glaucoma surgeries as well. Accordingly, it is important to discuss the risk of cataract development with the patient.

Section 4 - Approach to angle-closure glaucoma

1. *Indications for surgery in angle closure*

As different underlying mechanism(s) may affect the outcome of treatment in angle closure, intraocular pressure (IOP) lowering cannot be predicted on the basis of baseline factors.

2. *Indications for surgery in angle closure*

An anteriorly positioned ciliary body, a thick iris, and a greater degree of closure at baseline are associated with risk of residual angle closure after laser peripheral iridotomy (LPI).

3. *Indications for surgery in angle closure*

Based on data from recent trials, the benefit of prophylactic laser iridotomy over five to six years appears to be small in Chinese patients who are primary angle-closure suspects (PACS).

Comments:

- Whether the same results are repeatable in non-Chinese populations remains to be determined.

4. *Indications for surgery in angle-closure glaucoma*

Decisions about when and how aggressively to intervene in patients with angle-closure glaucoma ought to take into consideration the severity of disease and the rate at which the individual is progressing.

5. *Indications for surgery in angle-closure glaucoma*

The goal for IOP lowering in angle-closure glaucoma is likely similar to that seen in open-angle glaucoma, and therefore initial treatment should aim to lower IOP, depending on patient factors and disease severity.

Lasers

6. *LPI*

Generally, LPI is effective for relieving pupillary block in eyes with primary angle-closure disease.

Comments:

- This includes PACS, primary angle closure (PAC), and primary angle-closure glaucoma (PACG).
- Up to one-third of patients show residual iridotrabecular contact despite a patent LPI and relief of pupil block.

7. *LPI*

Effectiveness of LPI may decrease with increased severity of the disease — in terms of greater degree of peripheral anterior synechiae (PAS), a higher IOP, and a greater cup-to-disc ratio.

Comments:

- Studies showed that most PACS eyes did not need any further intervention after LPI, while many PAC, PACG, and acute PAC eyes required additional treatment to control IOP.
- In eyes with > 180° PAS there is potential for IOP spikes following LPI.

8. *Argon laser peripheral iridoplasty*

Argon laser peripheral iridoplasty (ALPI) can be applied in the conditions involving non-pupillary-block appositional angle closure, such as plateau iris and nanophthalmos.

Comments:

- A Cochrane review did not find sufficient evidence to recommend its use in all cases of PAC and PACG.

9. *ALPI*

ALPI can be an effective procedure to break iridotrabecular contact in an acutely symptomatic angle closure.

Comments:

- Iridoplasty can be used as a first-line treatment or in cases that are refractory to medical treatments.
- However, iridoplasty does not replace iridotomy for the treatment of angle closure.

10. *Laser trabeculoplasty*

Selective laser trabeculoplasty has been shown to produce a mild reduction in IOP in the short term for PAC and PACG where the angle opens up at least 180° after iridotomy. However, its utility in eyes with more than 180° of synechial angle closure is unknown and likely limited.

Comments:

- Argon laser trabeculoplasty has overall poor long-term success rates and is currently not recommended for any form of PAC or PACG.

11. *Laser Cyclophotocoagulation*

There are few studies evaluating specifically transscleral cyclophotocoagulation (TSCPC) and micropulse TSCPC in angle-closure patients.

Incisional surgery12. *Lens extraction*

In patients with co-existing cataract and angle-closure disease, lens extraction surgery is an effective intervention and often associated with a substantial reduction in IOP.

13. *Lens extraction*

Clear lens extraction (CLE) can be considered for the initial management of mild to moderate PACG, as well as PAC with IOP > 30 mmHg, for patients over 50 years of age.

Comments:

- The increase in average angle-width parameters was significantly greater after cataract extraction compared with LPI.
- In the EAGLE trial, CLE resulted in slightly better IOP lowering, reduced medication use and subsequent glaucoma surgery, improved quality of life, and cost effectiveness compared to LPI.
- In non-Chinese/non-European populations these results are uncertain.
- Lens extraction can be more complicated intraoperatively and postoperatively than for routine eyes.

