HAAG-STREIT DIAGNOSTICS

HAAG-STREIT Meeting Highlights

Octopus Expert Conference

10 – 11 July 2015 in Pfaeffikon, Switzerland

Introduction

Visual field defects remain major causes of morbidity worldwide. Extensive research and developments over the past decades have led to the development of improved diagnostic and monitoring tools. This article provides a synopsis of the major topics discussed at the recently concluded Octopus Expert Conference (10 – 11 July 2015 in Pfaeffikon, Switzerland), which served as a genuine platform for sharing best practices between clinicians and those at the cutting edge of the science of perimetry. Some of the important topics discussed included tools to analyze visual field progression, new methods, programs and strategies, and semi-automated kinetic perimetry.

Clinical Recommendations on Methods, Programs and Strategies

Why I screen every patient in my practice

Speaker: Dr. Elliot. M. Kirstein O.D., FAAO, Founder and Director, Harper's Point Eye Associates, Cincinnati, Ohio, United States

Every year in the Unites States, clinicians perform more than 75 million eye examinations. Although comprehensive eye examinations take a long time to accomplish, the information derived from these, as noted by Dr. Kirstein, may be immensely important in early detection of serious eye diseases. However, increasing economic pressure means that in recent years, clinicians have to cope with less time to perform full eye examinations and come up with a diagnosis. On a day-to-day basis, clinicians are saddled with deciding what is going to create yield and improve their practice, while remaining constantly aware of problems outside their area of specialty.

Dr. Kirstein and colleagues shared their thoughts on why they decided about 25 years ago to screen everybody above age 10. This decision was based on their need for more information on the patient; more than just basic eye examination data and improved documentation. They have opted to use the Octopus (Haag-Streit, Koeniz, Switzerland) as their preferred screening instrument. On a day-to-day basis, they have discovered that simple screening tests using the Octopus can reveal far more than basic confrontation testing. By integrating visual field screening into routine practice, they have discovered the importance of visual field screening in the validation of normal, as well as in early identification of eye conditions like cone dystrophy and geographic macular degeneration. The Octopus perimeter has a key role in simplifying eye screening as it allows quick visual field examination.

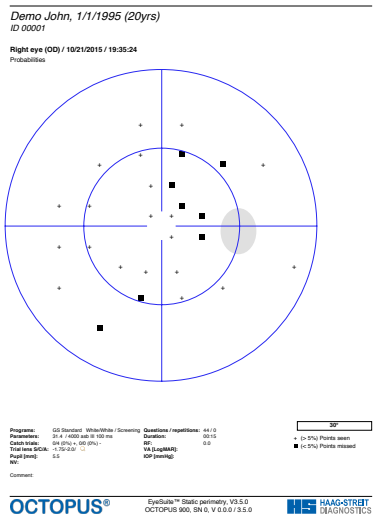
Furthermore, Dr. Kirstein stated the importance of visual field screening from the marketing perspective, as value of care is increased from patients' perspective.

The technology available for making visual field screening available to everyone is getting simpler and changing rapidly. For example, Dr. Kirstein provided an outlook on iPad-based screening, in which there are still many open questions. Nonetheless, Dr. Kirstein concluded that visual field screening should be an integral part of every eye exam.

The novel Octopus screening strategy

Speaker: Prof. Andrew Turpin, Ph.D., Associate Professor of Computer Science and Software Engineering, University of Melbourne, Australia

Octopus Screening Test



Printout of the novel Octopus screening test that allows distinction between normal and abnormal visual fields in less than a minute.

To successfully identify visual field loss in diseases like glaucoma, the ability to delineate healthy patients from those with early stage disease is of utmost importance.

An optimal screening test for this will be, as explained by Prof. Turpin, "a supra-threshold test that runs in under 1 minute for normal vision, uses static, white on white size III targets, uses a subset of the G-pattern, and has a high specificity to avoid many false alarms.

