ASSESSMENT OF FOVEAL AND EXTRA-FOVEAL PHOTOSTRESS RECOVERY TIME IN PRIMARY OPEN ANGLE GLAUCOMA

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Abstract

Photostress recovery time (PSRT) is a clinical procedure that measures the amount of time required for the macular to return to its normal level of function after being exposed to a bright light source. This study was a case control clinical study carried out to measure the foveal and extra-foveal photo stress recovery time in participants with primary open angle glaucoma. Fifty five subjects, 24 with primary open angle glaucoma with a mean age of 34.38±12.19 and 31 control subjects with a mean age of 26.58±7.23 were used in this study. The mean photostress recovery time measured on the fovea, 7o nasal, temporal, inferior and superior to the fovea were, 62.38±4.67, 8.71±7.19, 11.23±10.96, 12.08±8.96 and 12.44±9.30 respectively for subjects with primary open angle glaucoma. For the control subjects, the mean photostress recovery time measured on the fovea, 7o nasal, temporal, inferior and superior to the fovea were 23.29±1.63 11.89±8.62, 11.53±8.19, 12.89±8.67 and 13.60±8.36 respectively. Analysis with SPSS version 21 using the two factor ANOVA showed a significant difference (P<0.05) in photostress recovery time 7o nasally, temporally, inferiorly and superior to the fovea between primary open angle glaucoma subjects and a control group. Data analysis with the independent sample t-test also showed a significant difference (P<0.05) in photostress recovery time on the fovea between primary open angle glaucoma subjects and a control group. In conclusion, primary open angle glaucoma alters the photostress recovery time, both on the fovea and extra-foveal region of the retina. Photostress recovery test should be included in the routine eye examination of patients.

Keywords: Primary Open angle glaucoma, Photostress recovery time, foveal, extra-foveal

Introduction

Glaucoma is an optic neuropathy associated with a characteristic structural damage to the optic nerve and visual dysfunction which are seen clinically as enlargement of the optic disc cup and loss of peripheral field of vision[1]. Glaucoma is characterized by increased intraocular pressure (IOP), visual field loss beginning with peripheral vision loss resulting to what is known as tunnel vision and damaging the optic nerve head. It is one of the leading causes of irreversible blindness in the world affecting about 70 million persons worldwide[2,3]. Primary open-angle glaucoma (POAG) also referred to as chronic simple glaucoma is generally bilateral but not always a symmetrical disease, characterized by an adult onset,

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lOP above 21 mmHg at some point in the course of the disease, an open angle of normal appearance, glaucomatous optic nerve head damage and visual field loss[4]. Although 4-7% of the population over the age of 40 years have lOPs >21 mmHg, only 1% of individuals with ocular hypertension will develop glaucoma each year[5]. The risk of damage increases as the lOP rises. Screening for glaucoma should always be performed as part of a standard eye examination. Testing for glaucoma should include measurements of the intraocular pressure through tonometry, changes in size or shape of the eye, gonioscopy and examination of the optic nerve head for any visible damage or change in the cup-disc ratio, rim appearance and vascular changes[6].

The photostress recovery time is a clinical procedure that measures the amount of time required for the macula to return to its normal level of function after being exposed to a bright light source[7]. It is simply the measurement of the time it takes to start seeing again after being exposed to light of high intensity. The time it takes to return to baseline acuity after a patient has been exposed to intense illumination for about 10 seconds is the photostress recovery time (PSRT). The normal Photostress recovery time is 50secs but with certain diseases like diabetic retinopathy, age related macular degeneration. prolonged photostress recovery test time is observed[8]. Optic nerve diseases can be differentiated from retinal diseases with the Photostress test. If the recovery time is about the same for both eyes, the cause of a lowered visual acuity in the “bad” eye is an optic nerve lesion. However, if the recovery time is considerably longer for the eye with reduced visual acuity more than the normal eye, the cause is a retinal disease[9]. A prolonged recovery time or delayed dark adaptation is reported in glaucoma, which mainly affects ganglion cells. This suggests that a ganglion cell abnormality may delay recovery or that glaucoma may cause visual pigment abnormality. It can be used to evaluate retinal function[8].

