

DIFFERENT STRATEGIES FOR HUMPHREY AUTOMATED PERIMETRY: FASTPAC, SITA STANDARD AND SITA FAST IN NORMAL SUBJECTS AND GLAUCOMA PATIENTS

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SUMMARY

Purpose: To evaluate the influence on examination time and test quality of the recently introduced SITA strategies of the Humphrey Field Analyzer.

Methods: The sample consisted of 41 subjects (19 normal subjects and 22 glaucoma patients), all experienced in automated perimetry, ranging in age from 24 to 83 years. One eye of each patient was examined with the HC30-2 program using the FASTPAC (FP) and SITA Standard (SS) or SITA Fast (SF) strategy on the same day, in random order. Examination time was evaluated as a function of the strategy. To evaluate the test quality both regional and global visual field parameters were analyzed. Global parameters included mean deviation (MD) and pattern standard deviation (PSD). Regional parameters (mean and maximum loss) were calculated to estimate the extent and the depth of localized visual field defects. For this purpose each visual field was divided in 4 quadrants and in 10 clusters as defined in the glaucoma hemifield test.

Results: 1. There is a considerable test time reduction from FASTPAC over SITA Standard to SITA Fast for comparable MD and PSD values. On average, the SITA Fast test duration is half that of the FASTPAC procedure. For each strategy, the test duration increases for increasing visual field loss. 2. Between all three strategies, there is a good correlation for the

global indices (MD, PSD) 3. For the regional indices (mean loss, maximum loss) the same high correlation exists.

Conclusion: The SITA strategy causes a significant test time reduction without decreasing the test quality.

RÉSUMÉ

Intention: Evaluation de l'influence sur la durée et sur la qualité de l'examen des nouvelles stratégies SITA sur le Humphrey Field Analyzer.

Méthodes: L'échantillon est composé de 41 sujets (19 sujets normaux et 22 patients), âgés entre 24 et 83 ans. Un oeil de chaque sujet est examiné avec le programme HC30-2 utilisant le même jour le FASTPAC (FP) et SITA Standard (SS) ou SITA Fast (SF) dans un ordre randomisé. La durée du test est évaluée en fonction de la stratégie. Les paramètres globaux et régionaux sont analysés pour évaluer la qualité du test. Les paramètres globaux sont 'mean deviation (MD)' et 'pattern standard deviation (PSD)'. Les paramètres régionaux (mean loss et maximum loss) sont calculés pour estimer l'étendue et la profondeur des pertes localisées. Dans ce but le champ visuel est divisé en 4 quadrants et en 10 groupes définis comme dans le 'glaucoma hemifield test'.

Résultats: 1. Il y a une réduction considérable de la durée de l'examen entre FASTPAC, SITA Standard et SITA Fast pour un MD et PSD comparable. En moyenne, le SITA Fast a une durée d'examen réduite à la moitié de celle du FASTPAC. Pour chaque stratégie, la durée du test se prolonge en fonction de l'étendue des déficits du champ visuel. 2. Pour les trois stratégies, il y a une haute corrélation pour les paramètres globaux (MD, PSD). 3. Une même

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haute corrélation existe pour les paramètres régionaux.

Conclusion: La stratégie SITA donne une réduction considérable de la durée du test tout en gardant la qualité des mesures.

KEY WORDS:

algorithms-glaucoma-threshold automated perimetry-SITA

MOTS CLÉS:

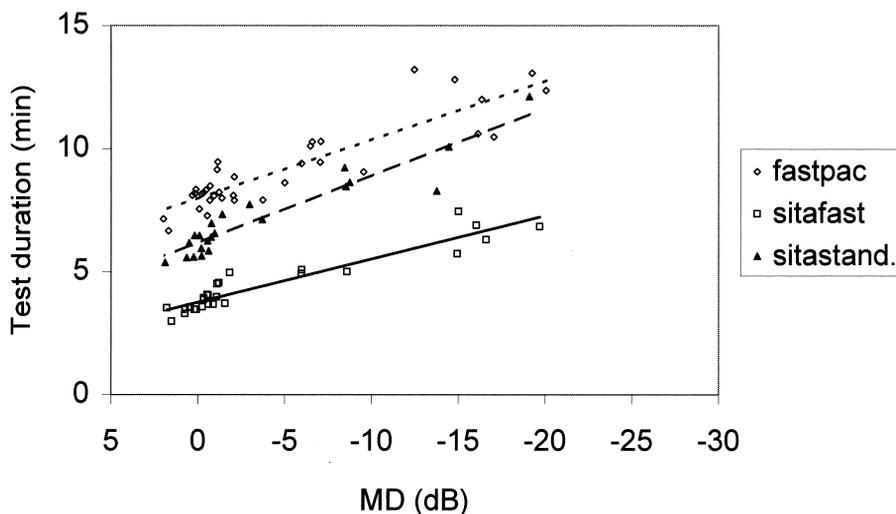
algorithmes-glaucome-périmétrie automatisée-SITA

