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SHORT WAVELENGTH AUTOMATED PERIMETRY CAN DETECT VISUAL FIELD CHANGES IN DIABETIC PATIENTS WITHOUT RETINOPATHY: AN OBSERVATIONAL STUDY

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Abstract

Background
The purpose of the research was to assess the efficacy of SAP and SWAP-blue on yellow in detecting several changes taking place in the retinal sensitivity of the visual field in diabetic patients either with retinopathy or without retinopathy.

Materials and methods
This study was carried out at IMS and SUM Hospital, Bhubaneswar. The study was conducted for six months. Participants in the research who do not provide consent are not allowed to participate. Overall, 120 participants were included in the study.

Results
The Average age of participants in group 1 was 51.2±6.8, while that of group 2 was 53.7±7.4. A statistically significant difference in the duration of diabetes was seen between groups 1 and 2, with a p-value of less than 0.0001. SAP and SWAP were shown to be statistically significantly correlated in groups 1 and 2, with mean deviation p-values of 0.001 and <0.0001, respectively.

Conclusion
It has been found that compared to people with clinical retinopathy, diabetic patients without overt retinopathy are more likely to have aberrant findings picked up by the SWAP approach.

Recommendation
We recommend SWAP because SITA SWAP will prove to be useful for the early detection of glaucomatous conversion.

Keywords: *Short fluctuations, short wave automated perimetry, Non-Proliferative Diabetic Retinopathy, Mean Deviation.*
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Introduction
Globally, diabetic retinopathy, or DR, was found to be the main cause of vision loss [1, 2, 3]. Retinal neurodegeneration may occur before the vascular changes that are clinically evident, even though retinal vasculature abnormalities are now used for DR diagnosis and staging [4]. Clinically evident retinopathy can occasionally occur before retinal neurosensory deficits [5].
Numerous investigations have demonstrated that diabetic retinopathy might affect the visuality; and that too at more severe stages of the illness, these alterations are more evident [6, 7, 8]. Diabetic retinopathy frequently results in varying degrees of visual field loss, along with the degree of loss varying according to the severity of the sickness [9, 10].
A study conducted by Wisznia et al. to assess diabetic retinopathy in diabetic patients found that partial reduction of central isopters was seen in diabetic patients with non-proliferative diabetic retinopathy [11].
In India, diabetic retinopathy was determined to be 12.5% [12]. One recent and current advancement in the early detection of ischemia change in diabetes is shortwave length automated perimetry (SWAP), sometimes referred to as blue-on-yellow perimetry. The only way it varies from standard automated perimetry (SAP) is that blue light at a precisely selected wavelength, while a particular color and brightness of yellow light serves as the background illumination and both the light is being employed to their respective stimulus. Therefore, it is further believed that SWAP, in comparison to SAP, is a better predictor of function loss in ischemia change in diabetes. It has been demonstrated that in diabetic conditions, SWAP results in a greater reduction in visual field than SAP [13].
Diabetic patients' sensitivity loss has usually been assessed using photopic settings (also known as "white-on-white" SAP) or mesopic settings (microperimetry) [14]. A more sensitive indicator of visual impairment would be visual field sensitivity in dark-adapted

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environments, where the rod pathway mediates performance. That is, the increased metabolic requirement of the rod photoreceptors under dark-adapted circumstances may lead to hypoxia in the retina of a diabetic [15].
A functional test called white on white (SAP) is used to detect various anomalies relevant to the visual field in patients who are at high risk of developing diabetic retinopathy, provided that the SAP is still within normal ranges [16].
The study has been conducted to find the importance of SWAP-blue on yellow in comparison to SAP for identifying alterations in the visual field's retinal sensitivity in diabetic patients with or without retinopathy.

Methodology

Study Setting and Duration

This study was carried out at IMS and SUM Hospital, Bhubaneswar. The study was conducted for a duration of six months.

