Original Contribution

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Section Editors: Clare Fraser, MD
Susan Mollan, MD

# A Consensus Statement on the Terminology for Automated Visual Field Abnormalities

Joshua M. Kruger, MD, PhD, Zina Almer, MD, Yehoshua Almog, MD, Eyal Aloni, MD, Anat Bachar-Zipori, MD, Omer Bialer, MD, Iris Ben-Bassat Mizrachi, MD, Josepha Horowitz, MD, Ruth Huna-Baron, MD, Yair Ivanir, MD, Haneen Jabaly-Habib, MD, Ainat Klein, MD, Irena Krasnitz, MD, Hana Leiba, MD, Idit Maharshak, MD, Mira Marcus, MD, Michal Ostashinsky, MD, Michael Paul, MD, Daniel Rappoport, MD, Hadas Stiebel-Kalish, MD, Eitan Z. Rath, MD, Guy Tam, MD, Eyal Walter, MD, Chris A. Johnson, PhD

**Background:** A multitude of terms have been used to describe automated visual field abnormalities. To date, there is no universally accepted system of definitions or guidelines. Variability among clinicians creates the risk of miscommunication and the compromise of patient care. The purposes of this study were to 1) assess the degree of consistency among a group of neuro-ophthalmologists in the description of visual field abnormalities and 2) to create a consensus statement with standardized terminology and definitions.

**Methods:** In phase one of the study, all neuro-ophthalmologists in Israel were asked to complete a survey in which they described the abnormalities in 10 selected automated visual field tests. In phase 2 of the study, the authors created a national consensus statement on the terminology and definitions for visual field abnormalities using a modified Delphi method. In phase 3, the neuro-ophthalmologists were asked to repeat the initial survey of the 10 visual fields using the consensus statement to formulate their answers.

**Results:** Twenty-six neuro-ophthalmologists participated in the initial survey. On average, there were 7.5 unique descriptions for each of the visual fields (SD 3.17), a description of only the location in 24.6% (SD 0.19), and an undecided response in 6.15% (SD 4.13). Twenty-two neuro-ophthalmologists participated in the creation of a consensus statement which included 24 types of abnormalities with specific definitions. Twenty-three neuro-ophthalmologists repeated the survey using the consensus statement. On average, in the repeated survey, there were 5.9 unique descriptions for each of the visual fields (SD 1.79), a description of only the location in 0.004% (SD 0.01), and an undecided response in 3.07% (SD 2.11%). Relative to the first survey, there was a significant improvement in the use of specific and decisive terminology.

**Conclusions:** The study confirmed a great degree of variability in the use of terminology to describe automated visual field abnormalities. The creation of a consensus statement was associated with improved use of specific

Department of Ophthalmology (JMK, EW), Hadassah-Hebrew University Medical Center, Israel; Department of Ophthalmology (ZA), Assaf Harofe Medical Center, Zerifin, Israel; Department of Ophthalmology (YA), Meir Medical Center, Kfar Saba, Israel; Department of Ophthalmology (EA), Barzilai University Medical Center, Ashkelon, Israel; Department of Ophthalmology (AB-Z, AK), Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel; Neuro-Ophthalmology Unit, Department of Ophthalmology (OB, HS-K, MO), Rabin Medical Center, and Sackler School of Medicine, Tel Aviv University, Israel; Department of Ophthalmology (IB-BM, RH-B, GT), Sheba Medical Center, Tel Hashomer, Israel; Department of Ophthalmology (JH), Carmel Medical Center, Haifa, Israel; Department of Ophthalmology (RH-B, HS-K), Sackler School of Medicine, Tel Aviv University, Israel; Clalit Health Organization (YI), Israel; Department of Ophthalmology (HJ-H), Baruch Padeh Medical Center, Tiberias, Israel; Maccabi Health Care Services (IK), Israel; Department of Ophthalmology (HL), Kaplan Medical Center, Rehovot, Israel; Faculty of Medicine (HL), The Hebrew University Hadassah Medical School, Jerusalem, Israel; Department of Ophthalmology (IM, MP), Wolfson Medical Center, Holon, Israel; Department of Ophthalmology (MM), Soroka University Medical Center, Beer Sheba, Israel; Department of Ophthalmology (DR), Shaare Zedek, Medical Center, Jerusalem, Israel; Department of Ophthalmology (ER), Galilee Medical Center, Nahariya, Israel; and Department of Ophthalmology and Visual Sciences (CAJ), University of Iowa, Iowa City, Iowa.