INTRODUCTION

Perimetry results are essential in the diagnosis and management of glaucoma and other eye diseases. Determining a visual field with an automated perimeter is a time-consuming task for technician and patient, especially for patients with an advanced glaucomatous loss. Therefore faster strategies have been developed over the last years. A recently introduced algorithm for threshold determination, is the SITA strategy (Swedish Interactive Thresholding Algorithm) (1,2). The algorithm was designed to reduce the test duration without any loss of quality in results. A visual field model for normal fields and for glaucomatous defects is constantly up-dated during the test. The software estimates the threshold-value and also the certainty to which the threshold is known at each point. Testing stops at each point where the certainty level has reached a predetermined level. The threshold-value and the certainty-value of each point is influenced by the values of the neighboring points, so the test can be re-opened in each point. Each test subject starts initially with the same visual field model (correction for age). The model changes shape during the test. Another characteristic of the SITA-strategy is the time pacing. The patient can determine the time interval between two stimuli. Initially this interval is the same for all test subjects; as the test proceeds the time interval becomes more adapted to the patient. The SITA strategy uses methods to detect false true and false negative answers, which are more reliable and less time-consuming than the previous strategies. When the test is completed, the algorithm recalculates the threshold-estimates and integrates them in the total answer-frame of the patient. This strategy is especially developed for glaucoma pathology. It uses methods, which take into account the anatomy of the nerve fiber layer. The threshold-estimate at a given point is influenced by the responses at adjoining points, and the influence is greater if the adjacent points lie along the same retinal nerve fiber layer bundle than if they lie across the nerve fiber layer bundle. This explains why a neurological field defect is best determined with other strategies than SITA strategy (1).

We investigated the extent of time reduction, when using the SITA strategy compared to the

Figure 1: MD versus test duration for the three strategies: FASTPAC (FP), SITA Fast (SF) and SITA Standard (SS) in the total group of subjects (normal subjects and glaucoma patients).



FASTPAC strategy and how much testing time is influenced by the severity of the visual field defect. The second part of our study investigates the test quality of the SITA strategy. We used the FASTPAC (FP) strategy as a standard in our clinical trial for comparison and evaluation of the new SITA-method. There are two SITA strategies; SITA Standard (SS) and SITA Fast (SF). The SITA Standard is based on the Full Threshold strategy, whereas the SITA Fast is based on the FASTPAC strategy. In our study we emphasized the comparison between FASTPAC and SITA Fast.

PATIENTS AND METHODS

Forty-one subjects (normal subjects and glaucoma patients) from the Department of Ophthalmology at the University Hospital in Leuven participated in this study. All subjects with a medical history of diabetes mellitus, thyroid or neurological diseases were excluded. Glaucoma patients with other accompanying ophthalmologic pathology were also excluded. All subjects underwent a routine ophthalmologic examination and had previous reliable visual field testing with automated perimetry. The group included 19 normal subjects and 22 glaucoma patients.

The group of normal subjects consisted of 14 females and 5 males, with a mean age of 44.5 years \pm 17.6 years. Best-corrected visual acuity was always better than 0.8.

The sample of glaucoma patients consisted of 14 females and 8 males with a mean age of 68 years \pm 10.1 years. Visual acuity ranged between 0.3 and 1.0. The diagnosis of glaucoma was based on the presence of at least two out of three of the following criteria: intra-ocular pressure before treatment $>$ 22 mmHg, glaucomatous disc-excavation (cup/disc-ratio $>$ 0.6), obvious visual field defect on previous visual field examinations. Eight of the 22 glaucoma patients underwent previous glaucoma-surgery, 10 had received previous laser treatment, and 18 were being treated with topical beta-blockers. Glaucoma patients were chosen to cover a large range of deficits.

All subjects had pupils greater than 3 mm, a spherical ametropia of less than ± 7 diopters and/or less than ± 2.5 diopters of cylindrical correction.

