Original Article

Comparison of 30-2 Standard and Fast programs of Swedish Interactive Threshold Algorithm of Humphrey Field Analyzer for perimetry in patients with intracranial tumors

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Purpose: To find out whether 30-2 Swedish Interactive Threshold Algorithm (SITA) Fast is comparable to 30-2 SITA Standard as a tool for perimetry among the patients with intracranial tumors. **Methods:** This was a prospective cross-sectional study involving 80 patients aged ≥18 years with imaging proven intracranial tumors and visual acuity better than 20/60. The patients underwent multiple visual field examinations using the two algorithms till consistent and repeatable results were obtained. **Results:** A total of 140 eyes of 80 patients were analyzed. Almost 60% of patients undergoing perimetry with SITA Standard required two or more sessions to obtain consistent results, whereas the same could be obtained in 81.42% with SITA Fast in the first session itself. Of 140 eyes, 70 eyes had recordable field defects and the rest had no defects as detected by either of the two algorithms. Mean deviation (MD) ($P = 0.56$), pattern standard deviation (PSD) ($P = 0.22$), visual field index ($P = 0.83$) and number of depressed points at $P < 5\%$, 2%, 1%, and 0.5% on MD and PSD probability plots showed no statistically significant difference between two algorithms. Bland–Altman test showed that considerable variability existed between two algorithms. **Conclusion:** Perimetry performed by SITA Standard and SITA Fast algorithm of Humphrey Field Analyzer gives comparable results among the patients of intracranial tumors. Being more time efficient and with a shorter learning curve, SITA Fast my be recommended as a standard test for the purpose of perimetry among these patients.

Access this article online

Website: www.ijo.in

DOI: 10.4103/ijo.IJO_315_17

Quick Response Code:

Key words: Intracranial tumors, neuro-ophthalmic field defects, perimetry, SITA Fast, SITA Standard, SITA

Intracranial tumors commonly lead to compression of visual pathway resulting in visual field defects. Imaging modalities such as magnetic resonance imaging and coaxial tomographic scan can assess precise structural changes. However, they are costly and time-consuming and are not capable of assessing the functional impact of the lesions on visual function. Perimetry is noninvasive and it is easy to perform investigative modality which can quantify the functional visual damage caused by these lesions. Changes in visual field defects, over a period of time, may be used for assessment of progression, regression, or recurrence of intracranial tumor.

Humphrey Field Analyzer (HFA) is the most popular automated perimeter used to record visual fields. Soon after its introduction in 1997, Swedish Interactive Threshold Algorithm (SITA) strategy became popular as it was a time-efficient technique compared to older, more lengthy strategies.[1-5] Following multiple independent validation studies, full threshold (FT) technique has been discontinued.

There is a lack of gold standard program for recording visual fields among the patients with intracranial tumors. Clinicians generally use 30-2 SITA Standard based on their experience with field recording for patients of glaucoma. On a thorough Medline search, studies comparing 30-2 SITA Standard and 30-2 SITA Fast among the patients of glaucoma or normal controls were found.[6-13] However, no such study comparing different strategies or different algorithms within each strategy could be found among the patients of intracranial tumors. It is understandable that the results obtained from these studies cannot be extrapolated for the patients with neurological field loss due to basic differences in characteristics of field defects and also due to poor well-being of patients with neurological diseases. The current study was designed to compare 30-2 SITA Standard and SITA Fast for perimetry among the patients of intracranial tumors to identify a simpler and less tiring test which could collect equally useful information in these sick patients.

Methods

This prospective, cross-sectional observational case study was carried on 80 patients who had attained 18 years of age and had imaging documented intracranial tumors. These patients were referred to the Department of Ophthalmology of our hospital between November 2014 and March 2016. Patients who were too sick to undergo multiple visual field examinations, those with best-corrected visual acuity (BCVA) lesser than 20/60, patients with any disease likely to cause visual field defect and those who had undergone neurosurgery were excluded

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Manuscript received: 02.05.17; Revision accepted: 03.08.17

Cite this article as: Singh MD, Jain K. Comparison of 30-2 Standard and Fast programs of Swedish Interactive Threshold Algorithm of Humphrey Field Analyzer for perimetry in patients with intracranial tumors. Indian J Ophthalmol 2017;65:1198-202.

from this study.

