Published in final edited form as:

Am J Ophthalmol. 2007 December ; 144(6): 908–913.

Reproducibility of Visual Field Endpoint Criteria for SAP, FT and SITA strategies: Diagnostic Innovations in Glaucoma Study (DIGS)

Rupert R. A. Bourne, M.D., Keyvan Jahanbakhsh, Catherine Boden, Ph.D., Linda M. Zangwill, Ph.D., Esther M. Hoffmann, M.D., Felipe A. Medeiros, M.D., Robert N. Weinreb, M.D., and Pamela A. Sample, Ph.D.

Hamilton Glaucoma Center, Department of Ophthalmology, University of California, San Diego, La Jolla, California

Abstract

Purpose—To compare the inter-threshold and intra-threshold strategy agreement of visual field endpoint criteria for standard automated perimetry (SAP) with the Full Threshold (FT) and SITA (Swedish Interactive Thresholding Algorithm) algorithms.

Design—Prospective longitudinal cohort study.

Methods—The inter-strategy group included a randomly selected eye of 173 participants in the Diagnostic Innovations in Glaucoma Study who had performed FT and SITA within 3 months (Sequence 1 ‘FT&SITA’).

Intra-strategy agreement for FT (Sequence 2 ‘FT&FT’) was tested for 44 (25.4%) participants who had performed a FT within a year of the FT used in the inter-strategy pairing, and for 89 patients (51.4%) who had performed a SITA within a year before (Sequence 3 ‘SITA&SITA’).

Four different endpoint criteria using Statpac II indices were tested Inter-strategy agreement was compared with intra-strategy agreement using kappas (k).

Results—FT&SITA agreement (k) for PSD<1% was 0.82, for PSD<5%, k=0.64; and for ≥ 4 PDP points, k=0.43. Agreement with GHT was significantly higher ($P<0.01$) for FT&FT (k=0.94) than FT&SITA (k=0.67), and approached significance ($P=0.07$) when comparing FT&FT with SITA&SITA (k=0.77). GHT was more likely to be abnormal on the SITA test than on the FT. No other significant differences were found.

Conclusions—To minimize misinterpreting an abnormal GHT on SITA as evidence of change when switching strategies, both SITA and FT should be performed and compared within a short time period. Other indices are comparable between the two strategies.

Corresponding author: Pamela A. Sample, Ph.D., Hamilton Glaucoma Center, University of California, San Diego, 9500 Gilman Dr., Dept. 0946, La Jolla, CA 92093-0946, Phone: (858) 534-6629, Fax: (858) 822-0615, Email: psample@glaucoma.ucsd.edu.

*Disclosure

Form on file at AJO office. Call for details if necessary. 904-953-2555.

Contributions of Authors Form

This piece of the submission is being sent via mail.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

INTRODUCTION

In the 1990s the Swedish Interactive Thresholding Algorithm (SITA) was introduced¹ for standard automated perimetry (SAP). This perimetric threshold strategy offered a reduced testing time (by nearly 50%), comparable accuracy^{2,3} and similar or slightly improved reproducibility^{4–6} when compared with the Full Threshold (FT) testing strategy. SITA fields have slightly higher differential light sensitivities than FT fields,⁷ particularly in the upper tail of the threshold distribution⁴. SITA strategies have smaller normal variability than FT strategies. As a consequence early pathological defects that might be within the range of normal variability with FT are detectable with SITA on probability maps, which quantify and account for the way in which normal variability depends upon test point location.

Longitudinal studies of glaucoma progression may involve subjects who have performed visual fields using both SITA and FT strategies within the period of follow-up. Ideally, the detection of glaucomatous visual field loss in a given SAP visual field using one or more visual field endpoint criteria, should have very good agreement with another SAP visual field performed close to the same time, whether the paired field is of the same or different thresholding strategy.

Several different criteria can be used to judge whether a visual field has a glaucomatous visual field defect. Many of these endpoints have been combined in the Statpac-like Analysis for Glaucoma Evaluation (SAGE).⁸ Johnson and colleagues evaluated specificity for each and for combinations of these criteria for single visual fields and also for confirmation with a successive visual field. Specificity increased when deficits were present on two successive visual fields. The following three criteria resulted in good specificity and sensitivity: (1) Pattern Standard Deviation (PSD) < 1%, (2) Glaucoma Hemifield Test (GHT) outside normal limits, (3) four pattern deviation locations worse than the 5% probability level.

