Medical Hypothesis, Discovery & Innovation Ophthalmology Journal

Original Article

Sensitivity and Specificity of Swedish Interactive Threshold Algorithm and Standard Full Threshold Perimetry in Primary Open-angle Glaucoma

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ABSTRACT

Perimetry is one of the mainstays in glaucoma diagnosis and treatment. Various strategies offer different accuracies in glaucoma testing. Our aim was to determine and compare the diagnostic sensitivity and specificity of Swedish Interactive Threshold Algorithm (SITA) Fast and Standard Full Threshold (SFT) strategies of the Humphrey Field Analyzer (HFA) in identifying patients with visual field defect in glaucoma disease. This prospective observational case series study was conducted in a university-based eye hospital. A total of 37 eyes of 20 patients with glaucoma were evaluated using the central 30-2 program and both the SITA Fast and SFT strategies. Both strategies were performed for each strategy in each session and for four times in a 2-week period. Data were analyzed using the Student's t-test, analysis of variance, and chi-square test. The SITA Fast and SFT strategies had similar sensitivity of 93.3%. The specificity of SITA Fast and SFT strategies was 57.4% and 71.4% respectively. The mean duration of SFT tests was 14.6 minutes, and that of SITA Fast tests was 5.45 minutes (a statistically significant 62.5% reduction). In gray scale plots, visual field defect was less deep in SITA Fast than in SFT; however, more points had significant defect ($p < 0.5\%$ and $p < 1\%$) in pattern deviation plots in SITA Fast than in SFT; these differences were not clinically significant. In conclusion, the SITA Fast strategy showed higher sensitivity for detection of glaucoma compared to the SFT strategy, yet with reduced specificity; however, the shorter test duration makes it a more acceptable choice in many clinical situations, especially for children, elderly, and those with musculoskeletal diseases.

KEY WORDS

Humphrey Field Analyzer; Perimetry; Primary Open-Angle Glaucoma; SITA Fast strategy; Standard Full Threshold Strategy

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INTRODUCTION

Glaucoma diagnosis is mainly based on optic disc visualization, visual field (VF) evaluation, and intraocular pressure measurement. Automated full-threshold achromatic perimetry is the standard test for the evaluation, staging, and diagnosis of increased glaucomatous VF defect [1-8]. Several devices and strategies have been developed for more accurate and faster determination of the extent and depth of glaucomatous VF defect [9, 10]. The Standard Full Threshold (SFT) strategy in the Humphrey Field Analyzer (HFA) is the current gold standard for VF evaluation in most centers; however, the test is time consuming, lasting almost 30 minutes for both eyes in an average patient and even more in patients with glaucoma [11-14]. In contrast, with a more intelligent determination of threshold sensitivities, the Swedish Interactive Threshold Algorithm (SITA) Fast strategy is a much faster way for VF evaluation in glaucoma, with a test duration of almost 10 minutes for both eyes, which means a 75% reduction in the test duration [15-17]. The strategy requires a combination of parameters, including the usage of data about the surrounding points, information about threshold values in age-matched controls and glaucoma patients at every location, differences in the pacing of the test, elimination of retest trials for the ten points applied to calculate short-term fluctuation in the full threshold algorithm, changing the manner in which false-positive and false-negative reliability parameters are declared, and the use of a maximum likelihood procedure for calculating the threshold [17-19]. It has been proposed that SITA strategies should replace the full-threshold algorithm for detection and follow-up of glaucomatous VF defect [20]. However, there are limited reports comparing the sensitivity and specificity of these strategies [15, 21, 22]. Our aim was to determine and compare the diagnostic sensitivity and specificity of SITA Fast and SFT strategies of the HFA for identifying patients with VF defect in glaucoma disease.

