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Research Article

Photo Stress Recovery Time Variations in Common Posterior Segment Ocular Diseases

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Abstract

Purpose: The aim of this study was to determine the photostress recovery time (PSRT) of subjects with posterior segment ocular anomalies such as dry AMD, diabetic retinopathy, hypertensive retinopathy, and glaucoma.

Methods: This hospital-based study was carried out and PSRT evaluated for the fellow eyes of randomly selected 200 subjects. After a 10-second-bleaching of the retina, the subjects were directed to read from the line above best visual acuity (VA). Time taken to read the VA line was recorded. The data was presented and analyzed in table and the hypotheses tested at a given level of significance. Using Greenhouse-Geisser correction and Sphericity Assumed (0.000 < 0.05), observations were assessed for different ages and sexes.

Results: PSRT increased significantly in the above mentioned posterior segment ocular anomalies compared to the controls. Hence photostress recovery time test is recommended for diabetic retinopathy, hypertensive retinopathy, glaucoma and dry age related macular degeneration patients.

Conclusion: These findings show that PSRT increases in subjects with glaucoma, ARMD, hypertensive and diabetic retinopathy, mostly in older patients.

Keywords: ARMD; Diabetic Retinopathy; Glaucoma; Hypertensive Retinopathy; Photostress

Introduction

The photostress test is a clinical technique used to measure the time to recovery of light threshold after bleaching, which mainly depends on re-synthesis of visual pigments. It is use to differentiate between macula and optic nerve disease. Abnormal recovery time in retinal disease or toxicity suggests that the pathology in these conditions involves the outer layer of the retina or the pigment epithelium. Optic never disease can be differentiated from retinal disease with the PSRT, because optic nerve dysfunction does not affect PSRT [1].

Previous reports showed prolonged PSRT in patient with idiopathic central serous chorioretinopathy, age-related macular degeneration, diabetic retinopathy and digitalistoxicity. However, prolonged recovery time or delayed dark adaptation was reported in glaucoma which mainly affect ganglion cells [2]. This suggested that a ganglion cell abnormality may delay recovery time. There appears to be wide variation in the average photostress recovery time among different studies. The lack of standardization with respect to the intensity and duration of the bleaching of light, the method used to measure the visual acuity the chosen endpoint of

the test and the population studies could undoubtedly account for this wide variation in PSRT [3]. There is a difference in the recovery time for those patients. The acceptable recovery time of 50-60 seconds is more in line with patients over 40 years. Recovery time for younger healthy individuals with no macular problems can be markedly less. Patients with normal healthy macula function should be able to read the line in 50-60 seconds. Patients with visual acuities of 20/80 or worse are not good subjects for this test.

Methodology

In order to determine the photostress recovery time (PSRT) of subjects with posterior segment ocular anomalies like diabetic and hypertensive retinopathy, glaucoma and wet age related macular degeneration, the research method adopted was prospective and clinic based.

The research was carried out in Abia State University eye clinic. A total number of fifty (50) subjects (male and female) aged between 40-80 years already diagnosed of Diabetes, hypertension, glaucoma and wet age related macular degeneration participated in this research.

The following instruments were used: penlight for external examination and the photostress test, Illuminated distant Snellen's chart used as target PSRT test and for measurement of visual acuity, Stop-watch used for timing the recovery time, ophthalmoscope used to assess the integrity of the posterior part of the eye.

Visual acuity of the patient was taken and the two eyes and recorded differently. Then the patient was introduced to ambient lightening for about five minutes, after which the test PSRT was conducted monocularly on each eye and the result recorded.

Results

The subjects in the control Group showed a mean age of 49 ± 5.75 years, the subjects with diabetic retinopathy showed a mean age of 58 ± 8.32 years, the subjects with hypertensive retinopathy showed a mean age of 62 ± 7.20 years, the subjects with glaucoma showed a mean age of 62 ± 8.33 years and the subjects with Age related macular degeneration showed a mean age of 68 ± 5.47 years.

Figure 1: A Pie chart showing (%) frequency distribution of subjects with ocular anomalities.

Figure 1 shows the (%) distribution of subjects with ocular anomalies. Out of the 200 subjects tested, (25%) of the subjects tested had diabetic retinopathy, (25%) of the subjects had hypertensive retinopathy, (25%) of the subjects had Glaucoma, (12.50%) of the subjects had Age related macular degeneration and (25%) of the subjects fall in the control Group.