After many computer simulations, Prof. Turpin and colleagues came up with an algorithm that is applied to test a single location and can be used within the three categories of patients in a screening population: the perfect responder, the reluctant one and the `trigger happy' responder.

Furthermore, the chosen test stimulus will present at the lower 5% of age-corrected normal thresholds (i.e. bright enough that in 95% of cases, a normal person can see it). In addition, each respondent will have three chances to see the stimulus.

To make screening efficient in clinical practice, test duration should be short and limited to 1 minute. Therefore, modelling has been done and found that 28 locations can be tested per minute. However, this brings forth more questions: where are these locations and how do you choose them?

Using a technique shown by Henson and colleagues[1], these locations were selected based on the high positive predictive values, and other locations were included to make the screening applicable for a wider variety of diseases with ocular manifestations. Fail criteria were set for each location (must fail to see 3 times) and for the entire 28 locations (must fail 3 of 28) in order to declare a screening test as failed.

Following simulation on data sets, sensitivity levels were found to be about 80% and specificity nearly 100%. "This is a robust screening procedure, with a high specificity. It works very well in simulation, and hopefully, it works very well in practice," concluded Prof. Turpin.

TOP Strategy – 20 Years After

Speaker: Prof. Manuel Gonzalez de la Rosa, M.D., Professor of Ophthalmology, Departmento de Oftalmología, Hospital Universitario de Canarias, Universidad de la Laguna, Santa Cruz de Tenerife, Islas Canarias, Spain

Tendency Oriented Perimetry (TOP), pioneered by Prof. Gonzalez de la Rosa and colleagues, represents one important landmark in the history of modern perimetry. With previous methods, perimetry was more tedious, time consuming and much more demanding for the patient, increasing the likelihood of more false positive and false negative results. "TOP starts the examination with a luminous intensity equal to half the normal value corrected for the subject's age," Prof. Gonzalez de la Rosa said. "It examines 4 consecutive grids of intermingled points and refines threshold precision in more and more accurate steps. The answers are applied to the examined points as well as to those surrounding."

The TOP strategy, incorporated into Octopus perimeters (Haag-Streit, Koeniz, Switzerland), reduces the duration of testing to one fifth the average time of full threshold bracketing and to half the time of dynamic strategy, and the results are quite similar to those of bracketing or full threshold perimetry.[2] In addition, Prof. Gonzalez de la Rosa highlighted the importance of TOP in reducing the fatigue effect, which is a complication associated with other methods of automated perimetry.[3] Prof. Gonzalez de la Rosa further explained that "neurological fatigue makes us lose sensitivity with examination time and that attention losses are a big enemy of precision in perimetry."

Earlier researchers incorrectly concluded that TOP produced low variation values and underestimated glaucoma defects, and was therefore less efficient than the dynamic strategy for early detection.

"What they did not take into account was that the low variation value is usually overestimated in traditional visual field examinations," Prof. Gonzalez de la Rosa said. "If we examine a patient several times and then average the results, the threshold value would get closer and closer to its real value and hence the variance gets reduced. TOP is an averaging procedure in itself. Its variance is lower, but not because it ignores defects, but because it is more accurate."

"In fact, a paper carried out here, in Zurich, and published in 2007 by Scherrer[4], examined 171 eyes with dynamic and TOP strategies and only five big discrepancies were found," Prof. Gonzalez de la Rosa said. "When four eyes were re-examined, the discrepancy favored TOP. In conclusion: it is not that a more thorough strategy like dynamic may detect defects that remain undetected by TOP; the normal actual fact is that TOP is more specific than dynamic."

