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Research Article

## Visual fields before and after dilatation of pupils

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**Abstract:**

**Purpose:** To compare the changes in the visual fields plotted by standard automated perimetry (SAP) before and after dilation of pupils.

**Methods:** This is a prospective comparative study. Between November 2013 and October 2014, patients attending the general ophthalmology outpatient clinic of Govt. General hospital,Nellore, for routine ophthalmic examination, who were labeled as normal were examined and findings of visual acuity, proper refraction, pupil size and visual fields by automated perimetry, before and after dilatation were documented. The single field analysis printouts were collected and analyzed.

**Results:** Thirty five eyes of nineteen subjects were enrolled at general Ophthalmology OPD in GGH with mean age of 22.9 years, ranging from 17 to 35 years. The mean baseline pupil size and dilated pupil size were  $3.28 \pm 0.46$  mm and  $7.28 \pm 0.86$  mm in diameter respectively. There was a statistically significant worsening of the Mean Deviation (MD) with a mean decrease of 0.27 dB ( $P= 0.001$ ) between the baseline and dilated visual fields. There was a statistically significant worsening of the Mean Deviation (MD) with a mean decrease of 0.27 dB ( $P= 0.001$ ) between the baseline and dilated visual fields.

**Conclusion:** The present study shows that there was statistically significant worsening of the Mean Deviation (MD) ( $P = 0.001$ ) after pupillary dilation. There was no statistically significant change in the Pattern Standard Deviation (PSD) and foveal threshold after pupillary dilation. Thus this study emphasizes the importance of consistent pupil diameter in serial visual field testing.

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**Keywords:** Pupil size, Visual fields, Automated Perimetry, Mean deviation.

### INTRODUCTION

Automated static threshold perimetry is useful in evaluating patients who have glaucoma, patients suspected of having glaucoma and patients who have neurological disease. The major advantage of automated perimetry is that it compares the patient's sensitivity to stored values that have been obtained from normal people i.e, the normative data (7)-(14).

It has been found that pharmacologically induced miosis can cause constriction of visual field with automated perimetry<sup>(1)-<sup>(6)</sup></sup>. Using the Humphrey field analyzer, miotics were found to worsen the mean deviation in normal subjects compared to baseline perimetry.

Although the effects of miotics agents on visual field performance are well documented, the effects of pupillary dilation are not. Very few studies(1)-(6) have reported the effect of pupillary dilation on the visual field performance by automated perimetry. Some clinicians may choose to do visual fields examination after pupillary dilation and a few conditions such as central media opacities may necessitate

the same. Hence the effect of an active pupillary dilation on visual field performance is of concern to the ophthalmologists.

The present study is done to determine whether pupillary dilation changes the retinal threshold sensitivity and visual field performance by automated perimetry.

### MATERIALS AND METHODS

#### Study area

All patients attending the general ophthalmological Outpatient clinic of Govt General Hospital located in Nellore, Andhra Pradesh, Southern India,during November 2013 and October 2014, were included in the study for routine ophthalmic examination, after they have been labeled as normal subjects were included in the study

#### Study design

A prospective, comparative study.

**Sample size:** Thirty five eyes of nineteen subjects

**Study protocol**

All the subjects underwent baseline comprehensive eye examination including visual acuity assessment for distance and near, proper retinoscopy, BCVA, slit lamp examination, pupil size measurement before and after dilatation, visual fields by automated perimetry before and after pupillary dilation and direct ophthalmoscopy.

**Methodology:**

All subjects underwent baseline comprehensive eye examination including visual acuity assessment for distance and near, proper refraction, slit lamp examination, visual fields by HFA II automated perimetry before and after pupillary dilation and direct ophthalmoscopy.

After baseline ophthalmic examination, the subjects were given instructions about the automated perimetry procedure. The required data was entered into the automated perimeter and a baseline automated perimetry was done on each eye for all the subjects. After the completion of visual fields with undilated pupil, the pupil was dilated using 10% phenylephrine eye drops in both eyes, 3 times every 10 min. The post mydriatic automated perimetry was done on each eye 10 min after administration of last drop.

**Refractive Error:**

The patient’s refractive error for near was properly corrected, otherwise the visual fields will show generalized depression. In addition to correcting the refractive error for near vision, we have ensured that the glasses are properly placed in the trial frame of the automated perimeter and the correcting lens were very close to the testing eye to avoid artifacts. When the measured foveal threshold of the patient corresponds to the foveal threshold of the normal data, one is assured that the refractive status of the patient is optimal.

Humphrey Field Analyzer (HFA II) central-30-2 threshold program and SITA-Standard strategy was used with foveal threshold ‘on’.

**SITA – Standard:** The goal is to design a perimetric threshold method which collects twice as much as information per unit time as Humphrey Full Threshold standard algorithm. SITA Standard cuts the test time in half without compromising test reproducibility relative to the current international standard. Central 30-2 threshold test with White, size III stimulus. The single field analysis printout with SITA Standard strategy has reliability indices expressed in percentage except in case of fixation losses which is expressed in fractions and GHT analysis.