Consent was obtained from all the patients before enrollment. Ethics committee approval was obtained and this study adhered to the tenets of Declaration of Helsinki. Patients who fulfilled the inclusion and exclusion criteria were enrolled in the study and underwent complete ophthalmic examination followed by white-on-white perimetry on HFA (Carl Zeiss Meditec HFA II 745/750) using 30-2 SITA Standard as well as 30-2 SITA Fast algorithm till repeatable and consistent results could be obtained. The order of selection of algorithm during each test was randomized by a lottery system and at least 15 min rest was given between any two field recordings. The patients underwent all sets of visual field examinations within 15 days of first visual field recording to avoid any changes in visual fields caused by the growth of tumors. If no reliable and consistent fields were obtained after repeating the tests six times, the patient was excluded from the study.

Calculations of global indices were performed using StacPac for SITA version A10.1 (Humphrey Systems-Humphrey Instruments Inc, San Leandro, CA USA). This was done automatically by the field analyzer using its inbuilt software.

Normality of data was tested by Kolmogorov–Smirnov test. Quantitative variables between the two techniques were compared using paired *t*-test or Wilcoxon signed-rank sum test (when data sets were not normally distributed). Qualitative variables were compared using Chi-square test. Bland–Altman method was used to determine the level of agreement between two algorithms in assessing size and depth of visual field defect. The data analysis was done using Statistical Package for Social Sciences, SPSS version 21.0 (IBM Corporation, USA).

Results

A total of 140 eyes (75 right and 65 left) of 80 patients fulfilling the inclusion and exclusion criteria were analyzed in this study. Age and sex distribution of all patients is presented in Table 1. Mean age was 37.9 ± 14.4 years (median age being 35 years with range of 18–75 years) with 74% of the patients falling in the age group 20–50 years. BCVA of patients included in the study is summarized in Table 2. Most common radiologically documented intracranial tumor in our study was pituitary adenoma (81.25%). On repeated visual field examination, 81.4% patients could learn field charting with SITA Fast in one session itself, but almost 60% of those undergoing SITA Standard required more than two sessions ($P < 0.0001$) [Table 3]. Of 140 eyes, 70 eyes had recordable visual field defects whereas rest 70 eyes had normal visual fields which were detected with both the algorithms in the same patients (100% agreement). It was observed that when we compared mean of mean deviation (MD), foveal threshold, pattern standard deviation (PSD), visual field index and number of depressed points at $P < 5\%$, 2%, 1%, and 0.5% on MD as well as on PSD probability plot, there was no statistically significant differences in between two algorithms as depicted in Table 4. Average test duration of SITA Standard and Fast was 7.7 ± 1.3 and 4.7 ± 0.9 min, respectively, i.e., 30-2 SITA Fast was 38.7% faster than SITA Standard. The patients who took longer to perform SITA Standard also took more time in recording fields with SITA Fast ($r = 0.53$, $P < 0.0001$) [Fig. 1].

Table 1: Age and sex distribution of the enrolled patients

Age (years)	Frequency (%)	Males (%)	Females (%)
≤20	6 (7.50)	2 (4.88)	4 (10.26)
21-30	25 (31.25)	6 (14.63)	19 (48.72)
31-40	18 (22.50)	11 (26.83)	7 (17.95)
41-50	16 (20.00)	8 (19.51)	8 (20.51)
51-60	10 (12.50)	9 (21.95)	1 (2.56)
61-70	3 (3.75)	3 (7.32)	0
>70	2 (2.50)	2 (4.88)	0
Total	80 (100)	41 (51.25)	39 (48.75)

Table 2: Best-corrected visual acuity of the enrolled patients

BCVA	Number of eyes (%)
20/20	67 (45.71)
20/30	31 (22.14)
20/40	27 (19.29)
20/60	18 (12.86)
Total	140 (100)

BCVA: Best-corrected visual acuity

Table 3: Frequency of repetition of visual field charting before reliable and consistent results were obtained