Stimulus size V: The solution to fluctuation and dynamic range

Speaker: Prof. Michael Wall, M.D., Professor of Ophthalmology and Neurology, Carver College of Medicine, University of Iowa, United States

For most patients with mild visual field loss, the Goldmann size III stimulus remains the gold standard. However, this is no longer the case with advanced visual field loss, where the size III stimulus is associated with high levels of variability. Therefore, can we consider using other stimulus sizes in the setting of advanced visual field loss? Studies by Wall and colleagues have shown that using different stimulus sizes may be a strategy to address variability.[3] In patients with varying levels of visual field damage, Prof. Wall noted that "at low stimulus size, retest variability was observed to be so high, it was almost random."

According to Prof. Wall, repeatability and effective dynamic range are substantially improved by using larger stimulus sizes. These advantages occur, he noted, without compromising the sensitivity to detect defects in glaucoma patients.

Full Threshold size V testing has been found by Wall and colleagues to be slightly more sensitive in detecting glaucomatous loss compared to size III or size VI. In the detection of mild to moderate glaucoma, size V testing provides a favorable stimulus methodology. Therefore, in the detection and follow-up of glaucoma, size V stimuli may be preferable compared to size III stimuli.[5]

Paracentral scotomas: Are standard central programs sufficient?

Speaker: Prof. Ulrich Schiefer, M.D., Professor of Ophthalmology, University Eye Hospital, Institute for Ophthalmic Research, University of Tuebingen, Tuebingen, Germany

A paracentral scotoma is a focal depression of the visual field not corresponding to any other pattern and located within the paracentral region adjacent to the blind spot, but sparing fixation (i.e. no central scotoma).[6] Paracentral visual field loss is very common in glaucoma (15.6 % according to Keltner and colleagues)[7] and may be associated with mild hemorrhage. It is important to note that the paracentral area of the visual field is the most critical part of the visual field required for driving.

Clinical evaluation of small paracentral scotomas remains a challenge in routine ophthalmological practice. The standard 30-2 or 24-2 patterns only cover approximately 1.5% of the central 30-degree visual field. Because of the wide spread of test locations, many paracentral scotomas would be missed.

High resolution perimetric testing, although vigorous and time consuming, would represent the ideal strategy. However, this is not feasible in reality. Thus, the question remains: how can we best utilize these restrictions in assessing small paracentral scotomas?

Some fast strategies have been developed which significantly shorten test duration. However, these are still suboptimal. Results of simulations of alternative visual field test patterns showed that the physiology-based G pattern in the Octopus (Haag-Streit) perimeter performs better than the standard 24-2 visual field test pattern. However, there is still room for improvement and the same study showed that a modified version of the standard 24-2 pattern in which two extra points were added performs even better.[2]

Using an algorithm known as scotoma-oriented perimetry (SCoPe), Hood et al.[2] discovered that these paracentral scotomas have a unique representation in the inferior part of the optic disc. Therefore, Prof. Schiefer suggests that this technique, when combined with fundus-oriented Perimetry (FOP), can be very useful in the assessment of small paracentral scotomas.

The EyeSuite Progression Analysis

Visual field efficiencies in our clinic

Speaker: Dr. Jonathan S. Myers, M.D., Director, Glaucoma Fellowship, Wills Eye Hospital, Philadelphia, Pa., United States

Practical experience on clinical use of the EyeSuite Progression Analysis (Haag-Streit) software was shared by Dr. Myers. Quoting a study of Tanna et al[8], Dr. Myers stated: "Interobserver agreement in assessment of a series of individual visual fields is moderate at best (ranging from 45% to 55%), and is significantly better when a progression analysis software is used. This motivated us to look into the EyeSuite Progression Analysis Sofware and we found it allows for immense flexibility and it offers to clinicians a wide variety of analyses at the click of a button. This is not only convenient but also significantly reduces analysis time as compared to serial visual field analysis."

While ideally a lot of visual field tests should be done, both insurers and patients refuse an infinite amount of visual field tests. A further complication is that progression can be both small and episodic, making it thus even harder to assess. Thus, it is key to make best use of those visual fields available. Progression analysis offered by the EyeSuite allows for maximal use of available data, thereby reducing the need for repeated visual field testing.