14. *Combined lens surgery and trabeculectomy*

Combined lens surgery and trabeculectomy (phaco-trabeculectomy) should be considered when there are clinical indications for both lens extraction and trabeculectomy in the same eye.

Comments:

- These indications include visually significant cataract and/or the lens is deemed a major contributory cause of angle closure, as well as target IOP not achieved with maximally tolerated glaucoma medications and less invasive interventions and/or the IOP reduction from phacoemulsification alone is deemed not sufficient to achieve the perceived target IOP.
 - Phaco-trabeculectomy lowers IOP more effectively than phacoemulsification alone in treating uncontrolled PACG; however, it may be associated with more surgical complications.
 - Phaco-trabeculectomy may not be warranted in medically controlled PACG due to the increased rate of complications compared to phacoemulsification alone.
 - Phaco-trabeculectomy is associated with fewer subsequent surgeries compared to trabeculectomy in PACG, with similar IOP-lowering effect.
 - There is no significant difference in outcome when performing phaco-trabeculectomy through one or two sites.
15. *Trabeculectomy*
Trabeculectomy alone is not recommended immediately after an acute angle closure (AAC) episode.
16. *Trabeculectomy*
Modifications to the surgical technique of trabeculectomy in PACG have been suggested to avoid complications and improve the outcome.
Comments:
- This includes possibly using one or more of the following: lowering IOP before trabeculectomy by intravenous mannitol; making a more anteriorly placed sclerostomy; avoiding extreme IOP fluctuations during the intraoperative period by maintaining a deep anterior chamber; applying multiple, tight scleral flap sutures, preplacement of sutures before the sclerostomy; conservative suture lysis or removal, as well as the use of cycloplegic therapy.
 - No prospective studies assessing the beneficial effects of the above modifications have been described in the literature.
 - Phacoemulsification alone is often effective and might reduce postoperative complications.
17. *Trabeculectomy*
In medically uncontrolled chronic PACG in phakic eyes, both phacoemulsification and trabeculectomy are effective in reducing IOP.
Comments:
- If there is uncontrolled PACG and advanced damage, phacoemulsification alone may not be sufficient.
18. *Trabeculectomy*
Trabeculectomy is more effective than phacoemulsification in reducing dependence on glaucoma drugs but is associated with more complications, deterioration in visual function, and multiple subsequent surgical interventions.
19. *Trabeculectomy*
Factors associated with failure of trabeculectomy in PACG eyes include absence of LPI, presence of a crystalline lens, and diabetes mellitus. Increased age, limbus-based conjunctival flaps, and mitomycin C (MMC) duration > 1 minute were associated with increased chances of surgical success.

Glaucoma drainage device surgery

20. *Glaucoma drainage device surgery alone*

Glaucoma drainage device (GDD) surgery can be considered in individuals with sufficiently deep anterior chambers who are pseudophakic or phakic. In pseudophakic eyes with a shallow chamber, tube placement can be performed in the ciliary sulcus.

Comments:

- There is a lack of evidence comparing the results of GDD with trabeculectomy.

GDD surgery

21. *Combined lens and GDD surgery*

Combined cataract and GDD surgery should be considered when there are clinical indications for both lens extraction and glaucoma drainage implant surgery in the same eye.

Comments:

- Combined surgery has an additive effect on IOP lowering compared to each surgery alone; however, it may be associated with greater risk of surgical complications.

Goniosynechialysis

22. *Goniosynechialysis alone*

There is minimal evidence for the use of goniosynechialysis (GSL) alone to lower IOP in PACG.

23. *Combined lens and GSL surgery*

Combined lens and GSL surgery can be considered when there are clinical indications to lower the IOP in the presence of more than 180° PAS angle closure and a visually significant cataract.

Comments:

- There are conflicting data on the efficacy of phacoemulsification + GSL, but two RCTs showed no benefit of phacoemulsification + GSL over phacoemulsification alone.
- PACG eyes undergoing GSL combined with phacoemulsification have significantly increased aqueous outflow facility compared to phacoemulsification alone.

24. *Minimally invasive glaucoma surgery*

While minimally invasive glaucoma surgery have been used off license in angle closure, the literature is sparse and to date there are no published RCTs.

Comments:

- Angle procedures are at risk of occlusion in angle closure due to smaller anterior chambers and proximity of the iris.