Age group	Control photostress recovery time (seconds)	Grade I (mild non probiferative diabetic retinopathy) (seconds)	Grade ii (moderate non probiferative diabetic retinopathy) (seconds)	Grade iii (severe non probiferative diabetic retinopathy) (seconds)	Grade iv (probiferative diabetic retinopathy) (seconds)
41-50	19.79	52.03	59.70	62.70	79.65
51-60	14.75	55.27	59.01	60.58	69.44
61-70	15.76	51.10	59.10	62.11	68.70
71-80	20.67	52.00	58.50	61.62	72.27
>80	21.57	54.40	64.15	73.39	80.15

Table 1: Mean photostress recovery time in diabetic retinopathy.

Table 1 shows the mean photostress recovery time in subjects with diabetic retinopathy in relation to Age group.

For the age group (41-50 years), the subjects with proliferative diabetic retinopathy revealed a peak mean increase in photostress recovery time (79.65 seconds) than the subjects with mild non proliferative diabetic retinopathy (52.03seconds) in relation to the control subjects (19.79 seconds).

For the age group (51-60 years), the subjects with proliferative diabetic retinopathy revealed a peak mean increase in photostress recovery time (69.44 seconds) than the subjects with mild non proliferative diabetic retinopathy (55.27 seconds) in relation to the control subjects (14.75 seconds).

For the age group (61-70 years), the subjects with proliferative diabetic retinopathy revealed a peak mean increase in photostress recovery time (68.70 seconds) than the subjects with mild non proliferative diabetic retinopathy (51.10 seconds) in relation to the control subjects (15.76 seconds).

For the age group (71-80 years), the subjects with proliferative diabetic retinopathy revealed a peak mean increase in photostress recovery time (72.27 seconds) than the subjects with mild non proliferative diabetic retinopathy (52.00 seconds) in relation to the control subjects (20.67 seconds).

For the age group (>80 years), the subjects with proliferative diabetic retinopathy revealed a peak mean increase in photostress recovery time (80.15 seconds) than the subjects with mild non proliferative diabetic retinopathy (54.40 seconds) in relation to the control subjects (80.15 seconds). Analysis of variance (ANOVA) revealed a statistically significant difference in photostress recovery time for the 4 Grades of diabetic retinopathy ($p = 0.000$) with respect to the control subjects in relation to Age group.

Age group	Control photostress recovery time (seconds)	Grade i (barely dectectable artery narrowing) (seconds)	Grade ii (obvious arterial narrowing with focal irregularity) (seconds)	Grade ii (retinal haemorrhage, exudates, etc) (seconds)	Grade iv (papilloedema) (seconds)
41-50	19.79	53.70	59.56	60.50	70.55
51-60	14.75	56.81	59.00	62.33	72.45
61-70	15.76	54.40	59.40	63.05	77.25
71-80	20.67	53.10	60.10	66.00	76.60
>80	21.57	54.10	64.25	69.78	78.10

Table 2: Mean photostress recovery time in hypertensive retinopathy.

Table 2 shows the mean photostress recovery time in subjects with Hypertensive retinopathy in relation to Age group.

For the age group (41-50 years), the subjects with papilloedema revealed a peak mean increase in photostress recovery time (70.55 seconds) than the subjects with barely detectable artery narrowing (53.70 seconds) in relation to the control subjects (19.79 seconds).

For the age group (51-60 years), the subjects with papilloedema revealed a peak mean increase in photostress recovery time (72.45 seconds) than the subjects with barely detectable artery narrowing (56.81 seconds) in relation to the control subjects (14.75 seconds).

For the age group (61-70 years), the subjects with papilloedema revealed a peak mean increase in photostress recovery time (77.25 seconds) than the subjects with barely dectectable artery narrowing (54.40 seconds) in relation to the control subjects (15.76 seconds).

For the age group (71-80 years), the subjects with papilloedema revealed a peak mean increase in photostress recovery time (76.60 seconds) than the subjects with barely detectable artery narrowing (53.10 seconds) in relation to the control subjects (20.67 seconds).

For the age group (>80 years), the subjects with papilloedema revealed a peak mean increase in photostress recovery time (78.10

seconds) than the subjects with barely detectable artery narrowing (54.10 seconds) in relation to the control subjects (21.57 seconds). The ANOVA revealed a statistically significant difference in photostress recovery time for the 4 Grades of hypertensive retinopathy (p = 0.000) with respect to the control subjects in relation to Age group.