We tested one eye of each subject with a HC 30-2 program (white stimulus, size III) commonly used in our clinic at the time of the study. Nowadays the 24-2 program is accepted as the standard because it contains 99% of the information provided by the 30-2 [Zeyen, personal communication] but is shorter and has fewer artifacts. All subjects were submitted to a FAST-

Figure 2: PSD versus test duration for the three strategies: FASTPAC (FP), SITA Fast (SF) and SITA Standard (SS) in the total group of subjects (normal subjects and glaucoma patients).

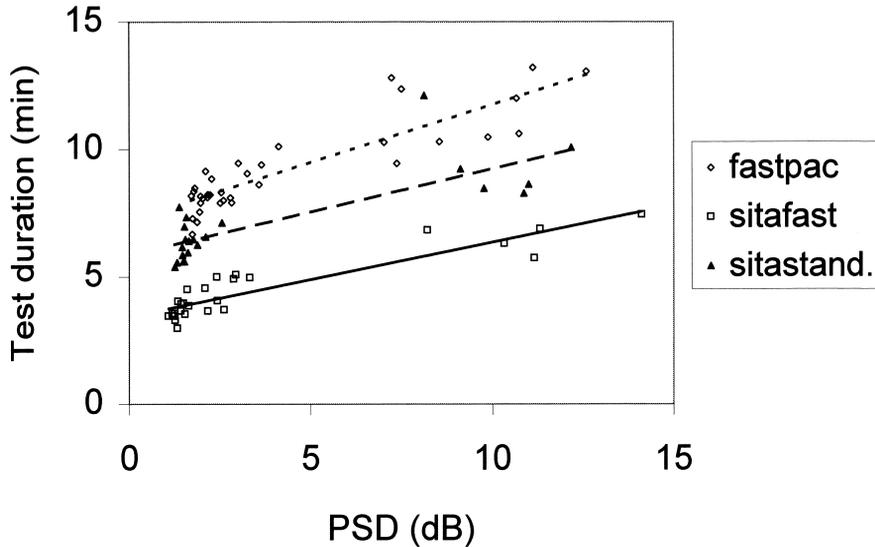


Table 1: Mean (\pm SD) time, MD and PSD and p-values (T-test, two-tailed) for the three strategies in the group of normal subjects. Number of subjects that performed FASTPAC and SITA Fast is 16, Fastpac and SITA Standard is 13.

NORMAL SUBJECTS				
	Fastpac	SITA Standard	SITA Fast	p-value
Time (minutes)	8 \pm 0.6		3.8 \pm 0.5	<0.0001
	8.1 \pm 0.6	6.1 \pm 0.5		<0.0001
MD (mean)	-0.4 \pm 1.1		-0.1 \pm 1.0	0.11
	-0.5 \pm 0.9	-0.05 \pm 0.8		0.04
PSD (mean)	2 \pm 0.3		1.6 \pm 0.6	0.0006
	2.1 \pm 0.3	1.6 \pm 0.2		<0.0001

Table 2: Mean (\pm SD) time, MD and PSD and p-values (T-test, two-tailed) for the three strategies in the group of glaucoma patients. Number of patients that performed FASTPAC and SITA Fast is 12, Fastpac and SITA Standard is 9.

GLAUCOMA PATIENTS				
	Fastpac	SITA Standard	SITA Fast	p-value
Time (minutes)	10.6 \pm 1.7		5.5 \pm 1.2	<0.0001
	10.5 \pm 1.6	8.8 \pm 1.5		0.008
MD (mean)	-9.5 \pm 6.3		-9.3 \pm 6.7	0.82
	-9.8 \pm 6	-9.1 \pm 5.8		0.34
PSD (mean)	6.6 \pm 3.6		6.5 \pm 4.3	0.98
	7.3 \pm 2.7	7.6 \pm 4.1		0.76