Frequency of repetition*	Number of eyes (%)	
	30-2 SITA standard	30-2 SITA fast
1	57 (40.71)	114 (81.42)
2	47 (33.10)	25 (17.61)
3	19 (13.38)	0
4	13 (9.15)	1 (0.70)
5	4 (2.82)	0
Total	140 (100)	140 (100)

*Number of times visual field test was required to be repeated before getting reliable and consistent result. SITA: Swedish Interactive Threshold Algorithm

Compared to SITA Standard, SITA Fast was found to be 87% sensitive and 100% specific on the basis of MD and was found to be 85% sensitive and 92% specific on the basis of PSD as depicted in Figs. 2 and 3. Positive predictive value (PPV) of SITA Fast was 98% on basis of MD and 93% on basis of PSD as compared to SITA Standard. Depth-wise, visual field defect on SITA Fast was deeper in 41.4% fields, equal depth in 8.6% fields and shallower in 50% patients as compared to SITA Standard ($P = 0.03$). Size of visual field defect on SITA Fast was smaller in 45.7% fields and equal in size in 44.3% fields as compared to SITA Standard ($P = 0.55$). By applying Bland–Altman test, it was found that even though the differences in the averages of parameters between the measurements were statistically insignificant, considerable variability existed between two algorithms as depicted in Table 5 and Figs. 4 and 5.

Discussion

Learning curve of SITA Fast was found to be much shorter than SITA Standard, thus making SITA Fast a more user-friendly

Table 4: Comparison of various test parameters for 30-2 Swedish Interactive Threshold Algorithm Standard and 30-2 Swedish Interactive Threshold Algorithm Fast algorithms

Test parameter	Mean±SD		*P*
	SITA standard	SITA fast	
Foveal threshold	33.63±4.53 dB	33.48±4.62 dB	0.343
MD	−7.87±7.18 dB	−7.79±7.45 dB	0.561
Depressed points with *P*<5% on MD probability plot (*n*)	10.37±6.88	10.56±7.25	0.667
Depressed points with *P*<2% on MD probability plot (*n*)	8.74±4.91	9.48±5.85	0.56
Depressed points with *P*<1% on MD probability plot (*n*)	12±9.77	9.7±5.82	0.171
Depressed points with *P*<0.5% on MD probability plot (*n*)	25.63±24.55	28.33±22.53	0.137
PSD	7.01±6.1 dB	6.92±5.97 dB	0.22
Depressed points with *P*<5% on PSD probability plot (*n*)	3.44±2.02	4.14±2.42	0.121
Depressed points with *P*<2% on PSD probability plot (*n*)	2.57±1.8	2.97±2.24	0.47
Depressed points with *P*<1% on PSD probability plot (*n*)	2.74±1.7	3.44±2.42	0.433
Depressed points with *P*<0.5% on PSD probability plot (*n*)	28.13±18.06	28.7±20.76	0.424
VFI	81.04±22.89	81.54±22.86	0.829

SD: Standard deviation, MD: Mean deviation, PSD: Pattern standard deviation, VFI: Visual field index, SITA: Swedish Interactive Threshold Algorithm

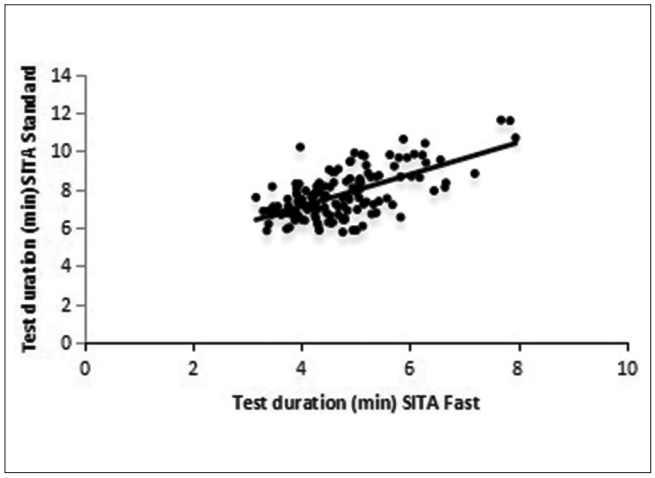

Figure 1: Correlation of test duration between 30-2 Swedish Interactive Threshold Algorithm Standard and 30-2 Swedish Interactive Threshold Algorithm Fast