**Definitions**

**Mean Deviation (MD):**

This index signifies average overall severity of field loss. It is the average of all the numbers shown in the TDNP except the two points nearer to the blind spot. The deviation from normal at each point is weighed according to the variance of the normal values at that location. Thus points with low variance

i.e, closer to fixation affect the MD value more than eccentric points which have a high variance. The MD is expressed in dB units with P value. The + ve sign indicates that the patient’s overall sensitivity is better than age related normals where as - ve sign indicates that the patient’s overall sensitivity is worse than the normals.

**Pattern Standard Deviation (PSD):**

This index is developed to express the irregular loss of retinal sensitivity. The irregular loss may be localized or generalized field loss. The irregular contour of hill of vision will be represented by high PSD value. When the PSD value is 0 or not significant, the contour of hill of vision will be smooth. Specifically, the PSD is the standard deviation around the mean that constitutes the MD index and indicates the degree to which the numbers in the total deviation numerical plot are not similar to each other. If the visual field profile of a patient is smooth, the PSD will be close to 0. The irregular contour with dropping of hill of vision indicates generalized depression with localized field defects. After adjusting to the height the irregular contour deviation from normal slope is by a positive number which is PSD. The higher the number the greater is the deviation from the normal slope.

**Statistical Analysis:**

The single field analysis printouts were collected and the data tabulated and analyzed using the paired Student’s t test. A p ≤ 0.05 was considered statistically significant.

**Results**

Thirty eyes of nineteen subjects were enrolled at general Ophthalmological OPD in Govt General Hospital was subjected to baseline comprehensive eye examination including the visual acuity assessment for distance and near, proper refraction, visual fields by HFA II automated perimetry before and after pupillary dilation. The mean age of the subjects included in our study was 22.9 years (range 17 - 35 years). There were 9 females( 45 %) and 10 males( 50 %) in the study. The mean baseline and dilated pupil sizes were 3.28 ± 0.46 mm and 7.28 ± 0.86 mm in diameter respectively. Fixation losses, false positive responses and false negative responses were similar between baseline and dilated automated visual fields.

There was a statistically significant worsening of the Mean deviation (MD) with a mean decrease of 0.27 dB ( P= 0.001 ) between the baseline and dilated visual fields (Table 1).

**Table 1: Comparison of pupil size and SITA – Standard parameters in baseline and dilated eyes**

	Pupil Size (mm)	FT dB	MD dB	PSD
<b>Baseline</b>	3.28 ± 0.46	36.03 ± 2.74	-2.14 ± 0.93	1.74 ± 0.52
<b>Dilated</b>	7.28 ± 0.86	35.89 ± 1.97	-2.41 ± 1.07	1.64 ± 0.40
<b>Mean difference</b>	4.00	0.14 ± 1.91	0.27 ± 0.45	0.10 ± 0.45
<b>P values</b>	--	0.661	0.001	0.199

FT = foveal threshold; MD = mean deviation; PSD = pattern standard deviation.

There was a statistically significant worsening of the Mean deviation (MD) with a mean decrease of 0.27 dB ( P = 0.001 ) between the baseline and dilated visual fields(Table 1).There was improvement in the Pattern Standard Deviation (PSD) with a mean of 0.10 (P = 0.199) after dilation, which was not statistically significant. There was a decrease in the foveal threshold by a mean of 0.14 dB after dilation which was significant. There was a decrease in the foveal threshold by a mean of 0.14 dB after dilatation which was again not statistically significant (Table 1).

The increase in pupil size of 4 mm was noted in most of the eyes (37.14%) (Table 2). The increase of pupillary dilation of 3 to 5 mm (mean, 4 mm) diameter was from baseline pupil size of 3 to 4 mm (mean, 3.28 ± 0.46). The worsening of Mean deviation was more in eyes with variation of pupil size by 5mm, the mean being 0.36 dB. (Table 2).With increase in dilation of the pupil, the Mean deviation was found to get worsened progressively with variation of mean from -0.159 dB to - 0.36 dB (Table 2).

**Table 2: Comparison of parameters with variation of pupil size**

Variation in pupil size ( mm )	Sample size N (%)	FT dB	MD dB	PSD					
3	11(31.42%)	0.72	-0.1509	-0.09					
4	13(37.14%)	-0.76	-0.3053	0.065					
5	11(31.42%)	-0.09	-0.36	-0.312					
Total	35(100%)	-0.14	-0.274	-0.10					

FT = foveal threshold; MD = mean deviation; PSD

It is apparent that 90.9 % with 5 mm of pupil size had worsening of Mean Deviation. Hence, the It is It is It is It is It is apparent that 90.9 % with 5 mm of pupil size had worsening of Mean Deviation. Hence, the maximum dilation of the pupil, worsened the Mean Deviation (MD) in significant number of eyes (P=0.0038) (Table 3). The parameters altered least with Δ 3 mm of pupil size (Table 3). Improvement in the PSD was noted in 72.2 % eyes with a 5 mm dilation of pupil from the baseline pupil size.