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Address correspondence to Joshua M. Kruger, MD, PhD, Department of Ophthalmology, Hadassah-Hebrew University Medical Center, Kiryat Hadassah, POB 12000, Jerusalem, Israel 91120; E-mail: kruger@hadassah.org.il

terminology. Future efforts may be warranted to further standardize terminology and definitions.

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Automated static perimetry is the most conventional method of accurately assessing peripheral vision in the clinical setting. Modern perimeters automatically assess reliability, differentiate normal from abnormal sensitivity, and quantify the degree of abnormality. A critical assessment that is left to the human reader is to characterize the *pattern* of abnormality, which is important in considering the localization of the defect (1). A multitude of terms have been used to describe automated visual field abnormalities, and application of the existing terminology in the clinical setting has been challenging (2). To date, there is no universally accepted system of definitions or guidelines. Variability among clinicians creates the risk of miscommunication and the compromise of patient care.

The purposes of this study were to 1) assess the degree of consistency among neuro-ophthalmologists in the description of visual field abnormalities and 2) to create a consensus statement with standardized terminology and definitions.

## METHODS

### Visual Field Survey

The study was performed with approval of the ethics review board of Hadassah Medical Center.

All automated static 24-2 perimetry tests performed at Hadassah Medical Center for any ophthalmology subspecialty, during a randomly selected week, were reviewed by J.M.K. Studies of right and left eyes were considered independently of each other. Ten visual fields, from either the left or right eye, were selected for the survey.

A visual field was excluded in the event of the following:
1) The pattern of the abnormality completely conformed to a single "classical" obvious neuro-ophthalmic visual field abnormality including: hemianopia, quadrantanopia, enlarged blind spot, nasal step, complete arcuate, complete altitudinal, central scotoma, and generalized reduction in sensitivity.
2) The pattern of the abnormality closely resembled a visual field test that was already selected for the survey.

All neuro-ophthalmologists in Israel were informed of the study and sent a link to an online survey conducted on surveymonkey.com. Participation was anonymous. The survey sequentially presented the 10 selected visual fields which were deidentified (See **Supplemental Digital Content**, File 1, http://links.lww.com/WNO/A595). The respondent was asked to describe, in free text, the abnormalities in each of the 10 visual fields.

All the neuro-ophthalmologists were requested to take a follow-up survey (voluntary and anonymous). Each of the original 10 visual fields was separately presented along with a list of the descriptive terms that were provided by the respondents in the first round of the survey (J.M.K. had reviewed the results and identified specific terminology within the free-text answers). The respondents were now asked "which terminology would you consider acceptable and sufficient to describe the abnormality (s)?" Respondents could select as many choices as they desired.

### Modified Delphi Method to Develop a Consensus Statement

The results of the initial survey were presented by J.M.K. at a meeting of the Israeli Neuro-Ophthalmology Society, and it was agreed to develop a consensus statement on the interpretation of visual field patterns. All neuro-ophthalmologists in Israel were invited to participate. The participants agreed to use the visual field classification protocols of the Optic Neuritis Treatment Trial (3) (ONTT), Ocular Hypertension Treatment Study (4) (OHTS), and Idiopathic Intracranial Hypertension Treatment Trial (5) (IIHTT) as a basis because they provided detailed descriptions of visual field abnormalities. J.M.K. and C.A.J. developed a summary of the 3 protocols and emailed it to each of the members (See **Supplemental Digital Content**, File 2, http://links.lww.com/WNO/A596). All members reviewed the document and emailed their feedback to J.M.K. including suggestions. An anonymized summary of the suggestions was emailed to the group. Each respondent was asked to vote for or against each specific suggestion that was made. It was predetermined that an agreement of at least 80% would constitute consensus and mandate adoption to the protocol. If a suggestion did not receive at least 80% approval, the submitter was offered the opportunity to send a written appeal of their case, which was anonymously distributed to the group for reassessment.

### Postconsensus Statement Survey

After the finalized draft of the consensus statement was distributed to the country's neuro-ophthalmologists, they were again asked to repeat the initial survey of the 10 visual fields. Respondents were asked to familiarize themselves with the consensus statement before taking the repeat survey, which was once again voluntary and anonymous. There had been no discussion among the group of the answers given in the first survey.