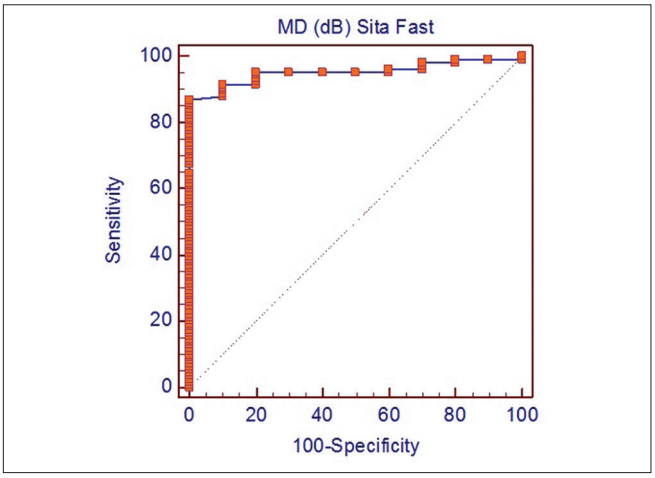

Figure 2: Receiver operating curve for mean deviation of 30-2 Swedish Interactive Threshold Algorithm Fast as compared to 30-2 Swedish Interactive Threshold Algorithm Standard

test, as expected. This is especially beneficial for patients of neurological diseases as they are usually too sick to undergo multiple visual field recordings. This also reduces the burden on the system charting the fields as well as the inconvenience to these patients.

In the present study, 60% of 80 patients had abnormal field results in one or both eyes, thus reiterating the morbidity caused by intracranial tumors and the importance of perimetry in these cases. It was also seen that if any field defect was detected in a patient on performing perimetry with 30-2 SITA Standard, it was also detected while performing perimetry with 30-2 SITA Fast. Thus, favoring our hypothesis that both the algorithms of perimetry are equally efficacious in detecting visual field defects.

When we compared various global indices between two algorithms, it was found that they were comparable with no statistically significant difference between them. A validation study by Budenz *et al*. found that 30-2 SITA Standard and 30-2 SITA Fast had excellent sensitivity (98%) and specificity (95%) for the detection of glaucomatous visual field defects using FT as the reference standard.[9] Another validation study by Budenz *et al*. concluded that the ability of detection of glaucomatous visual field defects with both the SITA algorithms was comparable to FT with size and severity of the defects also being same. However, the defects were shallower with SITA algorithms as compared to FT.[8] A similar study observed that both of the SITA algorithms, i.e, 30-2 SITA Standard and SITA Fast, could identify all the significant glaucomatous field losses as detected on perimetry with FT.[10]

In our study, average test duration of 30-2 SITA Fast was 38.7% shorter as compared to 30-2 SITA Standard which was comparable to the previous studies which have reported test duration of SITA Fast to be 39%–52% shorter than SITA Standard.[8,9,11] Approximately 82% patients could learn field charting with SITA Fast in one session itself but 60% of those undergoing SITA Standard required two or more sessions to learn field charting, which was statistically very significant ($P < 0.0001$). It has also been suggested that shorter

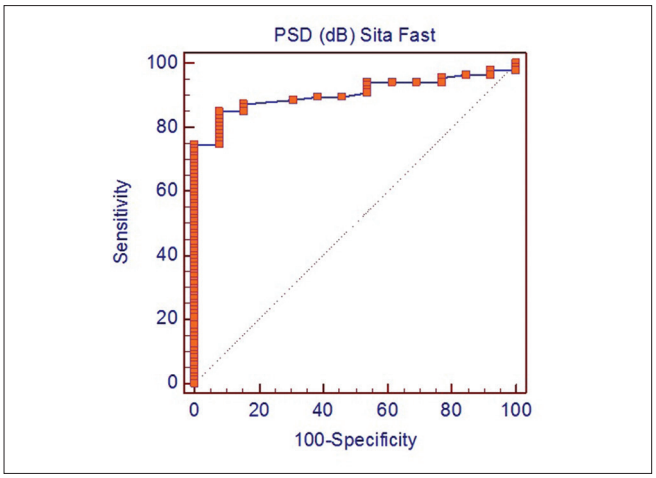

Figure 3: Receiver operating curve for pattern standard deviation of 30-2 Swedish Interactive Threshold Algorithm Fast compared with 30-2 Swedish Interactive Threshold Algorithm Standard