**Table 3: Subject-specific comparison of variation of parameters**

Variation in pupil size in mm		FT (dB)	MD (dB)	PSD
		N%	N%	N%
3	Worsening	1 (9.0%)	5(45.5%)	5(45.5%)
	Improvement	5(45.5%)	6(54.5%)	6(54.5%)
	Unaffected	5(45.5%)	0(0.00%)	0(0.00%)
4	Worsening	8(61.5%)	8(61.5%)	5(38.5%)
	Improvement	3(23.1%)	5(38.5%)	7(53.9%)
	Unaffected	2(15.4%)	0(0.00%)	1(7.6%)
5	Worsening	6(54.5%)	10(90.9%)	1(9.1%)
	Improvement	5(45.5%)	1(9.10%)	8(72.7%)
	Unaffected	0(0.00%)	0(0.00%)	2(18.2%)

FT=fovealthreshold;MD=mean deviation;PSD= pattern standard deviation

**DISCUSSION**

Mydriasis is thought to have a minimal influence on perimetric performance in healthy subjects while pharmacologically induced miosis can cause constriction of visual field with automated perimetry.

Using the Humphrey Field Analyzer, miotics worsened the mean deviation in normal subjects compared to baseline perimetry. Although the effects of miotics agents on visual field performance are well documented, the effects of pupillary dilation are not. Very few studies have reported the effect of pupillary dilation on the visual field

performance by automated perimetry.

The present study compared the perimetric performance between the baseline and dilated eyes using SITA – Standard global indices. Fixation losses, false positive responses and false negative responses were similar between baseline and dilated automated visual fields. The mean deviation (MD) worsened with a mean decrease of 0.27 dB (P = 0.001). The pattern standard deviation (PSD) improved by a mean of 0.10 (P = 0.199). There was worsening in foveal threshold with a mean decrease of 0.14 dB (P =

0.661).

Subject specific information showed that dilation worsened the mean deviation in 23 eyes (65.71%) and improved in 12 eyes ( 34.29 % ) as compared to the mean deviation of baseline field. 90.9 % ( n = 10/11) eyes with 5 mm dilation of pupil size from baseline showed worsening of mean deviation while only 9.1 % showed improvement. The mean deviation ( MD ) worsened maximally with a mean decrease of 0.36 dB and the Pattern standard deviation (PSD ) improved by a mean of 0.312 in the above eyes .

Among the various studies done to determine the effects of pupillary dilation on visual fields by automated perimetry, worsening of the mean deviation was the most consistent conclusion. The present study also showed the same result.

Kim et al(1), W.K.Kellogg eye center, Michigan reported worsening of mean deviation by 0.83 decibels in dilated fields as compared with baseline visual fields. In the present study, Mean Deviation worsened by 0.27 dB and the foveal threshold worsened by 0.14 dB which was less in the present study as compared to Kim et al where worsening was 0.55 dB.

When compared to Kim et al (1) variation in Mean Deviation was similar where as variation of Pattern Standard Deviation was against their observation. The mean difference in the pupil size was 4 mm in diameter in the present study where as Kim et al study calculated the pupillary area with a mean difference of 30 mm<sup>2</sup> between baseline and dilated pupils. Subject specific information showed that dilation worsened the mean deviation in 66% of eyes in the present study as compared to 78 % of eyes in Kim et al(1).

In the study by Kim et al<sup>[1]</sup> , the author explains the worsening of the parameters on the basis of altered retinal illumination. Increased retinal illumination occurs with mydriasis under mesopicperimetric conditions and thus threshold sensitivity values would be expected to improve. This expected improvement may be reduced by the Stiles – Crawford effect, spherical and chromatic aberrations. PSD is an index of localized defects and is thus not significantly altered.

Kudrna et al<sup>[2]</sup> compared the results in both eyes of all subjects and reported worsening of Mean deviation with a range of 1.15 dB to 1.43 dB and decrease in foveal threshold in a range of 1.95 dB to 2.56 dB.

Most of the studies used cycloplegics like tropicamide whereas in the present study mydriatic agent, 10 % phenylephrine eye drops were used.

One limitation was that, in our study, visual field testing was done only on normal subjects. If it was done on patients with glaucoma, there is a possibility that the results could have been altered. The inter eye dependence was not considered in our study. A second limitation was that our study was a hospital based study with a small sample size.

## CONCLUSION

The results of the study have lead to the conclusions that there was statistically significant worsening of the Mean deviation after pupillary dilation. There was no statistically significant change in the Pattern standard deviation and foveal threshold after pupillary dilation. Hence this study emphasizes the importance of consistent pupil diameter in serial visual field testing. Further comparative studies may be required on normal and glaucomatous subjects.

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