### Analysis of the Surveys

All responses from the first survey and the postconsensus statement survey were randomized and presented to 3

anonymous volunteer neuro-ophthalmologists. They were masked to whether each response was part of the presurvey or postsurvey, and they reviewed the results separately. Each volunteer was asked to review the free-text descriptions and select the words/terms that specifically related to the pattern of the abnormality. If the respondent merely described the abnormality by its location, the reviewer was asked to categorize the response as "location." The reviewers were asked to categorize the response as "undecided" if the respondent offered several alternative descriptions for the same abnormality. If there was disagreement among the 3 volunteer reviewers, if 2 of the 3 chose the same term, that term was accepted as the final choice. In cases where there was complete disagreement among the reviewers, each was asked to provide their rationale to J.M.K., who anonymously presented the comments to the other 2. In each case, one of the volunteers acquiesced, a majority opinion was achieved, and the official answer was finalized.

### Statistical Analysis

The results of the first and last survey were compared with each other using a paired *t* test (Graphpad, San Diego, CA).

## RESULTS

### Initial Survey

In August 2017, 10 visual fields were selected for the survey. All automated visual fields from a 5-day period were reviewed, a total of 120 test results for either the right or left eye. Twenty-nine of the test results were within normal limits. Twenty-seven had only one type of classic abnormality. Of the 64 remaining tests, 10 were selected that represented a variety of patterns.

The first survey was conducted in October 2017. Of the 29 neuro-ophthalmologists practicing in Israel at the time, 26 completed the survey (J.M.K. refrained). The free-text responses of the participants are provided in **Supplemental Digital Content**, (See File 3, http://links.lww.com/WNO/A597). These responses were analyzed by a panel of 3 neuro-ophthalmologists who categorized terminology (See **Supplemental Digital Content**, File 4, http://links.lww.com/WNO/A598). The results are graphically depicted in Figure 1 (light gray bars). On average, there were 7.5 unique descriptions for each of the visual fields (SD 3.17), a description of only the location in 24.6% (SD 0.19), and an undecided response in 6.15% (SD 4.13).

The follow-up survey conducted 6 months later was also completed by 26 neuro-ophthalmologists. Again, there was a great degree of variability in the responses (See **Supplemental Digital Content**, File 5, http://links.lww.com/WNO/A599). For example, even the most favored description for each of the 10 visual field studies was only considered, on average, to be sufficient and acceptable to 49% of the respondents (SD ±17%).

### Consensus Statement

Twenty-two Israeli neuro-ophthalmologists participated in a modified Delphi method to create a consensus statement on guidelines for the interpretation of automated visual fields. All components of the proposed summary of the ONTT,

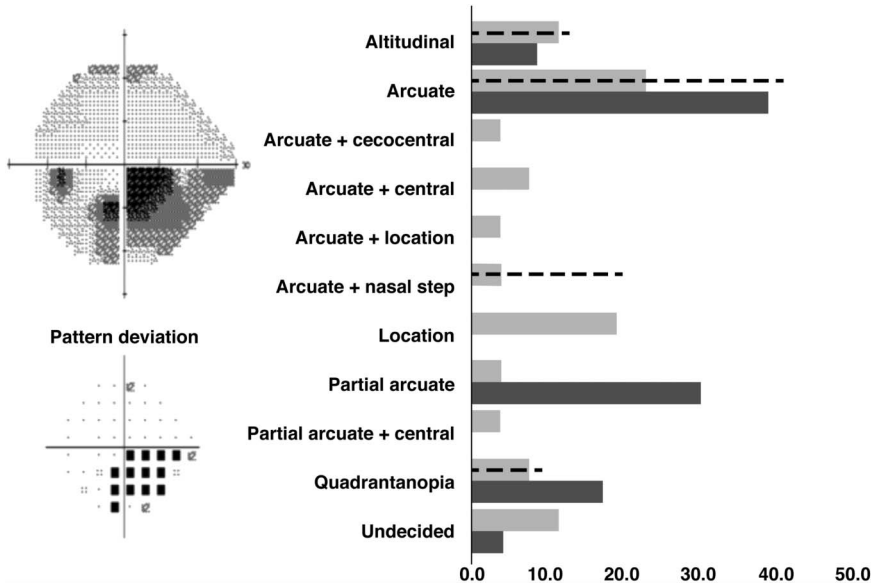


**FIG. 1.** Survey results of the first of the 10 visual fields. The bar chart adjacent to the visual field displays the descriptions provided during the first survey (light gray bars) and postconsensus statement survey (dark gray bars) according to the designation of the panel of the 3 reviewers. The hatched lines represent the percentage of respondents who deemed the given description acceptable and sufficient to describe the abnormality. The results of the survey for all 10 visual fields are included in the **Supplemental Digital Content**, (See File 1, http://links.lww.com/WNO/A595).