Materials and Methods

This study was a case control clinical study which involved the measurement of the photostress recovery time of participants with primary open angle glaucoma and a non-glaucomatous control group. Participants who satisfied the inclusion and exclusion criteria were examined at the Optometry Teaching Clinic, Federal University of Technology, Owerri. These are male and female adults who do not have a debilitating disease, a mental problem, an ocular pathology apart from Primary Open Angle Glaucoma, and who gave an informed consent. Fifty five participants were used in this study, 24 were cases with primary open angle glaucoma and 31 controls without POAG. The controls had similar characteristics (such age 18 years and above) as the cases apart from presence of primary open angle glaucoma. The cases had no other visible pathology apart from POAG. The controls had no POAG and any other visible pathology. Case history, visual acuity, penlight examination, slit lamp biomicroscopy, ophthalmoscopy and perimetry were conducted on all the participants. The IOP of the participants were measured and recorded using the schiotz tonometer. For measurement of the foveal and extra-foveal photostress recovery time, participants were asked to fixate at the spot at the center of the bjerrum tangent screen at one meter. With one eye occluded, the ophthalmoscope light[10] was shone on the fovea, 7 degrees nasal, temporal, inferior and superior to the fovea with the aid of a protractor for 10 seconds. The time it took for the patient to see the target again after the ophthalmoscope light was removed was recorded as the PSRT. A PSRT above 50 seconds is indicative of an abnormality[9]. Data obtained was uploaded into the IBM SPSS version 21 software and the two-factor ANOVA and the independent sample T – test was used to test the hypotheses at 0.05 level of significance and 95%

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confidence interval. Ethical clearance for this study was obtained from the ethical committee of the School of Health Technology, Federal University of Technology, Owerri.

Results

A total of 55 participants between ages 18 years and above were used for this study; 24 subjects (48 eyes) with primary open angle glaucoma and 31 (62 eyes) control participants. The distribution of photostress recovery time on the fovea of participants with POAG showed that 3(6.25%) subjects recorded between 0-20 seconds; 12(25%), 21-40 seconds; 13(27.09%), 41-60 seconds; 10(20.83%), for both 61-80 seconds and above 80 seconds. For the control subjects, 33(53.23%) subjects recorded between 0-20 seconds; 21(33.87%), 21-40 seconds; 8(12.90%), 41-60 seconds; none of the subjects recorded above 60 seconds (Table 1). Distribution of photostress recovery time 7° nasal to the fovea of participants with POAG as presented in Table 2, showed that 31(64.58%) participants recorded between 0-10 seconds; 11(22.92%), 11-20 seconds; 6(12.5%), 21-30 seconds; none of the subjects recorded above 30 seconds. For the control subjects, 24(38.71%) recorded between 0-10 seconds; 29(46.77%), 11-20 seconds; 9(14.52%), 21-30 seconds; none of the control subjects recorded above 30 seconds. Distribution of photostress recovery time 7° temporal to the fovea of participants with POAG showed that 30(62.5%) recorded between 0-10 seconds; 9(18.75%), 11-20 seconds; 8(16.67%), 21-30 seconds; none of the subjects recorded 31-40 seconds while 1(2.08%) subject recorded above 40 seconds (Table 3). For the control subjects, 27(43.55%) recorded between 0-10 seconds; 29(46.77%), 11-20 seconds; 4(6.45%), 21-30 seconds; 2(3.22), 31-40 seconds; none of the control subjects recorded above 40 seconds. Table 4 showed the distribution of photostress recovery time 7° inferior to the fovea of participants with POAG. From the Table, 24(50%) recorded between 0-10 seconds; 13(27.08%), 11-20 seconds; 12(25%), 21-30 seconds; 1(2.08%), 31-40 seconds; none of the subjects recorded above 40 seconds. For the control subjects, 26(41.93%) recorded between 0-10 seconds; 25(43.32%), 11-20 seconds; 9(14.52%), 21-30 seconds; 2(3.22), 31-40 seconds; none of the control subjects recorded above 40 seconds. Distribution of photostress recovery time 7° superior to the fovea of subjects with POAG as presented in Table 5 showed that 25(52.08%) recorded between 0-10 seconds; 11(22.92%), 11-20 seconds and 21-30 seconds; 1(2.08%), 31-40 seconds; none of the subjects recorded above 40 seconds. For the control subjects, 25(40.32%) recorded between 0-10 seconds; 24(38.71%), 11-20 seconds; 9(14.52%), 21-30 seconds; 4(6.45%), 31-40 seconds; none of the control subjects recorded above 40 seconds (Table 5).