Age group	Control photostress recovery time (seconds)	Grade i (early glaucoma) (seconds)	Grade ii (moderate glaucoma) (seconds)	Grade iii (severe glaucoma) (seconds)
41-50	19.79	57.21	67.27	78.50
51-60	14.75	58.21	61.61	68.75
61-70	15.76	52.71	62.12	71.94
71-80	20.67	50.69	61.70	74.26
>80	21.57	54.15	63.21	75.28

Table 3: Mean photostress recovery time in glaucoma.

Table 3 shows the mean photostress recovery time in subjects with Glaucoma in relation to Age group.

For the age group (41-50 years), the subjects with severe glaucoma revealed a peak mean increase in photostress recovery time (78.50 seconds) than the subjects with early Glaucoma (57.21 seconds) in relation to the control subjects (19.79 seconds).

For the age group (51-60 years), the subjects with severe glaucoma revealed a peak mean increase in photostress recovery time (68.75 seconds) than the subjects with early Glaucoma (58.21 seconds) in relation to the control subjects (14.75 seconds).

For the age group (61-70 years), the subjects with severe glaucoma revealed a peak mean increase in photostress recovery time (71.94 seconds) than the subjects with early Glaucoma (52.71 seconds) in relation to the control subjects (15.76 seconds).

For the age group (71-80 years), the subjects with severe glaucoma revealed a peak mean increase in photostress recovery time (74.26 seconds) than the subjects with Early Glaucoma (50.69 seconds) in relation to the control subjects (20.67 seconds).

For the age group (>80 years), the subjects with severe glaucoma revealed a peak mean increase in photostress recovery time (75.28 seconds) than the subjects with early Glaucoma (54.15 seconds) in relation to the control subjects (19.79 seconds).

The ANOVA revealed a statistically significant difference in photostress recovery time for the 3 grades of glaucoma (p = 0.000) with respect to the control subjects in relation to age group.

Age group	Aontrol photostress recovery time (seconds)	Category 1 (no age related macular degeneration) (seconds)	Category 2 (early age related macular degeneration) (seconds)	Category 3 (intermediate age related macular degeneration (seconds)	Category 4 (advanced age related macular degeneration (seconds)
41-50	19.79	53.15	61.72	76.17	87.19
51-60	14.75	51.43	63.12	74.25	84.57
61-70	15.76	56.88	61.27	71.20	77.30
71-80	20.67	55.71	65.77	76.50	77.53
>80	21.57	56.75	66.72	77.79	87.10

Table 4: Mean photostress recovery time in age related macular degeneration.

Table 4 shows the mean photostress recovery time in subjects with age-related Macular Degeneration in relation to Age group.

For the age group (41-50 years), the subjects with Advanced age-related Macular Degeneration revealed a peak mean increase in photostress recovery time (87.19 seconds) than the subjects with no age related macular degeneration (53.15 seconds) in relation to the control subjects (19.79 seconds).

For the age group (51-60 years), the subjects with Advanced Age Related Macular Degeneration revealed a peak mean increase in photostress recovery time (84.57 seconds) than the subjects with No Age Related Macular Degeneration (51.43 seconds) in relation to the control subjects (14.75 seconds).

For the age group (61-70 years), the subjects with Advanced Age Related Macular Degeneration revealed a peak mean increase in photostress recovery time (77.30 seconds) than the subjects with No Age Related Macular Degeneration (56.88 seconds) in relation to the control subjects (15.76 seconds).

For the age group (71-80 years), the subjects with Advanced Age Related Macular Degeneration revealed a peak mean increase in photostress recovery time (77.53 seconds) than the subjects with No Age Related Macular Degeneration (55.71 seconds) in relation to the control subjects (20.67 seconds).

For the age group (>80 years), the subjects with Advanced Age Related Macular Degeneration revealed a peak mean increase in photostress recovery time (87.10 seconds) than the subjects with No Age Related Macular Degeneration (56.75 seconds) in relation to the control subjects (21.57 seconds).

The ANOVA revealed a statistically significant difference in photostress recovery time for the 4 Categories of Age Related Macular Degeneration (p = 0.000) with respect to the control subjects in relation to Age group.