MATERIALS AND METHODS

Twenty patients with glaucoma with regular follow-up examinations in a tertiary eye hospital in northeast of Iran were recruited for research. All of the individuals who signed our written informed consent entered the study and the investigation adhered to the Declaration of Helsinki. The study proposal (no. 1542) was approved by the Ethical and Research Committee of the Mashhad University of Medical Sciences, Mashhad, Iran. Patients with an established diagnosis of primary open-angle glaucoma (POAG), having a pretreatment intraocular pressure more than 21 mmHg, open angle in static gonioscopy, and features of glaucomatous optic neuropathy, were included in the study. All of the included patients had a best-corrected Snellen visual acuity of 20/40 or more and had sufficient cooperation for performing repetitive VF testing. As the patients were selected among under-treated patients with glaucoma having prior experience with HFA visual testing, all of the included patients passed the learning phase, prior to the study. For each subject, four perimetry sessions were scheduled in a 2-week period. In each session, central 30-2 visual field testing was performed with both the SITA Fast and SFT strategies. As described previously [22], the strategy was randomly alternated between patients to produce similar fatigue across the tests, but the order was written constant for each subject in all testing sessions. A rest time of 30 minutes between consecutive tests was considered. All tests were performed with the HFA II 750-6474 Rev. A 10.2 (Carl Zeiss Meditec, Dublin, CA). Refractive error correction with consideration of appropriate near addition in presbyopic patients was used. Patients on miotic therapy were examined after an approximately equal time following miotic instillation, and pupil size was considered when interpreting VF. Considering the reliability indices, unreliable VFs were discarded. VFs were analyzed using the Glaucoma Hemifield Test (GHT) report according to Table 1.

Table 1. Interpretation of Visual Fields according to the Glaucoma Hemifield Test (GHT) Report

Positive for glaucoma	Negative for glaucoma
Borderline	Within normal limit
Outside normal limit	Within normal limit
Generalized reduction of sensitivity	Within normal limit

In each subject, the result of one session of SFT perimetry was randomly omitted and among the remaining 3 SFT results, the “overall” VF was interpreted as follows: if the GHT result in SFT was negative in 2 or 3 sessions, the test was considered negative; in contrast, VF was marked as abnormal if the GHT result was positive in 2 or 3 of SFT fields. Sensitivity and specificity of SFT and SITA Fast strategies were calculated by comparing the results of a randomly omitted session with those of the overall field. In addition, the number of abnormal points with a $P < 0.5\%$ and $P < 1\%$ in a total

deviation plot (TDP) and pattern deviation plot (PDP) of the two strategies were compared. Similar to Bengtsson et al., we used SITA Fast for a shorter threshold test compared to full-threshold strategy and similar quality (i.e., sensitivity and specificity). In recent studies, SITA Fast test duration was decreased by 66% in comparison to the full-threshold strategy. Bengtsson et al. concluded that SITA Fast could be an alternative screening strategy, with more reproducibility than the full-threshold strategy. Moreover, SITA Fast can better represent the functional VF. Based on this information, we decided to use SITA Fast in our investigation [23]. Student's t-test, analysis of variance, and chi-square test were used for comparison of quantitative and qualitative data. All statistical analyses were done using SPSS 11 (SPSS Inc. Chicago, IL). The statistical significance level was set at the $P < 0.05$ level and a power for detecting difference of 80% was considered when calculating the sample size prior to the study.

RESULTS

Thirty-seven eyes of 20 patients with glaucoma, including 19 right eyes and 18 left eyes, met the study criteria and were included in the final analysis. For each eye, SFT and SITA Fast perimetry was performed four times. Overall, 296 VF values were obtained. From these 296 values, 248 had positive GHT for glaucoma and 48 had negative GHT. The sensitivity for glaucoma diagnosis was 93.3% for both SITA Fast and SFT strategies. The SITA Fast strategy had a lower specificity (57.14%) than the SFT strategy (71.4%) (Table 2 and Table 3).

Table 2. Standard Full Threshold (SFT) Glaucoma Hemifield Test (GHT) results.

SFT GHT result Result	Overall SFT GHT result [gold standard]		Total
	+	-	
+	28	2	30
-	2	5	7
Total	30	7	37

Sensitivity = 93.3%, Specificity = 71.4%

Table 3. Swedish Interactive Threshold Algorithm (SITA) Fast Glaucoma Hemifield Test (GHT) Results.

SITA Fast GHT result	Overall SFT GHT Result [gold standard]		Total
	+	_	
+	28	3	31
-	2	4	6
Total	30	7	37