**Terminology for Description of Abnormalities in Automated Visual Fields**

| Neurologic | Nerve Fiber Bundle | Central |
|---|---|---|
| 1. Hemianopia | 7. Altitudinal | 13. Central |
| 2. Partial Hemianopia | 8. Arcuate | 14. Centrocecal |
| 3. Quadrantanopia | 9. Partial Arcuate | 15. Paracentral |
| 4. Vertical Step | 10. Nasal Step | |
| 5. Three Quadrants | 11. Pericentral | |
| 6. Enlarged Blind Spot (If the cause of the enlarged blind spot is peripapillary atrophy, the abnormality should not be regarded as a neurologic defect) | 12. Temporal Wedge | |
| **Diffuse** | **Artifactual/Retinal** | **Nonspecific** |
| 16. Multiple Foci | 19. Superior Depression | 24. Nonspecific |
| 17. Widespread / Generalized Depression | 20. Inferior Depression | |
| 18. Total Loss | 21. Partial Peripheral Rim | |
| | 22. Peripheral Rim | |
| | 23. Cloverleaf | |

**FIG. 2.** Terminology for the description of abnormalities in automated visual fields. Supplementary File 2: Summary of the methodology used for automated visual field interpretation in the ONTT, OHTS, and IIHTT studies. Supplementary File 3: Responses of the participants of an online, anonymous, survey. Participants were asked to assess each of the 10 visual fields presented in the **Supplemental Digital Content**, (See Figure 1, http://links.lww.com/WNO/A595) and to provide free-text descriptions of the abnormalities. Eleven of the respondents provided at least part of their responses in Hebrew, and they were translated to English. Supplementary File 4: Categorized answers from the first survey. Three volunteer neuro-ophthalmologists reviewed the free-text descriptions of the visual field abnormalities (See **Supplemental Digital Content**, File 3, http://links.lww.com/WNO/A597) and categorized the terminology. Supplementary File 5: Ratings of terminology suggested in the first survey. Each of the original 10 visual fields was separately presented along with a list of all the descriptive terms that were provided by the respondents in the first round of the survey. The respondents were asked "which terminology would you consider acceptable and sufficient to describe the abnormality (s)?". Respondents could select as many choices as they desired. Supplementary File 6: Israeli neuro-ophthalmology consensus statement on guidelines for the interpretation of automated visual fields. Supplementary File 7: Free-text answers from the final survey. Participants were asked to review the consensus statement and take a survey which presented the same 10 visual fields in the first survey. Supplementary File 8: Categorized answers from the last survey. Three volunteer neuro-ophthalmologists reviewed the free-text descriptions of the visual field abnormalities (See **Supplemental Digital Content**, File 7, http://links.lww.com/WNO/A601) and categorized the terminology. Supplementary File 9: The predominant term provided by the respondents to describe each of the 10 visual fields in the preconsensus and postconsensus statement surveys.

OHTS, and IIHTT protocols (See **Supplemental Digital Content**, File 2, http://links.lww.com/WNO/A596) received an approval of more than 90 percent.

The following 7 suggestions were made:

1) Add the term "scotoma" and define it as "a focal abnormality that is completely surrounded by a zone of preserved sensitivity."
2) Add the "cloverleaf" abnormality and define it as "preserved sensitivity centered 9 × 9° from fixation with sensitivity generally markedly reduced in all other locations within the quadrant and associated with a high false-negative rate."
3) Add the term "nonspecific" abnormality, which can be applied when none of the designations included in the classification system are suitable for describing a given abnormality.
4) Classify "enlarged blind spot" as a "neurologic" abnormality rather than a "nerve fiber bundle" abnormality.
5) Emphasize that trial lens artifact should be particularly suspected in cases of high plus lenses and that retinal disease must be suspected in cases where no trial lens was used.
6) In order for anomalous points to be regarded as abnormal, there should be clinical correlation (e.g., corresponding defects on funduscopy or OCT) or the anomaly should be reproducible.
7) In the absence of clinical correlation or reproducibility, an abnormality may be deemed "suspicious" if it meets the following criteria: 1) a cluster of at least 3 abnormal points, 2) 2 adjacent abnormal points where at least one is worse than the 1% level, and 3) a single abnormal point that is worse than 0.5%.

These 7 suggestions all received more than 80 percent approval and were, therefore, incorporated into the consensus statement. The consensus statement contained a total of 24 terms that were grouped into 6 categories (Fig.

