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Research Article

Using the 24-2 Sita Fast Humphrey to Detect Visual Field Defects Noted in Patients with Neurological Lesions Impacting the Visual Field Normally Assessed by Octopus Visual Field Testing

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ABSTRACT

Objective: To investigate the validity of the 24-2 SITA fast Humphrey Visual Field (HVF) testing compared to the established parameters of Octopus Visual Field (OVF) for detecting and monitoring patients with neurologic pathology impacting visual fields

Design: Retrospective chart review.

Participants: 108 adult patients derived from the Eye Institute of Alberta (EIA) database.

Methods: Study participants included adults with OVF testing, at the EIA between September 2015 to September 2017. Three blinded reviewers assessed if findings from each OVF would be identifiable on 24-2 SITA fast HVF testing based on established standardized degree of visual field cut-offs. Demographic data and level of agreement were measured using basic descriptive statistics.

Results: In total, 211 individual eye OVFs were scored. Based on our established measurements the 24-2 SITA fast HVF would have identified clinically relevant findings on visual field testing in 197 (93.4%) participants. Of the 6.4% not detected, 64% were due to the patient being unable to fixate on a I2e or I4e isopter, with an additional 18% suffering from movement disorders resulting in exam difficulty (i.e. Parkinson's disease).

Conclusion: The 24-2 SITA fast HVF has potential to be an appropriate alternative test to OVF for detecting and monitoring patients with neurologic pathology impacting visual fields. However, patients with severe vision loss or those not able to fixate on isopters I4e and lower would benefit from more robust testing available in OVF formats. Further head to head comparison of the two visual field modalities is warranted in this group of patients

Keywords: Perimetry; Visual fields monitoring; Humphrey visual field; Octopus visual field

ABBREVIATIONS

HVF: Humphrey Visual Field; SITA: Swedish Interactive Threshold Algorithm; OVF: Octopus Visual Field; EIA: Eye Institute of Alberta

INTRODUCTION

For years, perimetry and other forms of visual field testing have been used as an essential tool used for ocular diagnosis and patient care. Some of the earliest recorded examples date back to the 1850's when Von Graefe built on the work of Helmholtz to extrapolate visual field data to assess retinal pathology [1]. Over time, visual field testing has undergone significant enhancements. Goldmann Visual field testing has historically been considered the gold standard for assessment of neurological lesions, as it has been shown to be reliable for neurological and non-neurological visual defects in children and adults [2-5]. In 2007, production of the Goldmann Perimeter was discontinued and has since been replaced with the Octopus Perimeter. This test has since had its

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accuracy and reliability validated in the literature [6].

Currently Octopus visual field (OVF) testing is routinely used in several clinical scenarios, including detecting and monitoring patients with neurological pathology impacting the visual fields. This includes stroke, metastatic and non-metastatic cancers, and trauma. One weakness of the OVF is that a significant amount of time is required to complete an assessment. In our center, a typical OVF appointment ranges from forty to ninety minutes per patient. Consequently, there is a large burden of time and associated fatigue on both the patients and staff participating in the assessment.

Humphrey Visual Field (HVF) testing is another well-established static perimeter broadly used for assessment of ocular pathology [7]. The 24-2 SITA fast HVF tests 24 degrees temporally and 30 degrees nasally and altogether 54 static field points, however, it does not include kinetic visual field testing. It can be conducted in as little as 4 minutes per eye resulting in an examination that is much more efficient. A HVF assessment can provide relief to both patients and staff members from an otherwise more arduous and lengthy testing experience afforded by its OVF counterpart.

At our centre (The Eye Institute of Alberta/Department of Ophthalmology and Visual Sciences, University of Alberta), most patients undergoing OVF perimetry for assessment and monitoring of neurological pathology effecting the visual fields, had abnormalities predominantly impacting the central 30 degrees of the visual axis. We hypothesized that the 24-2 SITA fast HVF testing would provide enough information to detect visual field defects in these patients with the similar accuracy as the OVF perimetry. If our hypothesis were true, then from a theoretical perspective there would be significant benefit for patients in shortened testing times and less diagnostic fatigue. Providers would also benefit from decreased mental and physical strain from prolonged screen time and decreased workload burden. There is also a benefit to our publicly funded health care system from increased economic efficiency.

MATERIALS AND METHODS

Study design

Data for this cross-sectional study were derived from the Eye Institute of Alberta visual field database. All participants for this study were adults, 18 years and over, who had OVF testing at the EIA. Patient information was collected from testing conducted between September 2015 to September 2017. Study participants were excluded if they did not meet the age criteria or had incomplete or invalid information on examination of the data. This study was approved by the University of Alberta research ethics board (Pro00076551).