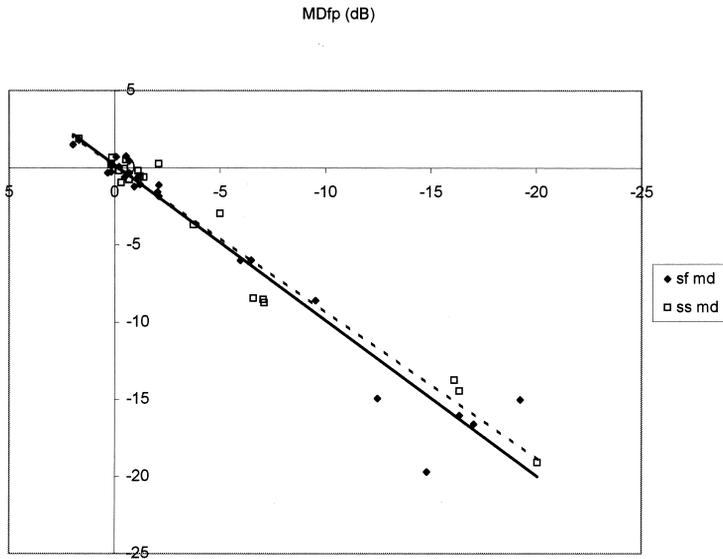
PAC and at least one SITA-strategy (SITA-standard and/or SITA-fast) on the same day. The order of examination was randomized. The choice was made not to include Full threshold testing because of the considerably longer test time although it is known that Full threshold testing gives the highest accuracy. Twelve subjects performed a FASTPAC and SITA Standard strategy; 16 did a FASTPAC and SITA Fast Strategy and 13 subjects were submitted to the 3 strategies (mostly normal subjects). For inclusion of the visual field, we used the following reliability criteria in the FASTPAC strategy: fixation losses (Heijl-Krakau method): < 25%; false

positive responses: < 25%; false negative responses: < 25%; short-term fluctuation: < 3,5dB.

DATA ANALYSIS

Standard global visual field indices calculated by the Humphrey program were used: mean deviation (MD) and pattern standard deviation (PSD). The FASTPAC strategy was used as a standard, as all subjects performed this strategy. For the standard FASTPAC procedure the MD-value for the normal subjects ranged from 1.98 to -2.09 dB; the MD for the glaucoma

Figure 3: MD of the SITA Standard (SS) and the SITA Fast (SF) strategy in function of the MD of the FASTPAC (FP) strategy for the entire group.



group ranged from - 1.15 to - 20.06 dB. The PSD range for the FASTPAC strategy in the normal group was between 1.71 and 2.59 dB; for the glaucoma group the PSD values were between 2.78 and 12.59 dB.

Additionally, we also introduced two regional parameters: mean loss (ML) and maximum loss (MXL). For this purpose, each visual field was divided in 4 quadrants and 10 clusters. The clusters are the same as used in the Glaucoma Hemifield Test (GHT), which compares corresponding areas in the superior and inferior hemifields (Fig.5b). For each quadrant and each cluster, we calculated the mean loss (ML) and the maximum loss (MXL). The mean loss (ML; in dB) was defined as the mean of the deviation values in the region under study; the maximum loss (MXL; in dB) was defined as the point with the maximum deviation in the region under study.

Statistical analysis was performed using the t-test (two-tailed; $p < 0.05$ was considered as statistically significant).

RESULTS

In this study we addressed two major questions. First, what test time reduction do the re-

cently introduced SITA-strategies provide compared to the standard FASTPAC strategy in normal subjects and in glaucomatous patients and secondly, can the (shorter) SITA strategy accurately detect glaucomatous field loss. If the two answers are positive, the SITA strategy could adequately be used for glaucoma follow-up at the Glaucoma Clinic.

A. TEST DURATION

The mean test duration, separately for the 3 strategies, in the group of the normal subjects and in the group of glaucoma patients is illustrated in Tables 1 and 2. Both groups (normal and glaucoma) were divided in two subgroups: one subgroup performed a FASTPAC and a SITA Fast strategy, the other subgroup was submitted to a FASTPAC and a SITA Standard procedure. In the group of normal subjects 16 performed the FASTPAC and the SITA Fast strategy, 13 combined the FASTPAC with the SITA Standard procedure. Twelve glaucoma patients performed a FASTPAC and a SITA Fast procedure, 9 were submitted to a FASTPAC and SITA Standard strategy.

In the normal group (table 1), on average the FASTPAC strategy took 8 minutes, while the

Figure 4: PSD of the SITA Standard (SS) and the SITA Fast (SF) strategy in function of the PSD of the FASTPAC (FP) strategy for the entire group.