Comparison of the mean PSRT at the different retinal regions for POAG and control group is shown in Table 6. It showed a mean foveal PSRT of 62.38 seconds for subjects with POAG and 23.29 seconds for the control subjects. At 7° nasal to the fovea, 8.71 seconds for POAG and 11.89 seconds for control. At 7° temporal to the fovea, 11.23 seconds for POAG and 11.53 seconds for control. At 7° inferior to the fovea, 12.08 seconds for POAG and 12.89 seconds for control. At 7° superior to the fovea, 12.44 seconds for POAG and 13.6 seconds for the control. Statistical analysis using the independent t-test showed that there was a significant difference ($P < 0.05$) in the PSRT on the fovea between subjects with POAG and the control subjects (Table 7). Testing the extra-foveal regions using the Two-Factor ANOVA at 0.05 level of significance and 95% confidence interval also showed a significant difference ($P < 0.05$) in the PSRT (Table 8).

Table 1
Distribution of Photostress Recovery Time on the fovea of subjects

PSRT (Seconds)	Frequency (n %)	
	POAG	CONTROL
0-20	3(6.25)	33(53.23)
21-40	12(25.00)	21(33.87)
41-60	13(27.09)	8(12.90)
61-80	10(20.83)	0(0.00)
Above 80	10(20.83)	0(0.00)
Total	**48(100.00)**	**62(100.00)**

Table 2
Distribution of Photostress Recovery Time 7° nasal to the fovea of subjects

PSRT (Seconds)	Frequency (n %)	
	POAG	CONTROL
0-10	31(64.58)	24(38.71)
11-20	11(22.92)	29(46.77)
21-30	6(12.5)	9(14.52)
31-40	0(0.00)	0(0.00)
Above 40	0(0.00)	0(0.00)
Total	**48(100.00)**	**62(100.00)**

Table 3
Distribution of Photostress Recovery Time 7° temporal to the fovea of subjects

PSRT (Seconds)	Frequency (n %)	
	POAG	CONTROL
0-10	30(62.5)	27(43.55)
11-20	9(18.75)	29(46.78)
21-30	8(16.67)	4(6.45)
31-40	0(0.00)	2(3.22)
Above 40	1(2.08)	0(0.00)
Total	**48(100.00)**	**62(100.00)**

Table 4
Distribution of Photostress Recovery Time 7° inferior to the fovea of subjects

PSRT (Seconds)	Frequency (n %)	
	POAG	CONTROL
0-10	24(50.00)	26(41.93)
11-20	13(27.08)	25(43.32)
21-30	12(25.00)	9(14.52)
31-40	1(2.08)	2(3.22)
Above 40	0(0.00)	0(0.00)
Total	**48(100.00)**	**62(100.00)**

Table 5
Distribution of Photostress Recovery Time 7° superior to the fovea of subjects