Data collection

Initial chart review and data collection were conducted to obtain demographic and examination information. Following this, individual patients OVFs were assessed. Assessment was conducted systematically using the following stepwise approach to scoring for each eye:

- Are there scotomas within the central 30º of vision?
- Does the I2e isopter detect any scotomas?
- Does the I4e isopter detect any scotomas?
- Is the overall visual field abnormal?
- Would the 24-2 SITA fast Humphrey Visual Field detect the same findings?

This assessment was conducted by three independent reviewers. Prior to initiation of formal assessment for the study, all three reviewers completed assessment of 20 separate OVFs and we determined an inter-rater reliability of >95%. After completing the formal study assessment, in the cases of discrepancy between reviewers, the three reviewers re-assessed differences in scoring together and majority vote provided the final assigned scoring.

Statistical analysis

All Statistical analysis was conducted on SPSS version 25.0. Demographic data and level of agreement between OVF and the pre-established scoring criteria mimicking the 24-2 SITA fast HVF was measured using basic descriptive statistics.

Post-Hoc analysis

After initial data analysis of the total 211 study participants - we identified those who had underwent a formal assessment of both a HVF and OVF within the 6 months of each other. These participants had their corresponding images directly compared to provide clinical context to the theoretical criteria used in our study. The same inclusion and exclusion criteria used in our initial assessment and analysis were used as well as basic descriptive statistics to quantify outcomes.

RESULTS

In total, 108 patients met inclusion criteria. There were 5 individual eye visual fields that were excluded due to missing data, resulting in 211 individual eye visual fields that were scored. The sample population was 48% female and the mean age was 53 years. Most participants were referred by our colleagues in Neurosurgery (64.8%), followed by Neurology (17.6%), Endocrinology (12.9%), and Radiation Oncology (4.6%) (Table 1).

Overall, 116 (55%) of individual OVFs were reported as abnormal. When reviewers were asked to assess if a 24-2 SITA fast Humphrey Visual Field would detect the same clinically relevant findings as the OVF for all cases, both normal and abnormal (Appendix A – Question 5), the reviewers responded "yes" for 197 (93.4%) of the 211 total cases (Table 2). Of the 6.6% of the overall visual fields in which reviewers responded "no" when asked if the degree of visual field testing from the 24-2 SITA fast HVF would detect the same as the Octopus Visual Field, 64% (n=9) were due to the patient being unable to fixate on a I2E or I4E isopter. An additional 21% (n=3) were reported to suffer

from movement disorders or mechanical limitations resulting in exam difficulty (i.e. Parkinson's disease). After controlling for patients with difficulty maintaining an adequate fixation during the exam, only 1% of total individual HVFs assessed (n = 2) did not agree with the OVFs findings.

Table 1: Characteristics of sample.

Characteristics	Sample n (%)
Total Sample Size	108
Total visual fields	211
OD	106
OS	105
Sex	
Male	56 (51.9)
Female	52 (48.1)
Age	
18 - 30	9 (8.3)
31 - 50	29 (26.9)
51 - 60	30 (27.8)
61 - 75	34 (31.5)
≥ 76	6 (5.6)
Referring service	
Neurosurgery	70 (64.8)
Neurology	19 (17.6)
Endocrinology	14 (12.9)
Radiation Oncology	5 (4.6)

Table 2: Grading of visual fields.

Stepwise Grading Questions	OD n (%)	OS n (%)	Total n (%)
Are there Scotomas within the central 30° of vision?	33 (31.1)	35 (33.3)	68 (32.2)
Does the I2e isopter detect any scotomas?	45 (42.5)	47 (44.8)	92 (43.6)
Does the I4e isopter detect any scotomas?	40 (37.7)	42 (40.0)	82 (38.9)
Is the Visual field Abnormal?	58 (54.7)	58 (55.2)	116 (55.0)
Would the 24-2 SITA fast Humphrey Visual Field Detect the same findings?	97 (91.5)	100 (95.2)	197 (93.4)

Post Hoc analysis revealed 8 patients who had underwent a formal assessment of both a HVF and OVF within 6 months of each other. Of these 8 participants a total of 15 individual eye visual fields were re-assessed. In total 26.6% (n=4) individual visual fields were considered to have an abnormal OVF on our primary analysis. After direct head to head comparison, all 4 also demonstrated the expected abnormalities on review of the actual HVF testing. Of the 11 other individual OVFs that had been previously scored as normal from our initial assessment 91% (n=10) were normal on review of the actual 24-2 SITA fast HVF. In addition, 1 of the 11 was scored as abnormal on the HVF and not on the OVF. In this case the patient had reported very poor fixation and subsequent reliability below what would be considered adequate for 24-2 SITA fast HVF standards.