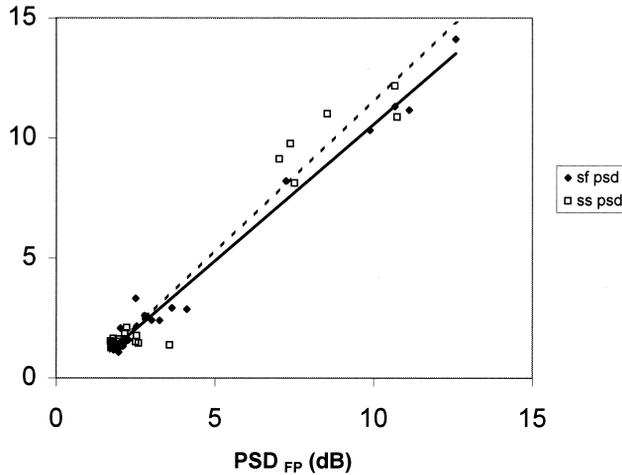


Table 3: Correlation factor r^2 per quadrant and the average value of r^2 for FASTPAC (FP) strategy versus SITA strategy (SITA Standard = SS; SITA Fast = SF) in the total group and in the glaucoma group considering the mean loss.

mean loss FP versus	total group		glaucoma group	
	SS	SF	SS	SF
Q1	0.856	0.952	0.574	0.945
Q2	0.918	0.707	0.865	0.514
Q3	0.925	0.960	0.872	0.940
Q4	0.968	0.945	0.970	0.900
average	0.917	0.891	0.820	0.901

Table 4: Correlation factor r^2 per quadrant and the average value of r^2 for FASTPAC (FP) strategy versus SITA strategy (SITA Standard = SS; SITA Fast = SF) in the total group and in the glaucoma group considering the maximum loss.

max. loss FP versus	total group		glaucoma group	
	SS	SF	SS	SF
Q1	0.857	0.799	0.447	0.748
Q2	0.613	0.582	0.307	0.450
Q3	0.863	0.916	0.687	0.821
Q4	0.755	0.870	0.637	0.808
average	0.772	0.792	0.519	0.707

SITA Standard strategy only took 6.1 minutes and the SITA Fast technique 3.8 minutes.

In the first group (FP and SF) of glaucoma patients (table 2) the mean test duration for the FASTPAC strategy was 10.6 minutes and 5.5 minutes for the SITA Fast strategy. The second group (FP and SS) required 10.5 minutes to perform a FASTPAC strategy and 8.8 minutes to do the SITA Standard procedure.

For both groups (glaucoma and normal subjects) a reduction of the test duration of approximately 50% was thus obtained when using the SF versus the FP strategy (normal subjects: 52.5%; glaucoma group: 48%).

The SITA Standard strategy was responsible for a time reduction of approximately 20%, compared to the FASTPAC strategy (normal subjects: 24%; glaucoma group: 16%).

The differences between the test duration for the 3 strategies in each of the two groups (glaucoma and normal subjects) were statistically highly significant (t-test; $p < 0.01$).

The MD and the PSD values of the 41 subjects (normal subjects and glaucoma patients) for the 3 strategies versus the test duration of each of the three strategies (FASTPAC, SITA-standard and SITA-fast) are illustrated in figure 1 and 2. The straight lines correspond to the linear regression function through the data points.

For each strategy (FASTPAC, SITA-standard and SITA-fast), the test duration progressively increases for increasing visual field loss (Fig.1). The slope of the regression line is -14.3, -16.4 and -10.5 for the FP, SS and SF strategy respectively. These comparable values correspond to the approximately parallel regression

Figure 5a:
Visual field divided in 4 quadrants.

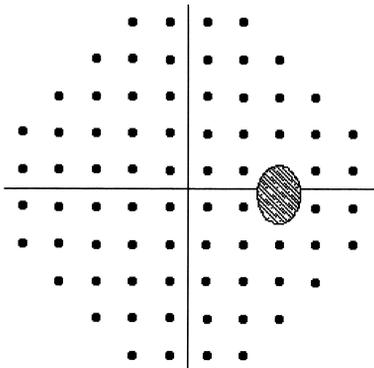


Figure 5b:
Visual field divided in 10 clusters,
as used in the Glaucoma Hemifield Test (GHT).