25. *Cyclodestruction*

Cyclodestructive procedures (e.g. transscleral cyclophotocoagulation, endoscopic cyclophotocoagulation, and high-frequency ultrasound) may have similar risk profiles in open-angle glaucoma and angle closure but few data exist.

Comments:

- Cyclodestruction has been proposed as a means to alter ciliary body shape in plateau iris (cilioplasty), but without outcome data available yet.

26. *Surgical peripheral iridectomy*

There remains a place for surgical iridectomy in specific clinical situations of PAC or PACG.

Comments:

- A surgical iridectomy may be required if a laser iridotomy has failed to break an attack of angle closure, in resource-poor areas without access to a laser, or if laser iridotomy cannot be practically achieved.

27. *Paracentesis*

Anterior chamber paracentesis is an option to provide a rapid IOP reduction and pain relief in selected patients with AAC.

Comments:

- Complications may occur, including: cornea, iris, or lens damage; lens dislocation; shallowing of the anterior chamber; bleeding; misdirection glaucoma; and decompression retinopathy.

28. *Timing of surgery*

Although there has been increasing knowledge on the pathogenic mechanisms underlying angle-closure disease, there is ambiguity regarding the different surgical interventions and their timing.

Section 5 - Approach to other glaucomas

A. Exfoliation glaucoma

1. The therapeutic algorithm for exfoliation glaucoma (XFG) is similar to primary open-angle glaucoma (POAG).

Comments:

- There are more intraocular pressure (IOP) fluctuations and faster progression with XFG, requiring a close follow-up.
- Need for selective laser trabeculoplasty (SLT) or earlier surgery is more frequent in XFG compared to POAG.

2. SLT, as a first-line treatment or as an adjunct therapy, is as effective in XFG as in POAG.

Comments:

- Energy settings may need to be reduced in areas of increased trabecular meshwork pigmentation.
- Special caution is required with respect to early post-laser IOP spikes and decreased efficacy over time.

3. Surgical indications and outcomes are similar to POAG. If combined with cataract surgery, there are increased intra- and postoperative risks.

Comments:

- Minimally invasive glaucoma surgery (MIGS) procedures that target the trabecular meshwork seem to work well in mild to moderate XFG, results being comparable to POAG. In the USA, the XEN gel stent has approval from the Food and Drug Administration (FDA) to be used in XFG. However, close follow-up is recommended as long-term results are not known.

B. Pigmentary glaucoma

4. No direct comparisons of different surgical options for pigmentary glaucoma (PG) have been performed to date, and there is currently no clearly superior surgical approach.

Comments:

- SLT, trabeculectomy, and nonpenetrating glaucoma surgery may be considered in patients with PG not controlled by maximal medical therapy.
- Some MIGS techniques could also be considered in subjects with PG. In the US, the XEN gel stent has FDA approval to be used in PG.
- Laser peripheral iridotomy (LPI) may be effective in reducing the pigment load, particularly for eyes with concave iris configuration and free-floating iris pigment.

C. Steroid-induced glaucoma

5. After discontinuing steroids, management of steroid-induced glaucoma or steroid-induced ocular hypertension is similar to POAG.

Comments:

- If patient condition allows it, corticosteroids should be discontinued for at least a few weeks to elicit a lower IOP before considering surgery.
- In a patient with steroid-induced glaucoma and raised IOP, discontinuation of steroids may reduce IOP. This may result in overestimation of the surgical outcome.
- SLT is sometimes effective for steroid-induced glaucoma.
- Trabeculectomy is effective for steroid-induced glaucoma.

D. Traumatic glaucoma

6. Pilocarpine and/or SLT are not recommended for the management of glaucoma associated with angle recession.
7. Trabeculectomy with mitomycin C (MMC) in post-traumatic glaucoma is an effective method to reduce IOP.

Comments:

- Glaucoma drainage devices (GDDs) are other options for the management of traumatic glaucoma.
- Transscleral or endoscopic cyclophotocoagulation can be considered in traumatic glaucoma refractory to these other surgeries.