Participants

Overall, 120 participants were included in the study. The inclusion criteria for enrolment of patients were the patients with Diabetes Mellitus and who were between 30-70 years of age. Patients with a history of glaucoma and opaque media, corrected visual acuity (VA) of less than 0.5, and those patients who had undergone retinal laser therapy were not included in the study.
They were further categorized as
Group 1- Diabetic Patients without Diabetic Retinopathy (n=40)
Group 2- Diabetic Patients with Diabetic Retinopathy (n=40)
Group 3- Healthy Volunteers (n=40)

Study Procedure

The patient's adjustment was made to allow for a 30-cm viewing distance. SAP was performed using either the 24-2, full-threshold program or the Twinfield Analyzer for Oculus perimetry introduction guide. Initially, the stimulus of size III was selected, and it was further projected onto a lighted bowl in the background. Additionally, SWAP was carried out with full-threshold performance utilizing the application 24-2. A blue spot with a wavelength of 440 nm was projected at a maximum brightness of 100 dc/m2 onto a yellow backdrop with a wavelength of 530 nm, constituting a size III light stimulus.
The visual field charts were used to analyze the pattern standard deviation (SD), mean deviation (MD), and test reliability (fixation losses, false-positive and false-negative rates).
A blind spot correction process was observed during the test. The reliability of each visual field test was evaluated; the test was deemed trustworthy if the fixation losses, false-positive and false-negative rates, and false-negative rates were all less than 25%. A percentage higher than 25% was deemed ineligible and eliminated.

Data Collection

The research participants gave their consent for further participation in the study. A comprehensive history was taken of each included patient, with particular attention paid to age, gender, and length of diabetes. Complete assessment, with special attention to VA measurement, intraocular pressure (IOP) measures, anterior segment assessment using a slit lamp, and fundus examination were all part of the ophthalmologic evaluation.
The visual field sensitivity was measured using Oculus Twinfield. Twinfield (a whole field projection perimeter) allows for exams in compliance with the Goldmann standard by providing automatic or manual testing, as well as static and kinetic testing. This study analyzed the outcomes of the first two threshold programs used in the central 24-2 threshold program: that is of SAP and SWAP, respectively. The first visit was scheduled mainly for perimetric patient training, VA and fundus examinations, refraction, and SAP and SWAP programs. Then, to prevent patient tiredness, visit 2 for a program of SAP was scheduled, and then finally, visit 3 for SWAP was conducted.

Statistical Analysis

SPSS version 20 was used for statistical analysis. The mean ± SD was used to express quantitative variables. The student's t-test was used to assess the statistical significance of the differences among the various groups.

Ethical Considerations

Informed consent was taken from all patients.

Results

Table 1 represents patients' demographic characteristics such as age (in years), gender, duration of diabetes, HbA1c, and intra-ocular pressure in participants. The average age of participants of Group 1 was 51.2±6.8, while that of Group 2 was 53.7±7.4. Female participants were predominantly in all the groups. P-value <0.0001 indicated a highly statistically significant difference in the duration of diabetes between groups 1 and 2, respectively.

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Table 1. Patients Demographics

Parameters	Group 1 (n=40)	Group 2 (n=40)	Group 3 (n=40)	P value 1 versus 2	P value 1 versus 3	P value 2 versus 3
Age (in years)	51.2±6.8	53.7±7.4	50.6±5.9	0.11	0.67	0.04
Males	14	18	17	-	-	-
Females	26	22	23	-	-	-
Duration of Diabetes (in years)	5.26±2.4	9.43±4.3	**-**	**<0.0001**	**-**	**-**
HbA1c	7.62±3.4	10.75±3.9	7.04±2.1	0.0003	0.36	<0.0001
Intra-ocular Pressure	12.72±1.7	12.45±1.3	12.91±.0.9	0.42	0.53	0.06

Data were presented as mean±SD
p-value was considered significant at <0.05

Table 2 depicts a comparison of perimetric techniques between SAP and SWAP among all three groups. Statistically significant association was observed between both perimetric techniques of SAP and SWAP in groups 1 and 2 with p-value <0.0001 and 0.001 respectively among mean deviation. No other significant association was observed between SAP and SWAP among the groups.

