21st Century Visual Field Testing—
the Evolution Continues
Diagnostics are a key factor in disease management, especially in glaucoma. Although tremendous advances have been made in ophthalmic imaging during the past few years, visual field testing remains essential to the diagnosis and management of glaucoma.

The Humphrey Field Analyzer (Carl Zeiss Meditec, Inc., Dublin, CA) has been widely recognized as the gold standard in automated visual field testing for more than 25 years, and it has provided clinicians with a widely accepted and broadly available language of perimetry that most doctors understand. All major glaucoma clinical trials have relied upon Humphrey perimetry, including the Advanced Glaucoma Intervention Study (AGIS), the Collaborative Initial Glaucoma Treatment Study (CIGTS), the Early Manifest Glaucoma Trial (EMGT), the Normal Tension Glaucoma Study (NTGS), and the Ocular Hypertension Treatment Study (OHTS).1-5

This article briefly reviews some of the reasons why the Humphrey perimeter has come to enjoy this status.

STANDARDIZATION

Among the many contributions to ophthalmology made by Hans Goldmann was the first universally standardized method for manual visual field testing: Goldmann perimetry. Goldmann perimeters all over the world used the same standardized stimuli and background level, allowing doctors to communicate in a common perimetric language. The Humphrey automated perimeter can be considered to be the modern day extension of Goldmann’s standardization efforts in terms of availability and worldwide acceptance. The Humphrey Field Analyzer is further enhanced by widely accepted standardized testing strategies, normative data, and analytical methods, all of which provides doctors not only with an international standard for visual field testing but also a standard language for communicating results. Such uniformity has provided universally accepted criteria for glaucoma staging and diagnosis that were not widely available even 20 years ago.

TESTING ALGORITHMS

Standardization by itself is insufficient if the methods used are not sensitive, reproducible, and efficient. In the early 1980s, automated threshold testing strategies could take as long as half an hour per eye, making them neither clinically practical nor well accepted by patients. While it was simple to reduce testing time by sacrificing precision and reproducibility, it was not until the late 1990s that strategies emerged that successfully reduced testing time while maintaining diagnostic performance.6 These new strategies came to be known as the Swedish Interactive Threshold Algorithm (SITA) and now include the SITA Standard, SITA Fast, and SITA SWAP (short-wavelength automated perimetry). The SITA methods effectively cut testing time in half without giving up reproducibility or diagnostic performance.7,8

The SITA strategies have provided clinicians with a broad set of testing options that can be tailored to specific patient needs. SITA Standard 24-2 testing can run in as little as 4 minutes and is usually the most reliable option. SITA Fast 24-2 testing can be performed in as little as 2 minutes and provides a reasonable alternative in situations that demand the briefest of true threshold tests.

Some threshold testing methods save time by assuming that responses obtained at nearby test-point locations also apply to the point being tested. This shortcut blurs test points together, effectively decreasing the number of truly tested points. It is important to note that SITA is a true threshold test, which is to say that SITA methods still determine threshold at each tested location in the visual field by finding at least one brightness that can be seen and one that cannot be seen.

STANDARDIZED ANALYSIS

Once test data have been acquired, the next immediate task is to interpret the results. If the Humphrey perimeter is the gold standard of visual field testing, then STATPAC (Carl Zeiss Meditec, Inc.) is the universal lan-
guage of perimetry. STATPAC software compares results to clinically validated, world-class, proprietary age-normal and glaucoma databases. Data analyses not only include simple plain language interpretations relative to normal or to baseline, but they also provide specific quantitative information that can help doctors make difficult treatment decisions. STATPAC analysis software is universally available, simple to use, and well documented in the peer-reviewed literature. In a world where simplicity is valued but details are often necessary, the inventors of STATPAC have made consistently practical and useful design decisions, and they continue to do so a quarter of a century after the initial introduction of the product.

HUMPHREY PERIMETRY—PAST AND FUTURE

With the recent—and in many ways stunning—improvements in ophthalmic imaging, it is easy to lose track of the continuing role of standardized automated visual field testing in glaucoma management. Continuing advances in this field, however, confirm the role of Humphrey perimetry as the gold standard in the diagnosis and management of glaucoma.


INNOVATIVE HIGHLIGHTS OF THE HUMPHREY FIELD ANALYZER

SWEDISH INTERACTIVE THRESHOLD ALGORITHM (SITA)
SITA is a family of testing strategies that measure threshold sensitivity and reliability parameters efficiently, thereby achieving optimal measurements in minimal time.