E. Uveitic glaucoma

8. Management of uveitic glaucoma depends on the type of uveitis, severity of inflammation, pathology of the angle, possibility of steroid-induced glaucoma, and necessity of long-term corticosteroid use.
9. Trabeculectomy with antimetabolites and GDDs are surgical options for uveitic glaucoma.

Comments:

- Preoperative preparation should ameliorate any anterior chamber inflammation.
- Hypotony maculopathy is a major complication.

10. The effect of Nd:YAG LPI may not be sustained with angle-closure glaucoma and iris bombé associated with uncontrolled uveitis.

Comments:

- An iridotomy can close but can be reopened. Surgical iridectomy could be considered in this situation, particularly if an LPI closes.

F. Neovascular glaucoma

11. Reduction of the ischemic stimulus in neovascular glaucoma, typically by panretinal photocoagulation, is critical for long-term control of the disease. Anti-VEGF (vascular endothelial growth factor) intravitreal injections provide a useful adjunct for the treatment of neovascular glaucoma when given prior to surgery — reducing the risk of hemorrhage and providing temporary reduction of IOP — but do not provide long-term IOP control, unless associated with panretinal photocoagulation.
12. Trabeculectomy with antimetabolites, GDDs, or cyclophotocoagulation are options for the surgical management of neovascular glaucoma.

Comments:

- Data on direct comparisons of different surgical options for neovascular glaucoma are limited, and there is currently no clearly superior surgical approach.
- With active neovascularisation, trabeculectomy should be avoided and a GDD should be considered.
- Success rates are lower, and intra- and postoperative complication rates are higher for neovascular glaucoma surgery than for POAG.

G. Glaucoma associated with aqueous misdirection

13. Laser therapy in the form of peripheral anterior hyaloidotomy and peripheral capsulotomy is indicated if medical therapy fails.

Comments:

- Disruption of the peripheral anterior hyaloid and communication between vitreous and anterior chamber is required for complete resolution. It has a fair to good immediate success rate, but a high recurrence rate.
14. The aim of surgical treatment is to create a communication between the vitreous cavity and the anterior chamber, i.e. a unicameral eye.

Comments:

- In phakic eyes, phacoemulsification with intraocular lens implantation/lensectomy, combined with vitrectomy (*pars plana* or anterior approach), peripheral iridectomy, and zonulo-capsulo-hyaloidectomy is recommended.
- In pseudophakic eyes, vitrectomy (*pars plana* or anterior approach) with peripheral iridectomy and capsulotomy or vitrectomy (*pars plana* or anterior approach) combined with peripheral iridectomy and zonulo-capsulo-hyaloidectomy have a high success rate.
- Transscleral cyclophotocoagulation can be performed in eyes with media opacities and poor visual prognosis.

H. Glaucoma associated with keratoplasty

15. Glaucoma post-keratoplasty is related to pre-existing glaucoma, indication for keratoplasty, surgical technique, inflammation, and use of steroids, among other factors.

Comments:

- Secondary ocular hypertension is more frequent after penetrating keratoplasty than lamellar keratoplasty.

16. Surgery is indicated when the disease cannot be controlled with medical therapy, or if medical therapy is harmful to the cornea.

Comments:

- Trabeculectomy with MMC is a good option when the conjunctiva is in good health.
- GDDs have good success rates in terms of IOP control, but may lead to higher rates of graft failure, often from tube touch.
- Cyclodestructive procedures may be used when other choices fail or are not recommended due to the condition of the eye.
- Any surgical procedure has to take into consideration both IOP control and graft survival.
- To avoid tube touch of the cornea, consideration should be given to placing the tube in the ciliary sulcus in the pseudophakic eye.

I. Glaucoma following vitreoretinal surgery

17. When incisional surgery is needed, scarring of the conjunctiva may preclude the indication of a trabeculectomy. A GDD may be indicated, although its insertion may be a challenge for the surgeon in the presence of a buckle.

Comments:

- GDDs may be placed over, posterior, next to, or within the encapsulation of the buckle.

18. In cases of secondary angle closure in the early postoperative period (e.g. in aphakic eyes with silicone oil insertion or blocked surgical iridectomy), a laser iridotomy for pupillary-block mechanisms can be performed.