The purpose of this study was to measure agreement of normal or abnormal designation for these criteria in a group of individuals who performed visual fields using both Full Threshold and SITA testing strategies within a short time period (inter-strategy agreement). An additional criterion, PSD < 5%, was also tested as this has been used in several other studies (e.g. Ocular Hypertension Treatment Study⁹) as a criterion for a glaucomatous visual field. In addition, the effect of disease severity, patient age and photographic evidence of glaucomatous optic neuropathy on inter and intra-strategy agreement was investigated.

METHODS

The visual field data came from a prospectively designed 15-year longitudinal study of visual function in glaucoma, the Diagnostic Innovations in Glaucoma Study (DIGS) at the Hamilton Glaucoma Center, University of California, San Diego.

Participants underwent complete ophthalmologic examinations including slitlamp biomicroscopy, intraocular pressure measurement, and dilated stereoscopic fundus examination. Simultaneous stereoscopic photographs were obtained for all participants using a Topcon TRC-SS camera (Topcon Instrument Corporation of America, Paramus, New Jersey, USA) and were of adequate quality for the subject to be included. Other inclusion criteria for DIGS at study entry are open angles, a best corrected acuity of 20/40 or better, a spherical refraction within ± 5.0 D, and cylinder correction within ± 3.0 D. A family history of glaucoma was allowed.

Participants were excluded if they had a history of intraocular surgery (except for uncomplicated cataract or glaucoma surgery). We also excluded all participants with non-glaucomatous secondary causes of elevated IOP (e.g. iridocyclitis, trauma), with other intraocular eye disease, with other diseases affecting the visual field (e.g. pituitary lesions,

demyelinating diseases, HIV+ or AIDS, or diabetic retinopathy), with medications known to affect visual field sensitivity, or with problems other than glaucoma affecting color vision. For this report, additional exclusion criteria for visual fields included unreliable visual fields (defined as fixation loss, false negative, and false positive errors $\geq 25\%$, unless false negatives could be explained by significant field loss). One eye was randomly selected for testing.

All photograph evaluations were performed by two experienced graders, using a stereoscopic viewer (Asahi Pentax Stereo Viewer II) with a standard fluorescent light bulb. The graders were masked as to the patient's identity, diagnosis, visual field status and each other's grade. They independently reviewed each photograph and classified it as normal, glaucomatous or poor quality. Differences between the two readers were resolved either by consensus or by adjudication by a third experienced grader. Evidence of glaucomatous optic disk damage was defined by the presence of excavation, neuroretinal rim thinning or notching, or retinal nerve fiber layer defects, based on standardized assessment of the photographs.

Primary Analysis

The participants involved in this analysis performed standard automated perimetry (SAP), using both Full Threshold (FT) and Swedish Interactive Threshold Algorithm (SITA; Humphrey field analyzer, Carl Zeiss Meditec, Dublin, Calif.). Order of test presentation was random. The test procedure for both test strategies consisted of a Goldmann Size III target, a 31.5 asb (10cd/m^2) white background and a program 24-2. The FT uses a 4-2-2 staircase procedure. The SITA testing strategy is based on a more complex model of the visual field that allows for more accurate choices of the initial stimulus brightness and more complete use of all available information when calculating threshold sensitivity.¹ In order to test agreement between the Full Threshold and SITA strategies, DIGS participants were selected who had performed this pair of tests within a period of three months.

Each of the three visual field sequences was tested for agreement, for each of the following endpoint criteria:

- i. Pattern Standard Deviation (PSD) $< 1\%$
- ii. Pattern Standard Deviation (PSD) $< 5\%$
- iii. Glaucoma Hemifield Test (GHT) "outside normal limits". A borderline GHT result was considered 'normal' for the purposes of this study.
- iv. 4 abnormal points ($p < 5\%$) on the Pattern Deviation Plot (PDP) in any location.
- v. 4 abnormal points ($p < 5\%$) on the Pattern Deviation Plot (PDP) with at least 4 locations the same on both tests.
- vi. vi. Glaucoma Hemifield Test (GHT) "outside normal limits" &/or a PSD $< 5\%$

Secondary Analysis

This data was collected during a transition in visual field testing between FT and SITA that took place during the DIGS study. In order to test intra-strategy agreement, FT fields performed in advance of this pairing within a year, were also selected for each patient. For convenience, these sequences are subsequently referred to in the text as 'FT&SITA' (FT followed by SITA within 3 months), 'FT&FT' (FT followed by FT within a period of a year) and 'SITA&SITA' (SITA followed by SITA within a period of a year).