EyeSuite Global Progression Analysis

EyeSuite Progression Analysis not only determines whether progression is significant but also whether it is local or diffuse. Simple graphical symbols allow interpretation at a glance.

Introduction to the EyeSuite Progression Analysis

Speaker: Prof. Hans Bebie, Ph.D., Retired Professor of Theoretical Physics, Institute for Theoretical Physics, University of Bern, Switzerland

Prof. Bebie, one of the key people in the development of the Octopus EyeSuite Progression Analysis (Haag-Streit), explained the considerations and terms used to assess visual field progression in Octopus perimetry.

He illustrated with an example the need for statistical support to assess progression. He showed that when progression is small, it is hard to detect significant change in a visual field series intuitively and that a statistical analysis is very helpful in those cases.

During the development of EyeSuite Progression Analysis, they also had to decide between event and trend analysis. He concluded that they chose to use trend analysis as this puts data in relation to time and provides the mathematical slope of progression as a measure of how fast change happens. It also allows to statistically assess whether change is significant without the need for a baseline.

When it comes to whether a global, local or clustered trend should be looked at, he concluded that they all provide valuable information and thus, EyeSuite Progression Analysis offers global trends, cluster trend analysis and a single-point trend analysis in polar coordinates called polar trend.

To assess overall levels of change, they used a number of indices. These include the well known indices of MD (mean defect) as a measure of overall change and sLV (square root of loss of variance), and the less well known DDc (diffuse defect) and LDc (local defect). DDc represents the diffuse component of the visual field loss that can stem from certain pathologies such as cataract or are a sign of unreliable fields due to factors such as fatigue or learning curves. In contrast, LDc (local defect) represents the local component of the visual field loss and is not affected by errors in calibration or long-term fluctuation.

Prof. Bebie explained that while they all are helpful to assess overall visual field progression and whether that progression is local or diffuse, they are somewhat redundant because they correlate. Typically, a set of either MD and sLV or DDc and LDc answers most questions about glaucomatous visual field progression.

But how many fields are necessary to judge progression? Glaucoma guidelines today say that at least 6 examinations within 2 years are needed. However, in their own unpublished data they have found that even with 7 examinations they only find statistical progression in 50% of progressing glaucoma patients, concluding that perhaps even more examinations may be needed.

EyeSuite Progression Analysis has been thoroughly studied by Kovalska et al.[9], who found it to be useful in assessing visual field progression.

Clinical usefulness of the corrected cluster trend and polar trend analyses

Speaker: Prof. Dr. Gabor Hollo, M.D., Professor of Ophthalmology, Department of Ophthalmology, Semmelweis University, Budapest, Hungary

Octopus Cluster Trend

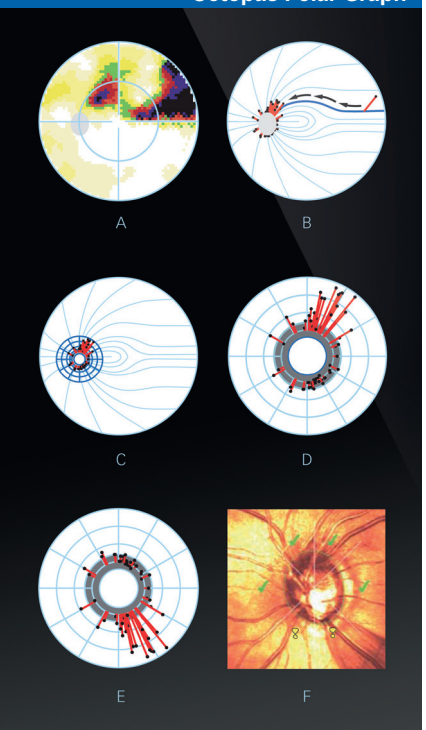
Octopus Cluster Trend analysis assesses visual field progression per nerve fiber bundle and is sensitive to detect early glaucoma progression.