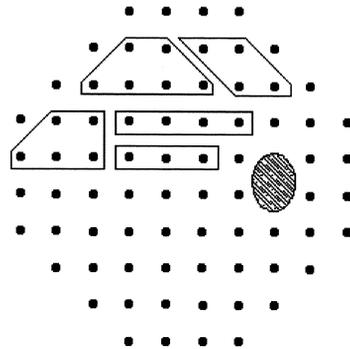


Table 5: Mean correlation factor r^2 per hemifield for the FASTPAC strategy versus SITA Fast and SITA Standard strategy in the total group and in the glaucoma group for the mean loss.

mean loss	total group		glaucoma group	
	SS	SF	SS	SF
FP versus upper hemifield (5 clusters)	0.838	0.860	0.688	0.777
lower hemifield (5 clusters)	0.920	0.906	0.907	0.859

Table 6: Mean correlation factor r^2 per hemifield for the FASTPAC strategy versus SITA Fast and SITA Standard strategy in the total group and in the glaucoma group for the maximum loss.

max. loss	total group		glaucoma group	
	SS	SF	SS	SF
FP versus upper hemifield (5 clusters)	0.777	0.866	0.591	0.824
lower hemifield (5 clusters)	0.869	0.903	0.821	0.860

lines. The correlation factors (r^2) are; 0.72, 0.88 and 0.87 for the FP, SS and SF strategy respectively.

The relation between test strategy and test duration therefore has to be considered for comparable visual field loss. For comparable MD values, there was a progressive time reduction from FASTPAC over SITA Standard to SITA Fast. On average, the SITA Fast test duration was approximately half of the FASTPAC procedure. This time gain holds for normal and glaucomatous fields.

Fig. 2 illustrates the test duration as a function of the pattern standard deviation (PSD). Again the increase of test duration as a function of increasing visual field loss is obvious (slope of the regression function is 28.2, 20.1 and 17.51 for the FP, SS and SF strategy respectively). This corresponds to the approximately parallel regression lines. The correlation factors (r^2) are; 0.76, 0.63 and 0.83 for the FP, SS and SF strategy respectively.

For comparable PSD values again the time reduction from the FP over the SS and SF strat-

egy was obvious for both the normal subjects and the glaucoma patients.

B. TEST-QUALITY

The first part of this study confirmed the considerable time gain obtained when using SITA strategies. It is obvious that the quality of determining the extent and the depth of scotomas should be preserved. In order to test the quality of testing we calculated the mean MD and mean PSD values for the 3 strategies in the group of normal subjects and the group of glaucoma patients. We compared the groups of subjects that performed the same strategy.

In the normal group 16 subjects performed a FP and SF strategy and 13 performed a FP and SS procedure. In table 1 (normal subjects) the mean MD values of the first group (FP and SF) were; -0.4 (FP) and -0.1(SF). The mean PSD values in this group were: 2 (FP) versus 1.6 (SF). For the 13 normal subjects who performed a FASTPAC and SITA Standard strategy the mean MD values were -0.5 (FP) and

-0.05 (SS); the mean PSD values were 2.1 (FP) and 1.6 (SS).

The t-test showed that there was no significant difference for the mean MD values in the group of normal subjects between FASTPAC and SITA Fast ($p=0.11$). On the contrary, there was a statistical difference ($p<0.05$) for the mean MD values of the FASTPAC and SITA Standard strategy. Also the PSD values in the normal group, with slightly lower PSD values for the SITA strategies, were statistically different (FP~SF $p=0.0006$, FP~SS $p<0.0001$).

In table 2 the mean MD and PSD values of the two subgroups of glaucoma patients are illustrated. For the 12 patients who performed a FASTPAC and SITA Fast strategy the mean MD values were respectively -9.5 and -9.3 (p -value of 0.82). The mean PSD values were 6.6 (FP) versus 6.5 (SF), (p -value of 0.98). The mean MD values of the 9 glaucoma patients who were submitted to a FASTPAC and a SITA Standard strategy, were respectively -9.8 (FP) versus -9.1 (SS, p -value of 0.34). The mean PSD values in this group were 7.3 (FP) and 7.6 (SS), (p -value of 0.76).

For the glaucoma patients tested, there was no significant difference between the MD values and PSD values for the 3 strategies.

We then considered the correlation of the MD (and PSD) values for the entire test population (normal subjects and glaucoma patients) for the 3 strategies (fig. 3 and 4). There was an excellent correlation for these visual field indices (MD, PSD), between the FASTPAC strategy and the SITA strategies (for the MD values: FP ~ SF: $r^2=0.94$; FP ~ SS: $r^2=0.94$; for the PSD values: FP ~ SS: $r^2=0.87$; FP ~ SF: $r^2=0.99$). The MD and PSD values are global parameters of the entire visual field tested. In a further step we introduced regional parameters to evaluate the extent (mean loss, ML) and the depth (maximum loss, MXL) of a localized visual field defect. Each visual field was divided in 4 quadrants and 10 clusters as illustrated in figure 5a and 5b.