Sensitivity = 93.3%, Specificity = 57.14%

Based on the pattern standard deviation (PSD), 46.6% of patients had mild VF defect ($PSD < 5$) and 39.2% and 14.2% of patients had moderate ($5 < PSD < 10.5$) and severe ($PSD > 10.5$) VF defect, respectively. Considering mean deviation (MD), absolute mean MD was lower in the SITA Fast strategy than in the SFT strategy (-10.41 ± 9.95 vs. -12.15 ± 9.33 dB, respectively). Although the difference was not statistically significant ($P = 0.279$), this indicates a shallower VF defect in the SITA Fast than in the SFT. Abnormal points with $P < 0.5\%$ and $P < 1\%$ in the PDP and TDP were compared between the two strategies. In the SITA Fast PDP and SFT PDP, 17.25% points and 13.88% points had $P < 0.5\%$, respectively; the difference was not statistically significant ($P = 0.324$). In the SITA Fast PDP and SFT PDP, 11.02% points and 8.94% points had $P < 1\%$, respectively; again, the difference was not statistically significant ($P = 0.626$). In the TDP, 19.72% points in the SITA Fast and 20.36% points in the SFT were abnormal at the $P < 0.5\%$ level, with no significant difference between the two groups ($P = 0.831$). The duration of the SITA Fast test was significantly shorter than that of the SFT strategy (5.45 ± 1.14 minutes vs. 14.6 ± 3.78 minutes for each eye, respectively; $P < 0.001$).

DISCUSSION

According to our investigation, the SITA Fast and SFT strategies had similar sensitivity of 93.3%. The specificity of the SITA Fast and SFT strategies was 57.4% and 71.4%, respectively. The mean test duration for the SFT strategy was 14.6 minutes, compared to 5.45 minutes for the SITA Fast strategy (a statistically significant 62.5% reduction). In gray scale plots, VF defect was less deep in the SITA Fast than in the SFT; however, more points had significant defect ($P < 0.5\%$ and $P < 1\%$) in the PDP for the SITA Fast than for the SFT strategy; these differences were not clinically significant. There is a trend toward faster strategies, including SITA, to substitute full threshold strategy in clinical practice. Although full-threshold, automated white-on-white perimetry is the current gold standard for VF evaluation in glaucoma, the long testing duration in association with a relatively long learning curve hinder its routine use in clinical practice. However, as VF defect as detected with SFT perimetry is one of the diagnostic criteria for glaucoma, obviously any other modality compared with it will have a lower sensitivity in diagnosing VF defects. As Budenz et al. stressed in their article [22], the lower sensitivity of SITA strategies in detecting glaucomatous field defect compared to full-threshold strategy does not mean that full-threshold testing is better at detecting glaucoma than the SITA algorithms. In fact, it is possible that the faster SITA algorithms could be more sensitive for the

detection of early glaucoma than the full-threshold algorithm. In our series, considering GHT, SITA Fast and SFT strategies had similar sensitivity for glaucoma diagnosis (93.3%), which was similar to other fast strategies such as FastPac. Sekhar et al. reported a sensitivity of 95.12% and 92.68% for SITA Standard and SITA Fast strategies, which is similar to our results. In addition, they had a similar test duration reduction of 50.12% and 80.96% for the SITA Standard and SITA Fast strategy, respectively [20]. Several other authors reported similar short test duration for SITA strategies; however, the relative test duration increases as a factor of disease severity in the SITA strategy [16, 17, 20, 24]. It has been suggested that regarding the considerable time savings with these newer test algorithms, it may be that SITA is producing a more accurate representation of the VF in glaucoma patients because reduction in test-taking time results in less fatigue and reduced retinal fatigue [12, 14, 22]. Threshold sensitivities are higher in the SITA Fast strategy than in the SFT; therefore, the VF defect is shallower in the SITA Fast gray scale plot. Considering that threshold determination in the SITA strategy is less variable, probability plots are similar between SFT and SITA Fast strategies [25]. In our series, absolute mean MD was lower in the SITA Fast than in the SFT, which indicated a shallower field defect. In contrast, considering PDP, more points were abnormal in the SITA Fast than in the SFT strategy; however, the difference was not statistically significant.

In conclusion, the SITA Fast strategy has higher sensitivity for glaucoma diagnosis compared to the SFT strategy, with considerably shorter test duration; however, their GSP, TDP, and PDP are distinct. With this in mind, one should be cautious when comparing SITA Fast and SFT perimetry printouts. As in patients with advanced glaucoma, the test duration is similar between SITA Fast and SFT strategies, SFT with more detailed information and its additional indices of short-term fluctuations and corrected pattern standard deviation may be a better option for glaucoma evaluation. In contrast, the SITA Fast strategy is the first choice for children, elderly, and those with musculoskeletal disease or limited constant attention, who may not be able to perform well in a more time-consuming SFT strategy. In summary and generally speaking, it seems that currently, there are sufficient evidences to replace full-threshold strategy with the SITA strategy for routine clinical use in patients with glaucoma.

DISCLOSURE

No funding or sponsorship was received for this study. All named authors meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship for this manuscript, take responsibility for the integrity of the work as a whole, and have given final approval for the version to be published. This study has been accepted on 30 December 2017.

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