Diagnosis of early progression of glaucoma is essential for making appropriately timed decisions on the modality of treatment. Therefore, Prof. Hollo and colleagues tried to explore whether the Cluster and Corrected Cluster Trend Analysis (CTA and CCTA) available in the EyeSuite Progression Analysis (Haag-Streit) software are clinically helpful to detect early glaucomatous visual field progression. In small scotomas, there is a likelihood that the change in visual field loss may be small, but its impact on patients' quality of life may be profound. Therefore, more than one kind of analysis will be needed to address both localized changes as well as overall defects in the visual field.

Octopus cluster trend: A sensitive glaucomatous progression analysis

In Octopus Perimetry (Haag-Streit), the test points in the standard G-pattern follow the retinal nerve fiber bundle distribution and test point location density is higher around the macula, which is the most important area of visual function. This distribution made it possible to arrange functionally related test points into individual clusters. The use of separate clusters allows separate analysis of functional progression for each cluster, based on trend analysis of the cluster Mean Defect (MD) value. Thus, CTA may be more sensitive to true changes than the rate of global MD change or separate evaluation of the cluster's individual test point sensitivity values. It focuses on localized changes that may have minimal influence on global MD, but at the same time it minimizes the influence of background noise and the between-point dispersion.[10]

Octopus Polar Graph



Local defects (A) are projected along the nerve fibers to the optic disk and are represented as red lines (B). The projected defects (C, D) are vertically mirrored and scaled with rings for 10, 20 and 30 dB deviation (E). The Octopus Polar Graph allows for direct comparison with structural (F) findings.

In a recent study, Prof. Hollo and colleagues investigated the ability of CTA, and Corrected CTA (i.e. based on CTA, but with the effects of diffuse loss eliminated) and single-point event analysis of Octopus visual field series to detect early glaucomatous progression.[10] In this study, one eye of 15 healthy, 19 ocular hypertensive, 20 pre-perimetric, and 51 perimetric glaucoma (PG) patients were investigated with the Octopus G-pattern and normal threshold strategy at 6-month intervals for 1.5 to 3 years. Progression was defined with significant worsening in any of the 10 Octopus clusters with CTA, and event analysis criteria, respectively. With event analysis, only 9 PG eyes showed localized progression. With CCTA, progression was indicated in 26 PG eyes including all 9 eyes with localized progression with event analysis. They therefore concluded that in PG, Octopus CCTA and CTA are clinically useful to identify progression early.

Further analysis revealed that 88% of the eyes detected with CCTA only were also suspicious for progression with single-point event analysis but not significant.

Octopus polar trend: Structure-function correlation made easy

"The Octopus polar trend is a form of analysis that combines structure and function," explained Prof. Hollo. Local defects are clearly represented and projected along the nerve to the optic disc. The projected defects are vertically mirrored and scaled with rings for 10, 20, and 30 db deviations.

Prof. Hollo and colleagues studied the clinical application of the Polar Trend Analysis (PTA) of the Octopus Field Analysis software to monitor the progression of medically treated glaucoma.[11]

Fifty-two participants underwent perimetric testing and nerve imaging with the use of RTVue-100 optical coherence tomography every 6 months. The eyes were categorized into progressors or non-progressors using PTA. Graphically, this presents as point wise linear regression analysis of focal defect at the corresponding nerve fiber angle at the disc margin. The variability of measurement throughout the follow-up period was significantly higher ($p<0.001$ for all comparisons) in the PTA progressors group for inferior and superior GCC thickness and inferior average RNFLT.

Therefore, Prof. Hollo and colleagues concluded that in glaucoma, PTA may be capable of indicating glaucomatous progression earlier in many patients than linear regression analysis of the RNFLT and GCC parameters do.