2). The details of the consensus statement are presented in the **Supplemental Digital Content**, (See File 6, http://links.lww.com/WNO/A600).

### *Postconsensus Statement Survey*

The postconsensus statement survey was completed by 23 respondents. The free-text and categorized answers are presented in the **Supplemental Digital Content** (See File 7, http://links.lww.com/WNO/A601) and **Supplemental Digital Content**, (See File 8, http://links.lww.com/WNO/A602), respectively. The categorized answers are graphically presented in Figure 1, dark gray bars. Relative to the first survey, the predominant answer changed in 7 of 10 visual fields (See **Supplemental Digital Content**, Table 9, http://links.lww.com/WNO/A603). Participants only described the location of the abnormality in 0.004% of the responses (SD 0.01), which was a marked improvement relative to the initial survey (paired *t* test, *P*-value 0.003). The average percentage of undecided responses per visual field improved to 3.07% (SD 2.11, paired *t* test *P*-value 0.03). For the postconsensus statement survey, there was an average of 5.9 unique responses used to describe the abnormality in each of the visual fields (SD 1.79). Compared with the initial survey, the paired *t* test *P* value was 0.087.

## CONCLUSIONS

Automated perimetry is an integral component of a comprehensive ophthalmology assessment. Although artificial intelligence is being increasingly used in the analysis of test results (6), many critical components of the test interpretation still require the clinician. This includes classifying the visual field defect to consider the relevant localization and pathology. Currently, there is no universally accepted nomenclature for classifying visual field abnormalities.

This study demonstrated a significant degree of variability in the terminology that neuro-ophthalmologists use in the description of visual field abnormalities. In recognition of the implications for patient care and education, a national consensus statement was developed among most of the country's neuro-ophthalmologists. When the survey was repeated, there was a greater tendency for the use of specific and decisive terminology.

The inclusion criteria favored selection of visual fields that had potentially ambiguous patterns of abnormality. Given that the participants were all staff neuro-ophthalmologists, it was believed that any field that simply had one classic abnormality would receive answers with essential uniformity or clear consensus. However, as any experienced ophthalmologist knows, automated perimetry test results in the clinical setting are typically not the simple classic examples that are shown in textbooks. Indeed, of the 91 abnormal test results considered for the survey, only 27 had classic patterns. Therefore, the variability measured among the participants likely exaggerates the true degree of variability.

The fact that different neuro-ophthalmologists offered different terminology to describe the same visual field abnormality does not necessarily imply that they disagreed. We considered the possibility that more than one descriptive term may be considered acceptable. To test this hypothesis, a follow-up survey was performed where respondents were asked to evaluate the suitability of responses that had been previously offered. The results demonstrated marked disagreement. For example, even the most popular choice was only considered to be acceptable, on average, to 49% of the respondents.

Although the study just involved Israeli neuro-ophthalmologists, we suspect that the results would be similar in other regions of the world. For example, most Israel's neuro-ophthalmologists underwent fellowship training in the United States suggesting that the opinions of the participants may reflect those of their American mentors.

We used the methodology of the ONTT, OHTS, and IIHTT studies as a basis for our consensus statement. These are landmark trials that have been globally recognized. They are extremely relevant to the fields of neuro-ophthalmology and glaucoma. The same group of experts developed the visual field guidelines for all these trials with highly specific definitions. An amalgamation of these protocols was a useful starting point for our general consensus statement. Seven modifications were made to increase the utility of the guidelines in the common clinical practice.

When comparing the results of the initial and repeat survey, the development of the consensus statement was associated with a significant reduction in the number of times that respondents either only described the location of the abnormality or were undecided about how to describe the abnormality. There was still a fair amount of variability in the descriptions of the abnormalities. There are several possible reasons for the persistent inconsistency: 1) All respondents were asked to familiarize themselves with the consensus statement before taking the repeat survey, but we did not confirm that this was performed, and we did not assess for retained knowledge. Therefore, it is possible that the respondents were not sufficiently knowledgeable of the consensus statement details to provide more cohesive responses. 2) There may still remain significant ambiguity in the definitions of the consensus statement. If so, revisions of the consensus statement may be needed.

Despite the stated limitations, we believe that the results of the current study will serve to improve communication among Israeli neuro-ophthalmologists and will also allow for more uniform teaching of the country's residents and fellows. We hope that our efforts will also stimulate other national neuro-ophthalmology societies to follow suit. The

current findings should also serve as a foundation for future artificial intelligence and deep learning procedures (5).

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