Comments:

- In eyes with silicone oil, the iridotomy or iridectomy should be performed at the 6 o'clock position.

19. When elevated IOP after intravitreal gas injection is not controlled with aqueous suppressants, aspiration of the gas with anterior chamber reformation may be required.

Comments:

- Laser iridotomy may be required if a pupillary block is present.
- If incisional surgery is needed, a GDD may be preferred.

20. In silicone oil-induced glaucoma, uncontrolled with medical management, silicone oil removal may be required. In case this is not possible or may not suffice, a GDD is recommended.

Comments:

- In the presence of silicone oil, the device is inserted inferiorly and the tube is placed inferiorly in the anterior chamber.

21. Although results are inconsistent, cyclophotocoagulation is an option in these cases, especially in eyes with poor visual potential or inoperable conditions.

J. Lens-related glaucoma

22. The treatment of any glaucoma associated with the lens is lens extraction. Glaucoma surgery can be added if necessary.

Comments:

- Open-angle, lens-related glaucoma may be due to leakage of lens proteins through the capsule in a hypermature cataract (phacolytic), obstruction of the meshwork by lens fragments after cataract surgery, trauma or laser capsulotomy (lens-particle), or hypersensitivity to own lens protein following surgery or trauma (phacoantigenic).
- Cataract extraction or surgical removal of residual lens material should be performed with irrigation/aspiration and/or vitrectomy if medical treatment does not succeed to reduce the IOP and/or inflammation.
- Trabeculectomy may be considered in patients with lens-related glaucoma not controlled after the surgical removal of the lens or residual lens material.

K. Glaucoma due to elevated episcleral venous pressure

23. Incisional surgery is often needed to reduce IOP.

Comments:

- Initial treatment should be directed to the cause of the elevated episcleral venous pressure, when possible.

24. Trabeculectomy and GDDs are both suitable surgical options.

Comments:

- Care should be taken to prevent hypotony intra- and postoperatively.
- The role of prophylactic sclerotomies to prevent suprachoroidal effusion and hemorrhage is controversial and requires further evaluation.

L. Glaucoma secondary to sustained, elevated IOP related to intravitreal injections of anti-VEGF

25. IOP may be elevated after intravitreal injections of anti-VEGF, but usually diminishes after 30 to 60 minutes.

Comments:

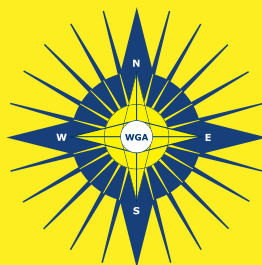
- Eyes with seven or more injections per year have an increased rate of glaucoma surgery.
- Often medical treatment is successful in controlling the IOP. However, surgical interventions have been reported when medical treatment was insufficient.
- Reports of surgical management are scarce and include laser trabeculoplasty, trabeculectomy, and GDDs.

M. Glaucoma secondary to iridocorneal endothelial syndrome

26. Although trabeculectomy with MMC and GDDs have good initial results, other surgeries may be needed.

Comments:

- Insertion of the tube in the sulcus or, when possible, in the vitreous cavity has been recommended to decrease the risk of corneal decompensation.
- If there are broad-based peripheral anterior synechiae, one should consider GDDs instead of trabeculectomy given the high risk of trabeculectomy failure.
- Ciliary ablation could be considered.



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NEWS FLASHES

- ★ Lower baseline IOP in open angle glaucoma produces comparable progression rates to other untreated normal tension glaucoma patients with baseline IOP that was 4-5 mm Hg higher
- ★ There were significant differences in costs of care between specific forms of glaucoma (POAG vs PXF)
- ★ This study confirms the significant and sustained reduction of the lamina cribosa depth after a filtering surgery
- ★ PCA hemodynamics of NTG eyes were already similarly affected as in the NAION eyes
- ★ 47% of the patients reported they were very likely or likely to continue using these reminders
- ★ The next important question is: does this study impact our current decision-making capability when treating glaucoma patients?
- ★ Circulation of CSF around the axons of the optic nerve can be affected due to an increase of the TLCPG
- ★ Quantification of neuroretinal damage from fundus photographs could potentially reduce the rates of undiagnosed glaucoma worldwide