For each of the criteria tested, 2x2 cross tabulation was used in order to calculate the level of inter and intra-strategy agreement. The percentage of the total number of patients in which the status of the visual field criterion (either normal or abnormal) in one test was found to agree

with the status of the criterion in the second test was expressed as the agreement. Kappa values were also calculated for each of these criteria. Kappa values were categorized into levels of agreement according to the scale proposed by Landis and Koch¹⁰ (kappa and strength of agreement: 0.01=poor, 0.01–0.20=slight, 0.21–0.40=fair, 0.41–0.60=moderate, 0.61–0.80=substantial; 0.81–1.00=almost perfect). Kappa values were compared between visual field sequences using the method proposed by Fleiss et al.¹¹ In order to test for an influence of age, visual field severity, or the presence of glaucomatous optic neuropathy (GON) on agreement, agreement was retested after dividing the patients into two groups, first using the median age, then median mean deviation and finally the presence or absence of photographic evidence of glaucomatous optic neuropathy. Analysis of variance was used to assess differences in age, mean deviation and proportion with GON between the three groups of participants of the visual field sequences.

RESULTS

173 DIGS participants performed a reliable FT and a reliable SITA within a period of three months (48 (27.8%) had both tests performed on the same day)). Of the 173 participants (21.4%) had GON evident on the closest photographs to these visual fields. Of the 173 patients, 44 (25.4%) had performed a FT within a year previously and 89 patients (51.4%) had performed a SITA visual field within a year previously. 19 participants were common to all three visual field testing sequences.

The demographic information and visual field indices for each visual field test sequence are presented in Table 1. There was no significant difference in age between the groups of patients in each of the visual field testing sequences (Mean age range: 61.7 to 62.6 years; ANOVA, $P=0.857$). There was no significant difference in mean deviation between the SITA fields included in the SITA&FT and SITA&SITA comparisons ($P=0.41$), or between the FT fields in the SITA&FT and FT&FT ($P=0.53$) comparisons. The ratio of those participants with and without photographic evidence of GON did not differ significantly between the three sequences (Pearson's $\chi^2=2.07$, $P=0.356$).

Primary Analysis: Inter-strategy agreement

The agreement among participants fulfilling each of the visual field endpoint criteria is presented in Table 2 for each test pairing. Of the individual criteria, a PSD of <1% achieved the highest level of agreement (94.8%, kappa=0.82 $\pm$ 0.06), followed by the GHT (88.4%, kappa=0.67 $\pm$ 0.07) and PSD <5% (86.1%, kappa=0.64 $\pm$ 0.07) criteria. Agreement in terms of ≥ 4 abnormal points on the PDP was 69.9% (kappa=0.43 $\pm$ 0.06) when considering any location on the VF. Among the 57 participants where there were ≥ 4 abnormal PDP points on the SITA and FT, 32 (56.1%) had at least 4 of the abnormal PDP points in the same location. Using the combination of an abnormal GHT and/or a PSD<5%, there was substantial agreement (86.7%, kappa=0.67 $\pm$ 0.06) between the SITA and FT fields. With the FT, 37 (21.4%) patients had an abnormal GHT, while on the SITA, 41 (23.7%) patients had an abnormal GHT. If only the 19 participants common to all three sequences were considered, higher levels of agreement were achieved (PSD<1%: 94.7% agreement, kappa=0.88 $\pm$ 0.11; PSD<5%: 89.5% agreement, kappa=0.79 $\pm$ 0.14; GHT: 89.5% agreement, kappa=0.78 $\pm$ 0.14; ≥ 4 abnormal PDP points: 78.9% agreement, kappa=0.59 $\pm$ 0.17).