STATPAC
STATPAC is a trademark for Humphrey software that performs a series of statistical calculations on visual field test results. Displays include single-field analysis, Guided Progression Analysis (GPA), change analysis, and overview.

GUIDED PROGRESSION ANALYSIS (GPA)
GPA is a new approach to detecting progression events and trends that spans several platforms including the Humphrey Field Analyzer (HFA) and Cirrus HD-OCT (both products from Carl Zeiss Meditec, Inc., Dublin, CA). On the HFA, the event-based GPA identifies statistically significant progression. Two visual fields are required to establish a baseline examination. GPA flags points exceeding expected patient variability and employs strict progression criteria from the Early Manifest Glaucoma Trial.

VISUAL FIELD INDEX
The Visual Field Index (VFI) is a perimetric staging index that is designed to be less affected by cataracts. VFI is expressed as a percentage, where 100% represents a normal visual field and 0% represents a perimetrically blind field.

VFI PLOT
The VFI PLOT applies linear regression analysis to series of test results to help identify patients who are progressing at rapid rates. The VFI PLOT can be found in the new GPA of the HFA.
Case Studies

BY NATHAN M. RADCLIFFE, MD

Case No. 1 Early Perimetric Glaucoma

Figure 1A shows the Humphrey Field Analyzer (HFA; Carl Zeiss Meditec, Inc., Dublin, CA) visual field single field analysis report for a 34-year-old man with early glaucoma and an abnormal Glaucoma Hemifield Test (GHT) on Swedish Interactive Threshold Algorithm (SITA) Standard.

The GHT is an automated, empirically derived algorithm that detects up-down asymmetry and symmetrically depressed visual field abnormalities.1 By comparing five corresponding sectors from the superior and inferior hemifields, the GHT serves as a sensitive indicator of focal visual field loss. Analysis of this patient’s glaucomatous visual field (Figure 1A) shows only two significantly \( P < .5\% \) depressed points on the total and pattern deviation plots. Although only a small region of the field is depressed, these two points are deeply depressed at 12 dB and 9 dB below the age-adjusted normal, as seen on the total deviation plot. The fixation losses, false positive and false negative errors are all within acceptable limits, and the gaze tracker demonstrates steady fixation. The prior SITA Standard test from several months earlier was completely normal, and fluctuation between normal and abnormal results may occur in early perimetric glaucoma.2 Note that the Visual Field Index (VFI) is still high at 96%, demonstrating that very little field loss is required in order for the GHT to become abnormal. The mean deviation is still in the positive range at +0.13 dB, indicative of the overall preserved hill of vision. The focal

Figure 1A. HFA Single Field Analysis.

Figure 1B. Cirrus HD-OCT ONH and RNFL OU analysis.
superior defect has distorted the shape of the hill of vision, however, causing the pattern standard deviation to be 2.92 dB, a value found in less than 2% of the normal population. The patient was informed that a small region of the superior visual field demonstrates characteristic visual field loss from glaucoma.

Figure 1B presents the bilateral Cirrus HD-OCT (Carl Zeiss Meditec, Inc.) optic nerve head (ONH) and retinal nerve fiber layer (RNFL) analysis. There is a good structure-function relationship between the inferior RNFL defect and the superior scotoma. Interestingly, the superior RNFL defect is not accompanied by an inferior perimetric deficit, indicating that a region of preperimetric neuroopathy has been detected by the sensitive optical coherence tomography RNFL deviation map.


Case No. 2 Moderate Glaucomatous Field Loss

Figure 2A shows the results of SITA Standard testing for a 26-year-old man with juvenile primary open-angle glaucoma.

The fixation losses and the false positive and false negative errors are all within acceptable limits. The gaze tracker demonstrates steady fixation with a brief period of unstable gaze about three-quarters of the way through the test. The GHT is outside normal limits. The total deviation plot reveals a paracentral superior arcuate scotoma with a more peripheral inferior arcuate scotoma, each respecting the horizontal meridian. Although a dense paracentral focal defect is present, the central visual acuity is unaffected, as reflected by the patient’s 20/15 visual acuity and by the normal foveal sensitivity value of 41 dB.

The presence of superior and inferior hemifield defects in addition to the paracentral vision loss would place this visual loss in the moderate category, despite the seeming-
ly high VFI value of 90%. The mean deviation is abnor-
mal but still modest at -3.14 dB, but it is smaller than
the pattern standard deviation at 5.99 dB, likely because
the dense superior paracentral scotoma has distorted
the shape of the hill of vision. The patient was informed
that there is damage to both the superior and inferior
visual field and that the superior damage is approaching
his central vision and must be carefully monitored.
A strong structure-function relationship is seen on
comparison with the Cirrus HD-OCT (Figure 2B).