1. QUADRANT ANALYSIS

A. First we considered the total group of test subjects (normal subjects and glaucoma patients). There was no significant difference between the FASTPAC and SITA strategies for each

quadrant, concerning the ML ($p=1.322$) and MXL ($p=0.952$). In fact there was a high correlation, concerning the mean loss, between the FASTPAC and SITA Standard strategy (average value of $r^2=0.917$), between the FASTPAC and SITA Fast strategy ($r^2=0.891$). Concerning the maximum loss, the correlation factors were only slightly lower, $r^2=0.772$ (FP ~ SS) and $r^2=0.792$ (FP ~ SF).

B. The same conclusions could be made for the group of glaucoma patients separately; 1. No significant difference between the strategies for each quadrant, concerning the mean loss ($p=1.87$) and maximum loss ($p=1.434$), 2. High correlation factors for the ML ($r^2=0.820$ FP ~ SS, $r^2=0.825$ FP ~ SF), 3. Slightly lower correlation factors for the MXL ($r^2=0.519$ FP ~ SS, $r^2=0.707$ FP ~ SF).

2. CLUSTER ANALYSIS

The ML and MXL was calculated for the different strategies for each cluster.

A. For each cluster, there was no statistical difference between the different strategies for the total (glaucoma and normal subjects) group, concerning the ML ($p=1.23$) and the MXL ($p=0.978$). When considering the 5 clusters of the upper hemifield the correlation was high for the mean loss ($r^2=0.838$ FP~SS; $r^2=0.860$ FP~SF) and the maximum loss ($r^2=0.777$ FP~SS; $r^2=0.866$ FP~SF). For the lower hemifield the results were comparable concerning the mean loss ($r^2=0.920$ FP~SS; $r^2=0.906$ FP~SF) and the maximum loss ($r^2=0.869$ FP~SS, $r^2=0.903$ FP~SF).

B. For the group of glaucoma patients the same conclusions hold for each cluster. There was no significant difference between the strategies for the ML ($p=1.68$) and MXL ($p=1.55$). There was a high correlation in the upper hemifield for the mean loss ($r^2=0.688$ FP~SS, $r^2=0.777$ FP~SF) and the maximum loss ($r^2=0.591$ FP~SS, $r^2=0.824$ FP~SF). Comparable high correlation factors were held in the lower hemifield for the mean loss ($r^2=0.907$ FP~SS, $r^2=0.859$ FP~SF) and the maximum loss ($r^2=0.821$ FP~SS, $r^2=0.860$ FP~SF).

We can therefore conclude that for each quadrant and cluster no significant difference existed between FASTPAC, SITA Standard and SITA Fast strategy in estimating localized visual field

loss when considering the mean and maximum loss.

DISCUSSION

The first study concerning the recently introduced SITA strategies was published in 1997, by Bengtsson et al.(1). The purpose of their work was to develop new test strategies, which significantly reduce test time without any reduction of data quality. In their early study they used computer simulations instead of test persons. Simulated test results obtained with this algorithm were slightly more accurate than those of the Humphrey Full Threshold test algorithm.

A. TEST DURATION

In 1998 the same team of Bengtsson et al. (2) evaluated the SITA strategy in a group of 20 normal subjects. They concluded that the SITA strategy was responsible for a significant time reduction of 50% when compared to the Full Threshold and 16% when compared to the FASTPAC strategy.

In the same year they performed another two studies (3,4) of the SITA-strategy, but now with patients with either glaucoma or ocular hypertension. Again they concluded that SITA test times were significantly shorter than those of Full Threshold and FASTPAC. SITA Fast was 53% shorter in test time than the FASTPAC.

Those first results were essentially confirmed by more recent studies (7-10). In the study of Wild et al. (9,10) the examination time in the glaucoma group increased with increase in severity of field loss, as we also concluded in our study. This increase was proportionately greater for the SITA strategies, especially SITA Fast. Our study shows a significant time reduction of approximately 50% when we compare the FASTPAC strategy to the SITA Fast strategy (52.5% in the normal group, 48% in the glaucoma group). The SITA Standard strategy is responsible for a time reduction of approximately 20% (24% in the normal group, 16% in the glaucoma group), compared to the FASTPAC strategy. The absolute test duration correlates with the severity of visual field defect. For each strategy, the test duration progressively increases for increasing visual field loss (MD, PSD). For advanced glaucomatous loss, the test du-

ration approximately doubles when compared to normal fields.