Use of Kinetic Perimetry in Clinical Practice

Why do we still need kinetic perimetry?: What we miss with static perimetry

Speaker: Prof. Chota Matsumoto, M.D., Ph.D., Professor of Ophthalmology, Department of Ophthalmology, Kinki University School of Medicine, Osaka, Japan

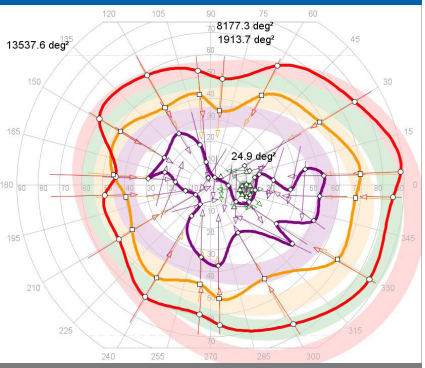
Evaluation of a complete visual field can be obtained theoretically by high-resolution static perimetry in the whole visual field. This however, may require about 3 million test points, and an examination time of up to 3 months to complete. Reducing the test point resolution to 6 degrees covering the full visual field shortens test time to about 1 hour. This is why today, only the central 30-degree visual field is usually tested in routine static perimetry. But what about the peripheral visual field, and how relevant is kinetic perimetry in comprehensive visual field testing today?

Critical cues to these questions were provided by Prof. Matsumoto, while highlighting the key role of kinetic perimetry in the holistic approach to evaluating patients with visual field defects. For example, in a presented case of retinitis pigmentosa, using static perimetry, the central visual field appeared with only little remaining vision in the macula, while full field kinetic testing showed a ring scotoma with many areas of intact peripheral vision. In addition, in a case of pituitary adenoma, bi-temporal hemianopia was detected using static perimetry but no further information was provided. However, using the kinetic perimeter, it was revealed that the hemianopia on the right side was more severe than the left. In a case of primary open-angle glaucoma, static perimetry showed advanced visual field loss, despite the absence of symptoms consistent with significant visual field disturbance. However, kinetic perimetry and subsequent merging of both visual fields revealed that the patient's lack of symptoms could be explained by compensation by the contralateral visual field.

Currently in static perimetry, Prof. Matsumoto stated that "only the central 30-degree visual field is tested with very low resolution test points. Furthermore, he highlighted the relevance of kinetic perimetry, in detecting the full extent of the visual field and for delineating the shape of visual field loss. Finally, in clinical practice, kinetic perimetry is useful in the diagnosis of advanced disease and is well accepted by both young and elderly patients.

A major challenge of the Goldmann kinetic perimetry, Prof. Matsumoto pointed out, is that it requires a trained perimetrist and so, reproducibility is poor among institutions. However, there is ongoing research to fully automate kinetic perimetry that looks promising.

True Goldmann Successor



Example of a kinetic visual field test performed on an Octopus 900. It allows for the same flexibility in kinetic testing like a manual Goldmann perimeter.

Octopus 900: The true successor of the manual Goldmann perimeter

Speaker: Dr. Fiona Rowe Ph.D., Senior Lecturer in Orthoptics, Institute of Psychology, Health and Society, University of Liverpool, United Kingdom

In light of recent progress made in the field of kinetic perimetry, many clinicians and perimetrists are considering a transition from the Goldmann perimeter into a more modern kinetic perimetry platform. This brings forth an interesting question: is the Octopus 900 (Haag-Streit) the true successor of the Goldmann perimeter?

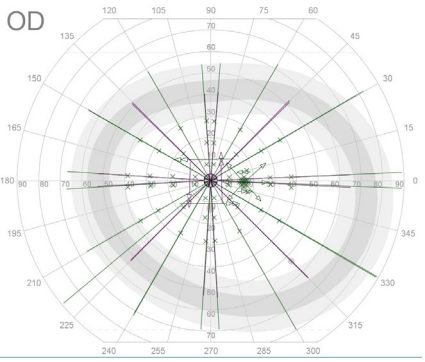
According to Dr. Fiona Rowe, the Goldmann and Octopus 900 perimeters are comparable in many ways. For example, the same templates and stimulus intensity settings are available in both perimeters.