Case No. 3  Advanced Glaucoma

A 64-year-old woman presented with blurred vision in her
left eye and was found to have both cataract and glaucoma
in this eye. Her visual acuity was 20/50 and could not be
improved with refraction. The reliable HFA 24-2 demon-
strated both superior and inferior arcuate scotomata that
involved her central field, with the GHT outside normal
limits.

Of greatest concern was the total deviation plot demon-
strating four depressed points surrounding fixation along
with the foveal sensitivity value of 22 dB (a value found in less
than 0.5% of the normal population). The mean deviation
was -7.78 dB, and the pattern standard deviation was 10.57 dB.
The VFI is 65% in this case, and it is notable that, in this par-
ticular patient, the majority of the visual loss has occurred in
the central visual field. To further investigate the central field,
a central 10-2 threshold test was performed, which revealed a
small central/temporal island of remaining vision.
The SITA Standard strategy and stimulus size III were cho-
sen in order to take advantage of the normative database
that allows us to review the total and pattern deviation plots.
Although the total deviation plot might seem to leave open
the possibility of preserved fixation, the reduced foveal sensi-
tivity on both examinations strongly suggests that the
patient’s visual acuity was reduced from glaucoma. In this
clinician’s experience, it is unlikely that glaucoma patients
with reduced foveal sensitivity will regain normal visual acuity

Figure 3A. HFA Single Field Analysis 24-2.
Figure 3B. HFA Single Field Analysis 10-2.
after cataract extraction. Although this does not always preclude cataract extraction, this finding can provide valuable insight and may help manage expected outcomes in advanced glaucoma. The patient was informed that significant visual field loss, most likely from glaucoma, was affecting her central vision.

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**THE SINGLE FIELD ANALYSIS PRINTOUT**

The Single Field Analysis presents the results of a single central threshold test. The top of the page presents patient data, test reliability indices, and test results in the grayscale and numeric formats. The information that STATPAC adds is found in the lower half of the page.

A – Glaucoma Hemifield Test
B – Total Deviation Plots
C – Pattern Deviation Plots
D – Global Indices (VFI, MD, PSD)

The new GPA Summary Report for the HFA II-i provides a concise overview of a patient’s entire visual field history on a single page.

A – Baseline Exams: Establish initial visual field status.
B – VFI Rate of Progression Analysis: Trend analysis of the patient’s overall visual field history.
C – Current Visual Field Summary: Complete report of current visual field including VFI, MD, PSD, the Progression Analysis Plot and the GPA alert.

1). VFI Value A summary measurement of the patient’s visual field status, expressed as a percent of a normal age-adjusted visual field.
2). VFI Plot Regression analysis of VFI values and 3 to 5 year projection.
3). VFI Bar A graphical depiction of the patient’s remaining useful vision at the current VFI value along with a 3 to 5 year projection of the VFI regression line if the current trend continues.
4). GPA Alert A message that indicates whether statistically significant deterioration was noted in consecutive tests.
Thank you …

... to all our Humphrey Field Analyzer (HFA) customers for almost 3 decades of dedication in helping us innovate the most widely used visual field platform. With your support, HFA is now recognized as a standard of care, with approximately 62,000 HFAs shipped across the world.

Whether you joined us in 1984 or anywhere along the journey to today with offerings such as the new Visual Field Index (VFI), the enhanced Guided Progression Analysis, and the recently launched world’s first Optical Coherence Tomography and Visual Field Combined Report*, we know that, without your support, it would have been impossible to have accomplished these advances. Your choice of an HFA made it possible for us to grow and to continue to improve and expand the HFA’s capabilities. We celebrate your partnership and extend our sincere thanks for your business.

Sincerely,
The Perimetry Team at Carl Zeiss Meditec

*The HFA-Cirrus Combined Report is available on the FORUM Eye Care Data Management system.

The Evolution of Innovation - Humphrey Field Analyzer

1984

- HFA I
- HFA I, STATPAC Plus
- FASTPAC

1988

- HFA II, Gaze tracking

1991

- FASTPAC

1994

- HFA IIi
- SITA
- Guided Progression Analysis

1997

- SWAP

1999

- SWAP

2001

- HFA II
- SITA SWAP

2003

- Glaucoma Progression Analysis

2007

- HFA-Cirrus Combined Report

2010

- Guided Progression Analysis, VFI