Secondary Analysis: Intra-strategy agreement

SITA&SITA—Intra-strategy agreement is presented in Table 2. Of the individual criteria, a PSD of <1% achieved the highest level of agreement (95.5%, kappa=0.87 $\pm$ 0.06), followed by the GHT (91.0%, kappa=0.77 $\pm$ 0.08) and PSD <5% (86.5%, kappa=0.69 $\pm$ 0.08) criteria. Agreement in terms of ≥ 4 abnormal points on the PDP was 76.4% (kappa=0.51 $\pm$ 0.17).

0.09) when considering any location on the VF. Among the 43 participants where there were ≥ 4 abnormal PDP points on the SITA and FT, 24 (55.8%) had at least 4 of the abnormal PDP points in the same location. Using the combination of an abnormal GHT and/or a PSD $<5\%$, there was substantial agreement (87.6%, kappa=0.73 $\pm$ 0.08). If only the 19 participants common to all three sequences were considered, higher levels of agreement were achieved (PSD $<1\%$: 94.7% agreement, kappa=0.88 $\pm$ 0.11; PSD $<5\%$: 89.5% agreement, kappa=0.79 $\pm$ 0.14; GHT: 84.2% agreement, kappa=0.67 $\pm$ 0.17; ≥ 4 abnormal PDP points: 84.2% agreement, kappa=0.65 $\pm$ 0.18).

FT&FT—Intra-strategy agreement is presented in Table 2. Of the individual criteria, the GHT (97.7%, kappa=0.94 $\pm$ 0.05) achieved the highest level of agreement, followed by a PSD of $<1\%$ (95.4%, kappa=0.87 $\pm$ 0.09) and PSD $<5\%$ (90.9%, kappa=0.78 $\pm$ 0.10) criteria. Agreement in terms of ≥ 4 abnormal points on the PDP was 79.5% (kappa=0.58 $\pm$ 0.12) when considering any location on the VF. Among the 14 participants where there were ≥ 4 abnormal PDP points on the SITA and FT, 10 (71.4%) had ≥ 4 abnormal PDP points in the same location. Using the combination of an abnormal GHT and/or a PSD $<5\%$, there was ‘almost perfect’ agreement (93.2%, kappa=0.84 $\pm$ 0.09). If only the 19 participants common to all three sequences were considered, higher levels of agreement were achieved (PSD $<1\%$: 94.7% agreement, kappa=0.88 $\pm$ 0.11; PSD $<5\%$: 94.7% agreement, kappa=0.89 $\pm$ 0.11; GHT: 100.0% agreement, kappa=1.00 $\pm$ 0.00; ≥ 4 abnormal PDP points: 100.0% agreement, kappa=1.00 $\pm$ 0.00).

Although the proportion with exact agreement between FT and SITA was high, a statistically significant difference in agreement (kappa levels) between sequence FT&FT (kappa=0.94) and FT&SITA (kappa=0.67) was found for GHT only ($P=0.002$). The difference approached significance for GHT between FT&FT and SITA&SITA (kappa=0.77)($P=0.067$). There were no significant differences between the sequences when considering any other endpoint criteria.

The effect of age, mean deviation, and presence of glaucomatous optic neuropathy on inter- and intra-strategy agreement were assessed. Inter-strategy agreement was significantly higher in those patients with above the median mean deviation than those below the median mean deviation for the criteria GHT ($P<0.001$) and PDP in any location ($P<0.01$). Division of the participants according to whether photographic evidence of GON was present or absent, led to the observation that agreement was consistently higher among the group with GON than those without GON for the criteria PSD $<1\%$ ($P<0.001$), PSD $<5\%$ ($P=0.16$), PDP ($P=0.001$), GHT ($P=0.035$). Division of the participants according to the median age, revealed no significant age effect on agreement between FT and SITA visual field endpoint criteria (all, $P\geq 0.40$).

There was no significant effect of age, proportion with GON, or mean deviation on intra-strategy agreement between FT visual fields for the criteria PSD $<1\%$ and abnormal PDP points in any location. A small number of agreements/disagreements when performing the analysis with the criteria GHT and PSD $<5\%$ meant that the effect of these variables on intra-FT agreement could not be tested on these two criteria. When testing agreement between SITA visual fields, patients with a mean deviation above the median had significantly better intra-strategy agreement than those below the median mean deviation for the criteria GHT and PSD $<5\%$. There was no significant effect of age or proportion with GON on agreement of these or the other criteria.