DISCUSSION

Over half of the visual fields (55%) that met study criteria were abnormal. For the overwhelming majority (93.4%), our examiners reported that a 24-2 SITA fast HVF Exam would have identified similar deficits as an OVF. This suggests that of those who received an OVF for monitoring, detecting, and following neurological pathology impacting visual fields, a 24-2 SITA fast HVF would be sufficient in identifying similar visual field defects in 93.4% of participants. Of the remaining 6.4%, all but 1% were noted to have difficulty viewing the exam due to well established reliability concerns for 24-2 SITA fast HVF testing including low vision (unable to see the I2E or I4E) isopter and/or a history of movement disorder increasing fixation difficulty or mechanical limitation [8,9]. Thus, in our study, patients who were able to maintain standard fixation with adequate vision to appreciate the stimulus size present in the 24-2 SITA fast HVF testing would likely have a theoretical reliability of the 24-2 SITA fast HVF of 99% when compared to the OVF. In the situations where a patient is not able to fully appreciate the stimulus size present in a 24-2 SITA fast HVF then and OVF would be preferential.

To the best of our knowledge this is the first study to assess the potential for a 24-2 SITA fast HVF to be used in place of an OVF in detecting or monitoring patients with neurologic pathology impacting visual fields. In 2013, Rowe et al. conduced a cross-sectional study examining 64 patients comparing Humphrey full field 120 to OVF standardized kinetic perimetry (SKP) to assess neuro-ophthalmic cases [10]. They concluded that although the full field HVF testing was useful, the OVF provided a more representative view of the actual visual field defect, depth, and size than the full field HVF in less time. Another study suggests a preference for Kinetic perimetry in patients with vision loss from pituitary disease over a HVF 30-2 and 24-2 [11]. Consistent with current clinical practice, both studies seemed to conclude that the overall accuracy of kinetic perimetry is superior to that of static among patients with neurological pathology. However, neither study explored the relationship between an OVF and a 24-2 SITA fast HVF nor both studies did note that the HVF assessment provides useful information with respect to neurologic pathology. A separate study found that the SITA family of perimetry was more accurate in detection of central visual field defects associated with severe neurological disease than Goldmann perimetry [12]. While this is useful information our study found the opposite in that those with low vision or severe neurologic disorders that increased the difficulty for a patient to maintain a still position for testing had lower accuracy.

Our study suggests that the 24-2 SITA fast HVF may be a useful alternative to octopus visual field assessment in detecting patients with neurological pathology impacting visual fields. Patients fatigue is an important concern with diagnostic testing in general, but also specifically with visual field testing. In our center an Octopus Visual Field Exam can range from 40-90 minutes depending on the patient and technician. In contrast, the 24-2

SITA fast HVF can take as little as 4-8 minutes per patient [13,14]. Furthermore, an additional potential positive outcome among our already stressed Canadian health care system is the impact of increased efficiency and subsequent financial cost benefit. Such conclusions are outside the scope of this study but, given our findings, future research to investigate this proposition is warranted.

It is important to note that this was a basic exploratory study that assessed the OVFs obtained from referrals to the EIA from multiple specialties surrounding Edmonton including Northern Alberta. While findings appear promising, given our sample size, they should be considered with caution when generalizing to a larger population. Strengths of the study include a moderate sample size, clear grading criteria, and three independent reviewers with a pre-established >95% interrater correlation. Strength of our scoring and assessment of the visual field reports was the standardized approach and cut-offs while grading. Additionally, our post-hoc analysis (albeit small and limited) does shed some light on the clinical correlate to our theoretical stance. However, findings would have further been validated if both Octopus and 24-2 SITA fast HVF testing were conducted on all participants to facilitate a direct head-to-head comparison with a larger sample size.

CONCLUSION

The 24-2 SITA fast HVF Exam may be a faster and more cost-effective alternative to an OVF test for detecting visual field defects in patients with neurological pathology. However, patients with severe vision loss or those not able to fixate on isopters I4e or lower may require a more robust assessment with OVF testing.

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