Table 2. Comparison of Various Perimetric Techniques

Parameters	Mean Deviation			Short Fluctuations			Corrected Pattern Standard Deviations		
	SAP	**SWAP**	**p-value**	**SAP**	**SWAP**	**p-value**	**SAP**	**SWAP**	**p-value**
Group 1	-0.91±1.76	-4.24±1.9	<0.0001	2.07±0.71	2.04±0.6	0.83	2.6±1.2	2.2±0.8	0.08
Group 2	-3.7±2.76	-5.81±2.9	0.001	2.10±1.2	2.2±1.0	0.68	2.8±0.1	3.1±0.9	0.03
Group 3	0.16±1.2	0.17±1.3	0.24	1.79±0.76	1.8±0.4	0.94	1.8±0.7	1.7±0.8	0.55

Data were presented as mean±SD
p-value was considered significant at <0.05

Discussion

The present study aimed to determine whether short-wavelength automated perimetry could identify alterations in the visual field in diabetic patients with or without retinopathy. The average age in all the groups was found to be 50 to 55 years. The result was found to be consistent with many other studies [17, 18].

Female participants were found to be more comparative to male participants. This finding was consistent with research by Mackey et al. that discovered diabetic retinopathy was more common in women [19]. One more study by Zico OA et in 2014 depicts the same result that females have been more predominantly having diabetic retinopathy [20].

According to the current study, diabetic individuals with non-proliferative retinopathy have been living with the disease for substantially longer than diabetic patients without retinal. It has been observed that diabetic retinopathy takes longer to develop, and thus longer duration of diabetes might help as the best predictor to analyse about progression of retinopathy. Also, according to the study by Wisconsin Epidemiologic, retinopathy was found to be more prevalent among people with diabetes who had diabetes at earlier ages: 8% at three, 25% at five, 60% at ten, and 80% at fifteen years [1].

According to Macky et al., a statistically significant greater prevalence of diabetes-related diseases (DR; $P < 0.001$) was linked to a longer duration of diabetes. Their findings are consistent with ours [19]. Hohenstein et al. discovered in another study that the average length of diabetes was 12.9 years [18].

In the current investigation, we showed that, regardless of the existence of DR, the parameters of the SWAP approach produced findings that were considerably different from the SAP one. This could be a reflection of the SWAP technique's sensitivity. Many studies performed earlier have shown that short-wavelength sensitivity deteriorates more rapidly compared to achromatic sensitivity in the cases of diabetic retinopathy [21, 22, 23, 24].

Nonetheless, when comparing diabetics to controls, both approaches showed values that were noticeably different.

Research conducted by Abrishami et al. reported that the diabetic group and the control group differed significantly in mean corrected sensitivity, mean corrected total deviation, and mean corrected MD [25].

A study by Han et al. conducted to assess multifocal electroretinogram and short-wavelength automated perimetry measures in diabetic eyes found that SWAP is a sensitive measure of diabetes impairment even before retinopathy [26].

Conclusion

The study concluded that perimetry was a useful method for evaluating diabetic patients' retinas. Also, it has been observed that the SWAP technique was better than the SAP technique. A significant association has been observed in the mean deviation between SAP and SWAP.

Limitations

The limitations of this study include the small sample population who were included in this study. Furthermore, the lack of a comparison group also poses a limitation to this study's findings.

Recommendation

We recommend SWAP because SITA SWAP will prove to be useful for the early detection of glaucomatous conversion.

Acknowledgement

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Data Availability

Data is available upon request.

Author contributions

All authors contributed to the design of the research. LB collected and analyzed the data. SD wrote the manuscript. All authors edited the paper.

List of abbreviations

DR- diabetic retinopathy
SAP- standard automated perimetry
SWAP- shortwave length automated perimetry
VA- visual acuity
SD- standard deviation
MD- mean deviation
IOP- intraocular pressure

Source of funding

No funding received.

Conflict of interest

The authors have no conflicting interests to declare.

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