DISCUSSION

This study addresses the important issue of whether visual field endpoint criteria similarly classify abnormality in FT versus SITA visual fields performed within a short time period (3

months). This has implications for the clinician when comparing visual fields with differing thresholding strategies for evidence of visual field defects. We compared the FT-SITA agreement with FT-FT and SITA-SITA to rule out the possibility that any two tests even of the same thresholding strategy would show differences.

Substantial to almost perfect agreement between different visual field endpoint criteria were achieved between visual fields on the same eyes using FT and SITA strategies. Agreement was also good when using the same strategy.

Although there were no inter-strategy differences in age, mean deviation or percentage with GON that may have explained differences in agreement, the latter two variables have been shown^{12,13} to have an effect on levels of agreement when patients are classified into groups based on disease severity. Studies such as that by Budenz et al¹³ have used FT as the 'gold standard'. Defining the minimal criteria for a glaucomatous VF defect as a GHT outside normal limits, corrected PSD (for FT algorithm) or PSD (for SITA) with p values of <5% (one of which had to be a P value of <1%), patients were required in that study to meet any of these criteria on repeat testing to be considered sufficient evidence of a VF defect. They reported a sensitivity of 98% and specificity of 96% for the SITA Standard when considering FT as a gold standard. A study by Sekhar et al,¹⁴ where a borderline GHT was considered a positive result, reported a high sensitivity of 95% for the SITA standard algorithm, but the authors did not separate their visual fields by severity. This is important, as evidenced by the findings of this current study, which showed that less agreement (and hence reduced sensitivity and/or specificity) between FT and SITA was obtained in the subgroup of participants with less severe visual field defects.

Although there was 88% agreement between FT and SITA ($\kappa=0.67$), agreement was significantly higher between FT and FT for the GHT criterion. This was true in spite of the greater time difference between the two FT tests. There were no significant differences between the sequences when considering any other endpoint criteria. This suggests that changing from one strategy to another would be no more likely to flag a field as abnormal than repeating within the same strategy for all the VF endpoint criteria except GHT. Since the management of glaucoma patients often involves GHT as the basis for defining visual field progression from normal to abnormal it is important to be aware of a possible problem when switching from FT to SITA, the latter strategy being the more likely to show an abnormal GHT. However, this finding should be viewed with caution in that differences may be attributable to the different participants included in each study group.

These findings are consistent with those from a study by Sharma et al¹² in 108 eyes. They found that, using the GHT, the performance of SITA was equivalent to that of FT testing in patients with glaucoma who had moderate to severe visual loss, but that there appeared to be more variability in those in a 'normal' control group. When considering 'borderline' cases of the GHT as "within normal limits", the authors reported that among 46 full threshold tests abnormal by GHT, 41 (89.1%) were also abnormal by GHT with the SITA test (performed within a 7 month period). This can be compared with our finding using only "outside normal limits" as abnormal that among 37 full threshold tests abnormal by the GHT, 29 (78.4%) were also abnormal using SITA. Sharma et al also reported that among 56 full threshold tests normal by the GHT, 48 (85.7%) were also normal by the GHT with SITA. We found 136 full threshold tests normal by the GHT, 124 of these (91.2%) were also normal using SITA.

This study has demonstrated substantial to almost perfect levels of agreement between different visual field endpoint criteria between successive visual fields within strategy and also between strategies. The levels of inter-strategy agreement were significantly affected by severity of glaucomatous disease. Although the agreement of the GHT result was high between SITA and

FT, it was significantly lower than between successive FT tests. This has implications for the clinician when switching strategies, specifically when encountering an abnormal GHT on SITA following a normal result with FT. Both SITA and FT should be performed on the same day (or within a short time period) when switching testing strategies in order to avoid misinterpreting an abnormal GHT on SITA as evidence of change.

Acknowledgements

A. Funding/Support: Supported in part by The TFC Frost Trust, UK (RB), NIH grants EY11008 (LMZ) and EY08208 (PAS), the Albert Einstein College of Medicine (K.J). DIGS participant retention incentive grants in the form of glaucoma medication at no cost: Alcon Laboratories Inc, Allergan, Pfizer Inc, and SANTEN Inc.

B. Financial disclosures: Research support (LMZ, FAM, RNW, PAS) and honoraria (RNW) from Carl Zeiss Meditec, Inc. Research support (RB, LMZ, FAM, RNW) and honoraria (LMZ, RNW) from Heidelberg Engineering. Research support from Welch-Allyn and Haag-Streit (PAS). None for all other authors.