B. TEST-QUALITY

Bengtsson et al.(2) examined the SITA strategy first in a group of normal subjects. Threshold values obtained with SITA were slightly higher than those produced by the other two strategies (Full Threshold and FASTPAC).

The same team (3,4) evaluated the SITA strategy with patients with glaucoma or ocular hypertension. The test-retest variability did not differ significantly between strategies. The inter-test variability of the pattern deviation analysis was lowest in SITA relative to both Full Threshold and FASTPAC. SITA and FASTPAC showed the same amount of visual field loss, although the defects detected by SITA Fast strategy were often deep and more localized than those detected by Full Threshold and FASTPAC strategy.

Quantitative analysis of global indices (MD and PSD) by Nordmann et al. (7) showed a high correlation between the indices ($r > 0.94$ for MD and PSD values). However SITA Standard and SITA Fast had the tendency to underestimate visual fields defects.

Bengtsson et al.(5) investigated the inter-subject variability and normal limits of the SITA strategies and compared them with those obtained with the traditional Full Threshold algorithm. They concluded that SITA test results from eyes with normal visual fields will on average be more even from center to mid-periphery as compared with Full Threshold fields. The visual fields of a SITA strategy also will appear slightly lighter in grey-scale representations and shallower depressions are needed in SITA fields for statistical and clinical significance.

In another study Bengtsson et al. (6) compared the magnitude of glaucomatous visual field defects between SITA and the Full Threshold strategy in 44 glaucoma patients. As in our study, the mean deviation (MD) did not differ between the 3 strategies in this study. In the glaucoma patients, both SITA strategies showed larger number of significantly depressed points than the Full Threshold strategy. They concluded that the two SITA strategies identified at least as much significant glaucomatous field loss as the Full Threshold algorithm.

Wild (9,10) examined the test-quality of the SITA algorithm in normal and glaucoma patients and concluded that both SITA algorithms produce a marginally higher mean sensitivity compared to the existing algorithms but with a statistically deeper defect and a marked reduction in examination time. The reduced between-subject variability of SITA in the normal group should result in narrower confidence limits for definition of normality. The author stated that for long term follow-up of glaucomatous patients SITA Standard is as safe as the Full Threshold strategy. Thereby it is important to realize that the fatigue effect of glaucoma patients would be responsible for an overestimation of the defect depth and a prolonged duration of the examination when using the Full Threshold instead of the SITA Standard.

In the second part of our study we examined the test quality of the SITA strategy. We concluded that in the normal and the glaucoma group there was no significant difference between the MD values for the 3 strategies except for the normal group, where there was a slight statistically significant difference ($p=0.04$) for the test subjects who performed the FASTPAC and SITA Standard strategy. In that same normal group, we noticed a small but statistically significant difference between the mean PSD values ($p < 0.05$) between FASTPAC and SITA strategies. The MD and PSD values of the SITA strategies were on average slightly lower than the MD and PSD values of the FASTPAC strategy. These differences are statistically significant but therefore not of clinical significance, because the MD and PSD values are the result of an algorithm especially made to detect defects in the visual field. On the contrary, in the group of glaucoma patients there was no significant difference between these MD and PSD values probably since these indices now accurately quantify the visual field defects.

On the basis of the regional parameter data we concluded that there was no loss of quality for estimating the extent (mean loss) and depth (maximum loss) of localized visual field loss, using the SITA strategies.

The SITA strategy is especially developed for the detection and follow-up of glaucoma pathology, since the SITA algorithm takes the anatomy of the retinal nerve fiber layer into account. Therefore the SITA strategy could be less suit-

able for screening and follow-up of other pathologies as neurological visual field defects and maculopathies.

The value of the recently introduced SITA strategy is that it is an interactive strategy that takes the characteristics and behavior of the individual patient into account. Through post-analysis of the threshold values the SITA strategy creates a visual field that is reliable and adapted to the patient.

Analysis of the data obtained in this study, made us conclude that the SITA strategy is appropriate for glaucoma follow-up in clinical conditions, due to the markedly reduced test time while preserving the data quality. However, one has to keep in mind that the SITA-Fast strategy is conceived for screening purposes and for patients who cannot perform a reliable SITA-Standard strategy. For an adequate clinical glaucoma follow-up SITA-Standard is the optimal strategy with reduced test time.

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