Several comparative studies between 2005 and 2008 compare previous versions of the Octopus with the Goldmann perimeter, looking at different stimulus speeds and vectors. These findings show no significant differences in test duration and similarities in isopter shape and size. Overall, these studies concluded that perimetry using the Octopus kinetic perimeter was reliable and accurate.

To confirm these findings, Dr. Rowe and colleagues[12] evaluated 40 control subjects (normal visual fields) versus 50 patients (visual field loss) in a recent prospective cross-sectional study. In the controls, speed, subject perceptions and area were utilized as outcome measures. Within the patient group, they compared test duration, stimulus speed and performed tests of correlation between the defect location and type.

They found that using 5 degrees per second perimetry settings, the Octopus had a comparable test duration to the Goldmann perimeter. Furthermore, the Octopus perimeter was able to reliably detect the type and location of the visual field loss. The results were found to be similar to the Goldmann perimeter results in 88.8 % of all cases. Rowe et al. therefore concluded that results obtained using the Octopus perimeter were reproducible for the detection of presence or absence of visual field defects. Taken together, these studies provide evidence that the Octopus 900 is fully equivalent with the Goldmann perimeter.

Customized Kinetic Template



An example of Dr. Rowe's kinetic template for general assessment. Kinetic custom templates allow standardization of testing methodology, but can be individually adapted during testing to each patient's situation.

Semi-automated kinetic perimerty to improve consistency and save time

Speaker: Dr. Fiona Rowe, Ph.D., Senior Lecturer in Orthoptics, Institute of Psychology, Health and Society, University of Liverpool, United Kingdom

The automated perimetry route is currently used for static perimetry, with known benefits of reduction in bias, and introducing standardization, repeatability and comparability. Therefore, this approach would seem beneficial if applied in the kinetic approach. Dr. Fiona Rowe highlighted some important user-friendly features on the Octopus (Haag-Streit) control panel.

Within the user interphase, a variety of settings of test vectors and reaction time vectors, stimulus speed, size and target brightness settings, and blind spot can be utilized. These can then be easily saved as templates applied automatically as standardized settings to all patients. However, the saved templates are also flexible and can always be customized to specific patients during testing. Using the same testing methodology with a template is highly important when consistency of visual field testing is needed, so that all patients at a given time, as well as over time, are assessed exactly the same way, even when towards the end of the exam the testing is customized. In addition, a standardized and reproducible testing template is beneficial in research settings.

The use of templates also results in significant time savings in busy clinics. Dr. Rowe discussed some of these templates and their settings in the Octopus 900. For example, a general assessment template consists of 14e and 12e peripheral vectors at 5 degrees per second, test/retest vectors, reaction time vectors, blind spot set up and central static points. This template has been customized for patients requiring pituitary assessment, who have far more vectors emerging from the superior peripheral field, and also far more static points set up. In addition, her group has also developed customized settings for assessing patients with hemianopia, superior quadrantinopia and inferior quadrantinopia, uniocular rotations and binocular single vision.

Dr. Rowe shows a prospective cross-sectional study in which she has used those templates to compare semi-automated kinetic perimetry (SKP) on an Octopus 900 perimeter to the peripheral 120FF static program with a Humphrey automated perimeter.

Sixty-four patients (113 eyes) underwent dual perimetry assessment. Mean duration of assessment for SKP was 4.54 minutes and 6.17 minutes for FF120, which was significantly faster. Overall, the results of both static and kinetic testing matched well, but semi-automated kinetic perimetry was significantly faster than static perimetry and also provided much more detailed information about the depth and size of a defect.

Conclusion

The Octopus Expert Conference provided an important opportunity for participants to learn more about the outstanding features available on the Octopus instruments and how these can be optimally utilized for improved patient care.

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