C. Contributions of authors: Design of the study: RB, CB, LMZ, PAS

Conduct of the study: RB, KJ, EMH, LMZ, PAS

Collection, management, analysis, and interpretation of the data: RB, KJ, EMH, FAM, LMZ, PAS

Preparation, review, or approval of the manuscript: RB, LMZ, RNW, PAS

D. Statement about conformity with Author Information: Informed consent was obtained from all participants after the nature and procedures of the study were explained. The Institutional Review Board of the University of California at San Diego approved the study, which follows the tenets of the Declaration of Helsinki.

E. Other Acknowledgements: None

References

1. Bengtsson B, Olsson J, Heijl A, Rootzen H. A new generation of algorithms for computerized threshold perimetry, SITA. *Acta Ophthalmol Scand* 1997;75:368–375. [PubMed: 9374242]
2. Heijl, A. The Humphrey Field Analyzer, construction and concepts. In: Heijl; Greve, editors. *Documenta Ophthalmol Proc series 42; Proceedings of the 6th International Perimetric Society Meeting 1984; Dordrecht. Junk Publishers; 1985. p. 77-84.*
3. Haley, MJ. *The Field Analyzer primer*. San Leandro, CA: Allergan Humphrey; 1986.
4. Bengtsson B, Heijl A. SITA Fast, a new rapid perimetric threshold test. Description of methods and evaluation in patients with manifest and suspect glaucoma. *Acta Ophthalmol Scand* 1998;76:431–437. [PubMed: 9716329]
5. Bengtsson B, Heijl A. Evaluation of a new perimetric threshold strategy, SITA, in patients with manifest and suspect glaucoma. *Acta Ophthalmol Scand* 1998;76:268–272. [PubMed: 9686835]
6. Tsuji A, Inazumi K, Yamamoto T, Kitazawa Y. Evaluation of the Swedish Interactive Thresholding Algorithm, a new thresholding algorithm, of the Humphrey field analyzer in normal subjects. *Nippon Ganka Gakkai Zasshi* 1998;102:359–364. [PubMed: 9656685]
7. Bengtsson B, Heijl A. Comparing significance and magnitude of glaucomatous visual field defects using the SITA and Full Threshold strategies. *Acta Ophthalmol Scand* 1999;77:143–146. [PubMed: 10321527]
8. Johnson CA, Sample PA, Cioffi GA, Liebmann JR, Weinreb RN. Structure and function evaluation (SAFE): I. criteria for glaucomatous visual field loss using standard automated perimetry (SAP) and short wavelength automated perimetry (SWAP). *Am J Ophthalmol* 2002;134:177–185. [PubMed: 12140023]
9. Gordon MO, Kass MA. The Ocular Hypertension Treatment Study: design and baseline description of the participants. *Arch Ophthalmol* 1999;117:573–583. [PubMed: 10326953]
10. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;33:159–174. [PubMed: 843571]

11. Fleiss, JL.; Levin, B.; Paik, MC. Statistical methods for Rates and Proportions. 3. Wiley-Interscience; 2003. The Measurement of Interrater Agreement; p. 598-26.
12. Sharma AK, Goldberg I, Graham SL, Mohsin M. Comparison of the Humphrey swedish interactive thresholding algorithm (SITA) and full threshold strategies. J Glaucoma 2000;9:20–27. [PubMed: 10708227]
13. Budenz DL, Rhee P, Feuer WJ, McSoley J, Johnson CA, Anderson DR. Sensitivity and specificity of the Swedish interactive threshold algorithm for glaucomatous visual field defects. Ophthalmology 2002;109:1052–1058. [PubMed: 12045043]
14. Sekhar GC, Naduvilath TJ, Lakkai M, et al. Sensitivity of Swedish interactive threshold algorithm compared with standard full threshold algorithm in Humphrey visual field testing. Ophthalmology 2000;107:1303–1308. [PubMed: 10889102]

Biographies

Rupert Bourne, Huntingdon, United Kingdom

Rupert Bourne, Bsc FRCOphth MD is currently Consultant Ophthalmic Surgeon and lead clinician of the Huntingdon Glaucoma Diagnostic & Research Centre, UK. He is Senior Lecturer at the International Centre for Eye Health at the London School of Hygiene & Tropical Medicine and Honorary Consultant at Moorfields Eye Hospital. He has glaucoma fellowship training at Moorfields and the Hamilton Glaucoma Center, University of California San Diego. Expertise: glaucoma, cataract surgery, ophthalmic epidemiology and altitude ophthalmology.