Tests of Within-Subjects Effects							
Measure: MEASURE_1							
Source		**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Psrt	Sphericity Assumed	6957.154	4	1739.289	920.074	.000	.997
	Greenhouse-Geisser	6957.154	1.304	5333.921	920.074	.000	.997
	Huynh-Feldt	6957.154	1.897	3666.777	920.074	.000	.997
	Lower-bound	6957.154	1.000	6957.154	920.074	.000	.997

Table 5: Tests of within – subjects effects.

Table 5 shows test of within-subjects effects for photostress Recovery time between control subjects, subjects with (diabetic retinopathy, hypertensive retinopathy, glaucoma, Age related macular degeneration).

Table 5 revealed a significant within subjects effect for photostress recovery time since P-value (0.000) < 0.05 using sphericity Assumed and Greenhouse-Geisser.

Tests of Within-Subjects Effects							
Measure: MEASURE_1							
Source		**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
psrt * SEX_1 * AGE_1 * SEX_2 * AGE_2 * SEX_3 * AGE_3 * SEX_4 * AGE_4	Sphericity Assumed	.000	0	.	.	.	.
	Greenhouse-Geisser	.000	.	.	.	.	.
	Huynh-Feldt	.000	.	.	.	.	.
	Lower-bound	.000	.000	.	.	.	.

Error(psrt)	Sphericity Assumed	.000	0	.			
	Greenhouse-Geisser	.000	.	.			
	Huynh-Feldt	.000	.	.			
	Lower-bound	.000	.000	.			

Table 6: Tests of within – subjects effects.

Table 6 revealed a significant within subjects effect for photostress recovery time, Age and Sex since P-value (0.000) < 0.05 using sphericity Assumed and Greenhouse-Geisser.

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	control_psrt & diabetic_retinopathy_psrt	11	-.179	.599
Pair 2	control_psrt & hypertensive_retinopathy_psrt	11	.023	.946
Pair 3	control_psrt & Age_related_molecular_degeneration_psrt	4	-.085	.915
Pair 4	control_psrt & glaucoma_psrt	11	-.337	.310

Table 7: Correlation Coefficients for Photostress Recovery Time.

Table 7 shows the correlation coefficients for photostress recovery time.

Table 7 revealed a very weak negative relationship between photostress recovery time of the control subjects and photostress recovery time of subjects with diabetic retinopathy. Since, correlation Coefficient r = (-0.179).

Table 7 revealed a very weak negative relationship between photostress recovery time of the control subjects and photostress recovery time of subjects with hypertensive retinopathy. Since, correlation Coefficient r = (-0.023).

Table 7 revealed a very weak negative relationship between photostress recovery time of the control subjects and photostress recovery time of subjects with Glaucoma. Since, correlation Coefficient r = (-0.085).

Table 7 revealed a very weak negative relationship between photostress recovery time of the control subjects and photostress recovery time of subjects with Age related Macular degeneration. Since, correlation Coefficient r = (-0.337).

		Mean	Std. Deviation	Std. Error Mean	t	df	Sig.(2-tailed)
Pair 1	control_psrt - diabetic_retinopathy_psrt	-42.11205	5.96512	1.79855	-23.414	10	.000
Pair 2	control_psrt - hypertensive_retinopathy_psrt	-42.63909	5.48317	1.65324	-25.791	10	.000
Pair 3	control_psrt - Age_related_molecular_degeneration_psrt	-50.90000	2.94313	1.47157	-34.589	3	.000
Pair 4	control_psrt - glaucoma_psrt	-43.82121	6.36086	1.91787	-22.849	10	.000

Table 8: Paired sample t-test.

Discussion

A Sample Size of 200 subjects was used for this study. 50 subjects with diabetic retinopathy, 50 subjects with hypertensive retinopathy, 50 subjects with glaucoma, 25 subjects with Age related macular degeneration and 25 subjects control subjects were under study. The data were analyzed using ANOVA and Paired Sample t-test. A significant effect of diabetic retinopathy, hypertensive retinopathy, Glaucoma and Age Related macular degeneration on photostress recovery time was observed, since P-value < 0.05.