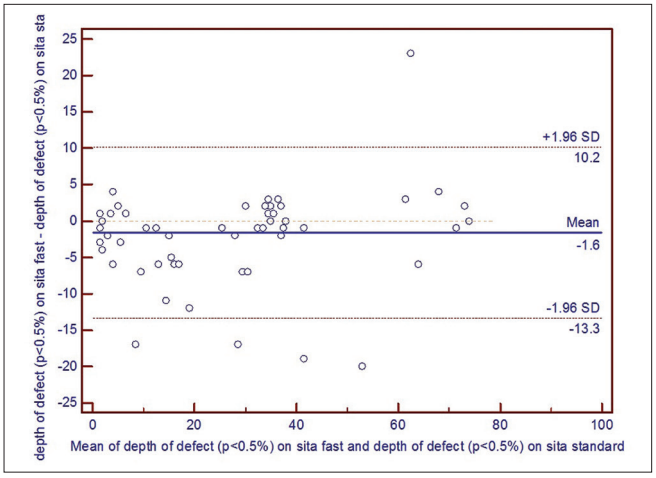

Figure 4: Bland–Altman plot showing the agreement of the depth of visual field defect as detected by 30-2 Swedish Interactive Threshold Algorithm Standard and 30-2 Swedish Interactive Threshold Algorithm Fast

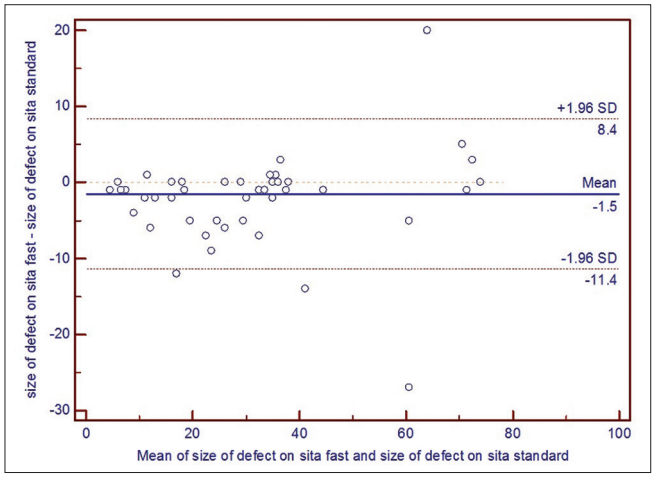

Figure 5: Bland–Altman plot showing agreement in size of visual field defect as detected by 30-2 Swedish Interactive Threshold Algorithm Standard and 30-2 Swedish Interactive Threshold Algorithm Fast

Table 5: Average difference in measurements in between the two algorithms

	Mean difference	SD	Lower limit	Upper limit	95% CI of agreement
Depth of defect	1.59	6.00	−13.3	10.2	−13.3-10.2
Size of defect	1.51	5.06	−11.4	8.4	−11.4-8.4

CI: Confidence interval, SD: Standard deviation

test duration potentially improves test reliability through reduction of patient's fatigue[14-16] but fatigue was not assessed by the design of our study. The patients who took longer time to perform 30-2 SITA Standard test also took more time in recording fields with 30-2 SITA Fast. Statistically, there was a significant correlation between the time duration of SITA Fast with SITA Standard [$r^2 = 0.53$, $P < 0.001$, Fig. 1]. There were no studies in the literature, to the best of our knowledge, which could validate this.