Pamela Anne Sample, Ph.D.

Professor and Director, Clinical Vision Research, Hamilton Glaucoma Center, Department of Ophthalmology, University of California San Diego, La Jolla, CA. Principal Investigator: NEI-funded Diagnostic Innovations in Glaucoma Study (DIGS) and multicenter African Descent and Glaucoma

Evaluation
Study
(ADAGES).
Research
interests are
improved
diagnosis and
management of
glaucoma using
psychophysical
in vivo
assessment of
specific retinal
ganglion cell
populations,
structure-
function
relationships,
and
individualized
approaches to
increase
diagnostic
information and
target follow-up
for earlier
identification of
progression.

Table 1

Demographic, structural and functional information for each of the testing sequences compared. The study compared inter-threshold and intra-threshold strategy agreement of visual field endpoint criteria for standard automated perimetry (SAP) with the Full Threshold (FT) and SITA (Swedish Interactive Thresholding Algorithm) strategies.

VF sequence	FT&SITA	FT&FT	SITA&SITA
Time separation of VF tests, months	≤3	≤12 months	≤12 months
Number of patients	173	44	89
Mean age of patients (median, range, SD), years	62.8 (64.1, 29.4 to 94.6, 12.2)	62.8 (67.8, 29.4 to 81.8, 13.9)	61.9 (64.0, 29.4 to 86.9, 13.6)
Mean MD of VF (median, range, SD), dB	FT: -1.97 (-1.13, -23.10 to 2.55, 3.66)	FT: -2.98 (-1.09, -20.20 to 1.41, 5.41)	SITA: -1.97 (-0.75, -18.02 to 2.68, 4.04)
	SITA: -1.82 (-0.97, -19.57 to 2.18, 3.50)		
Number of patients with GON (% of total)	93 (53.7)	28 (63.6)	45 (50.6)

* For FT&FT and SITA&SITA sequences, the age (or mean deviation given for the field) of a patient was the age (or mean deviation) when the FT or SITA of the inter-strategy FT&SITA was performed. For FT&SITA sequence, the age on the date the SITA was performed was taken.

VF: Visual Field

FT: Full Threshold

SITA: Swedish Interactive Threshold Algorithm

SD: Standard Deviation

dB: decibels

GON: Glaucomatous Optic Neuropathy

MD: Mean Deviation

Table 2

Percentage agreement (and kappa values $\pm$ standard error) for each visual field endpoint criteria for each of the VF testing sequences that compared inter-threshold and intra-threshold strategy agreement of visual field endpoint criteria for standard automated perimetry (SAP) with the Full Threshold (FT) and SITA (Swedish Interactive Thresholding Algorithm) strategies.

VF sequence		FT & SITA	FT & FT	SITA & SITA
All patients	PSD<1%	94.8 (0.82 $\pm$ 0.059)	95.4 (0.87 $\pm$ 0.089)	95.5 (0.87 $\pm$ 0.065)
	PSD<5%	86.1 (0.64 $\pm$ 0.066)	90.9 (0.78 $\pm$ 0.101)	86.5 (0.69 $\pm$ 0.082)
	GHT*	88.4 (0.67 $\pm$ 0.068)	97.7 (0.94 $\pm$ 0.055)	91.0 (0.77 $\pm$ 0.077)
	≥ 4 PDP	69.9 (0.43 $\pm$ 0.060)	79.5 (0.58 $\pm$ 0.124)	76.4 (0.51 $\pm$ 0.093)
	GHT&/or PSD<5%*	86.7 (0.67 $\pm$ 0.062)	93.2 (0.84 $\pm$ 0.088)	87.6 (0.73 $\pm$ 0.079)

* An abnormal GHT result.

VF: Visual Field

FT: Full Threshold

SITA: Swedish Interactive Threshold Algorithm

PSD: Pattern Standard Deviation

GHT: Glaucoma Hemifield Test

PDP: Pattern Deviation Plot