The subjects in the control group showed a mean age of 49 ± 5.75 years, the subjects with diabetic retinopathy showed a mean age of 58 ± 8.32 years, the subjects with hypertensive retinopathy showed a mean age of 62 ± 7.20 years, the subjects with glaucoma showed a mean age of 62 ± 8.33 years and the subjects with Age related macular degeneration showed a mean age of 68 ± 5.47 years.

A significant within subjects effect for photostress recovery time, Age and Sex was also observed since P-value (0.000) < 0.05 using sphericity Assumed and Greenhouse-Geisser.

A very weak negative relationship between photostress recovery time of the control subjects and photostress recovery time of subjects with diabetic retinopathy was observed. Since, correlation Coefficient r = (-0.179).

A very weak negative relationship between photostress recovery time of the control subjects and photostress recovery time of subjects with hypertensive retinopathy was observed. Since, correlation Coefficient r = (-0.023).

A very weak negative relationship between photostress recovery time of the control subjects and photostress recovery time of subjects with Glaucoma was observed. Since, correlation Coefficient r = (-0.085).

A very weak negative relationship between photostress recovery time of the control subjects and photostress recovery time of subjects with Age related Macular degeneration was observed. Since, correlation Coefficient r = (-0.337).

There was a significant difference in the PSRT of diabetics when compared to normal subjects. This is in accordance with the work carried out by Chilaris and shows that diabetes and hypertension lead to a longer recovery time [4].

Grosvenor showed that an impaired retinal pigment epithelium slowed down regeneration of photopigment [5]. There was also a significant difference in PSRT of hypertensive individuals when compared to normal subjects. This could be attributed to an impaired retinal vascular supply. There was no significant increase in the PSRT of diabetics when compared to the PSRT of hypertensive individuals.

The mean PSRT of the control was 44.70seconds and is also in line with that of Sherman [7] which is 41.97 ± 17.34 seconds, Chilaris given to be 10.50 seconds and Grosvenor which is 40-50 seconds. The increased PSRT of diabetic and hypertensive patients when compared to the PSRT is also in line with the work of Dhalla [6].

Photostress recovery time was measured in 30 eyes from 15 patients with chronic open angle glaucoma, and 30 eyes from 15 individuals of a similar age group with no ophthalmological disorder. The average recovery time in patients with glaucoma was 70.47 (SD 35.39) seconds. The average recovery time in the control population was 41.97 (SD 17.34) seconds. This difference was statistically significant (p less than 0.001). There was a small positive correlation between age and recovery time in the control population, whereas there was no correlation between age and recovery time in the glaucoma group. There was no correlation between visual acuity and recovery time for either group. There was also no correlation between intraocular pressure and recovery time for the glaucoma group. It was not possible to control for pupillary dilatation in this study. However, it has been previously demonstrated that pharmacological miosis will not delay photostress recovery time in normal subjects. This is the first report of photostress recovery testing in patients with chronic open angle glaucoma. The results are discussed in terms of the pathophysiology of glaucoma and previous photostress studies in patients with macular disease [7].

Conclusion

PSRT test was carried out on 50 diabetic patients, 50 hypertensive patients, 50 glaucoma patients, 25 Age related macular degeneration and 25 control and the results of the analysis got. Based on the analysis, the following conclusions were made:

- The mean PSRT of diabetic retinopathy was 58 ± 8.32 seconds.
- The mean PSRT of hypertensive retinopathy was 62 ± 7.20 seconds.
- The mean PSRT of glaucoma was 62 ± 8.33 seconds.
- The mean PSRT of age related macular degeneration was 68 ± 5.47seconds.
- The mean PSRT of control was 49 ± 5.75seconds.
- There was a significant difference between the PSRT of all the above mentioned posterior ocular anomalies compared to that of normal subjects ($P < 0.50$).

Recommendations

With regards to the findings in this research work, it is important to make the following recommendations.

- More research work should be done on this topic, possibly with more number of subjects.
- More risk communication and community engagement should be done on posterior segment ocular anomalies which includes diabetic retinopathy, hypertensive retinopathy, glaucoma and dry age related macular degeneration etc.
- Screening should be done from time to time to checkmate glaucoma, dry age related macular degeneration, diabetes and hypertension so as to reduce their systemic and ocular complications.
- Proper management of glaucoma, age related macular degeneration, diabetes and hypertension should be ensured in people already diagnosed to have these disorders.
- Balanced diet and vitamin A supplementation should be advised especially in high risk groups as they may preventbor slow doen progression of retinsl disease.

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