Area under the receiver operating (ROC) curve (AUC) was calculated to compare the sensitivity and specificity of SITA Fast with SITA Standard on the basis of global indices, viz. MD and PSD, as shown in Figs. 2 and 3. Area under the curve was 0.953 for MD and 0.906 for PSD implying that SITA Fast had excellent accuracy when compared with SITA Standard. As compared to SITA Standard, SITA Fast was found to be 87% sensitive and 100% specific on the basis of MD and was found to be 85% sensitive and 92% specific on the basis of PSD. Compared to SITA Standard, PPV of SITA Fast was 98% on the basis of MD and was 93% on the basis of PSD, again showing excellent correlation between the two tests. On the basis of above findings, it was concluded that MD was a better predictor of field loss as compared to PSD in neurological fields. This was probably because patients with intracranial tumors are usually younger patients with no media opacity and any defects in the field are only neurological and not due to media opacities. Field loss due to progressive media opacity, such as cataract, usually takes long duration to develop and any progression of field within a short duration of time is likely to be neurological in origin only and not due to media opacity. This is in contrast to glaucoma where PSD is a better predictor of field loss as compared to MD as glaucoma is a progressive disease persisting lifelong and patients are generally older, with high incidence of associated cataract. Thus, any progression in field defect in these patients can be both due to progressive cataract as well as to glaucoma. Therefore, one needs to differentiate generalized depression from localized field loss in these patients, making PSD a superior criterion. Another factor in regard to this could be the difference in the nature of field defects in these disorders. Whereas the neurological field defects are deep absolute defects with well-defined margins, glaucomatous defects may be relative defects with variable depth and sloping margins and are more likely to have long-term variations. This concept can also be extrapolated from a validation study by Budenz *et al.*, wherein the sensitivity of 30-2 SITA Standard and SITA Fast in detecting glaucomatous defects was 98% and 95%, respectively, as compared to FT. In the subset of mild glaucomatous field defects, sensitivity of SITA Standard was 92% versus 85% with SITA Fast as compared to FT. In the same study, sensitivity was 100% for both algorithms in moderate to severe glaucomatous defects. Specificity for glaucomatous

defects using SITA Standard and SITA Fast was 96% for both algorithms.[9]

Although we found that MD is a better predictor of field loss as compared to PSD in neurological fields, we still used PSD to calculate the size and depth of defect. This was done because in some patients with cataract, localized loss of field (actual neurological field loss) could be appreciated only on PSD probability plot. More studies are required in this direction to evaluate the size and depth of neurological field defect based on MD and PSD probability plots in patients with and without cataract.

We observed that visual field defect on SITA Fast (as compared to SITA Standard) was shallower in 50% of the cases (P = 0.03) which was statistically significant. Although the depth of defect between two algorithms was found to be significant, this finding may not be relevant in neurological fields as these defects are generally absolute defects. Also, since the depth of defect was found to be significant between two algorithms, these two should not be used interchangeably for follow-up in the same patient. Budenz *et al*. also noted that the depth of defects measured by SITA Standard and SITA Fast was significantly shallower compared to that measured by FT.[8]

We observed that field defects detected on SITA Fast were smaller in size as compared to SITA Standard in 46% of eyes. This was statistically insignificant (P = 0.55). Budenz *et al*. also noted that the size of glaucomatous defects was slightly larger using SITA Standard algorithm compared with FT.[8] Although our study found 100% agreement in the detection of presence or absence of field defect, variability of size of visual field defect in between SITA Standard and Fast algorithm may become significant in patients with early neurological field loss. Studies focusing on early field loss may throw better light on this parameter.

By applying Bland–Altman test, we concluded that inter-algorithm test results may be comparable in general, but in the management of the individual patients, field defect should be verified by repeat testing using the same algorithm. In other words, the two algorithms cannot be used interchangeably on different test sessions for the same patient [Figs.4 and 5]. If visual fields suggest a change in two sequential tests, this should be verified by repeat testing using the same algorithm.

Conclusion

Perimetry performed by SITA Standard and SITA Fast algorithm of Humphrey Field Analyzer gives comparable results among the patients of intracranial tumors. Being more time efficient and with a shorter learning curve, SITA Fast my be recommended as a standard test for the purpose of perimetry among these patients. However, the two algorithms cannot be used interchangeably on different test sessions for the same patient.

Acknowledgment

We would like to acknowledge the efforts of Dr. Bindu, Specialist, Department of Endocrinology, Dr. Ajay Chaudhary, Specialist, Department of Neurosurgery, Dr. RML Hospital, and Mrs. Bhawna, Statistician, for their invaluable support and guidance.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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