PSRT (Seconds)	Frequency (n %)	
	POAG	CONTROL
0-10	25(52.08)	25(40.32)
11-20	11(22.92)	24(38.71)
21-30	11(22.92)	9(14.52)
31-40	1(2.08)	4(6.45)
Above 40	0(0.00)	0(.00)
Total	**48(100.00)**	**62(100.00)**

Table 6
Distribution of mean Photostress Recovery Time on different regions of the retina

Region	POAG	CONTROL
Foveal	62.38	23.29
Nasal	8.71	11.89
Temporal	11.23	11.53
Inferior	12.08	12.89
Superior	12.44	13.60

Table 7
Relationship between foveal PSRT for Cases (POAG) and Controls

F-value	P-value	t-value	Degree of freedom	Mean Difference	Std. Error Difference
20.916	<0.001	-8.676	108	-39.085	4.505

Table 8
Relationship between extra-foveal regions of PSRT for Cases (POAG) and Controls

Source of Variation	Type III Sum of Squares	Degree of freedom	Mean Square	F-value	P-value
Intercept	60224.121	1	60224.121	774.941	<0.001

Discussion

Primary open angle glaucoma (POAG) causes a gradual decrease in visual acuity leading to total blindness if not properly managed. The subjects with POAG in this study had a poor visual acuity as they have been living with POAG. This reflected in the prolonged PSRT of the glaucoma subjects when compared to the control subjects who had no eye problem. Studies[11-13] showed similar results on photostress recovery time and pathologies of the retina. Omokhua and George[14] reported a higher PSRT among males than in females. Kamppeter, et al.,[15] in a study on re-adaptation time after photostress in normal subjects and glaucoma patients, confirmed that primary open angle glaucoma subjects showed a significantly prolonged fovea recovery time after a photostress test compared with the normal subjects.

Many of the subjects with POAG in this study were above 50 years and at this stage in life, there is always some form of eye problem associated with aging such as incipient cataract which can reduce the intensity of light reaching the retina. Esenwah et al.[16] reported a reduction in lens transparency, presence of vitreous floaters and slow response to light stimuli as common problems associated with aging. Any of these factors could contribute to the prolonged photostress recovery time but the POAG was the major factor in this study as no other visible pathology was seen upon ophthalmoscopy, pen light and slit lamp biomicroscope examination. Statistical analysis showed a significant difference in the recovery time between the cases and the controls both at the foveal (P (0.00) < 0.05) and extra-foveal regions (P (0.00) < 0.05) of the retina.

The PSRT is commonly tested at the central portion of the retina, but the peripheral region should be tested in cases in which the lesion is located outside the fovea, such as in glaucoma. When light is shone on the eye, the photoreceptors are bleached. Visual function is restored when the photoreceptors are regenerated. Cones are the photoreceptors that are concentrated in the fovea region while rods are concentrated in the periphery. When light is shone at the extra-foveal regions, it will take a shorter time for the subject to see. This is reflected in our study where the PSRT at the extrafoveal areas were shorter than the foveal PSRT. Tunnel vision as a result of a reduced visual field is one of the major symptoms of glaucoma. Most patients with POAG are not aware that their peripheral vision is compromised. The extra-foveal regions that were tested in this study however, are not greatly affected by POAG and hence the PSRT were not too far away from that of the control subjects. Yasuki, et al.[17] used a scanning laser ophthalmoscope to evaluate the extra-foveal region and found the PSRT was significantly longer after 20 seconds than after 10 seconds. Masayuki, et al.[18] measured the extrafoveal photostress recovery time in glaucoma patients and found that the PSRT does not correlate with location of the test spot.

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Conclusion

In conclusion, there is a significant difference in PSRT both on the fovea and extra-foveal regions on the retina in POAG and a control group. Photostress recovery test is valuable in glaucoma and other retinal diseases to detect possible lesion and scotoma areas especially at the early stages of the defect. Optometrists should carry out photostress recovery tests as part of routine eye examinations.