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# USE OF PHOTOSTRESS TEST TO STUDY MACULAR FUNCTION IN EYES WITH MACULOPATHIES

Ophthalmology

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## ABSTRACT

**Introduction:** There are various Psychophysical and Electrophysiological tests to evaluate macular functions. In present era of technology driven diagnostic testing, there is lesser utilization of simpler and cost effective clinical tests. This study was undertaken to evaluate macular function by Photostress test in eyes with and without Maculopathies.

**Aim:** Study various Maculopathies using Photostress test.

**Methodology:** This study was conducted on 389 eyes with maculopathies and 400 normal eyes. A detailed ophthalmic and macular examination with Photostress test was performed in all cases.

**Results:** Maculopathy was commonly observed in age group of 41 to 50 years with a higher prevalence amongst males. 18 types of maculopathies were found in the study, Dry ARMD(25.15%) and Diabetic Maculopathy(8.9%) were most common. Photostress test was positive in 46 out of 389 eyes with maculopathies (11.83%).

**Conclusion:** Photostress test is an useful indicator in early diagnosis of Maculopathies.

## KEYWORDS

Macula, Photostress test, Maculopathy

## INTRODUCTION

The photoreceptors of the macular area of the retina are responsible for photopic and colour vision. Disturbances in anatomical integrity of the macula by oedema, inflammation or degeneration results in disturbance in macular function. Visual acuity, colour vision and central fields get affected. Thus the macula is a vital area and our ability to evaluate its anatomy and function become important in the presence of disease.

The Macula or Area centralis, lies between the temporal vascular arcades. The centre of the macula is 3mm temporal and 0.8mm inferior to the centre of optic disc. The architecture of macula is unique and differs from rest of the retina in that it has more than two ganglion cell layers, while the inner layers of retina stop short here. Presence of the lutein and zeaxanthin pigments imparts a characteristic yellow colour to this region. The macular area is responsible for the central 20° of visual field of the eye.[1]

The density of cone photoreceptor is greatest in the foveal area reaching a density of 140,000 cones/mm². Each cone has a diameter of 0.006mm. For an image to be perceived two cones need to be stimulated and these two cones must be separated by a non-stimulated cone. Diseases which cause increased separation of cones from each other result in fewer cones being stimulated by an image so that the brain perceives a smaller sized image (micropsia). Conversely, crowding of cones results in a greater number of cones being stimulated and hence a perception of increased image size (macropsia).[1],[2]

The cones are stimulated by incoming light and a phototransduction cycle gets initiated. The visual pigments undergo a bleaching change. Following stimulation there is a refractory period when the cones don't respond to light stimulation. Once bleaching cycle is complete, reisomerization of visual pigments occur. This reisomerization is independent of light. Stimulation of fovea by light for a period of 10 seconds induces a fatigue. The recovery from photostress is dependent on the rate of photopigment resynthesis and the functional relationship between photoreceptors and retinal pigment epithelium. Normally recovery time is 15 to 30 seconds. In case of a maculopathy where the outer retinal layers and choroid are affected, the photostress recovery time (PSRT) is prolonged. If the cause of reduced visual acuity has its origin in the ganglion cell layer of the retina or higher visual centers, the recovery time will be within normal limits. This forms the basis of the Photostress test.[3],[4]

Photostress test was introduced by Baillliart (1954) who dazzeled the macula with light of an ordinary ophthalmoscope and measured recovery time of central vision.[5] The best corrected distance visual acuity is determined. Patient is asked to look at the light of a pen torch or an indirect ophthalmoscope held 3 cm away for 10 seconds. Time taken to read any three letters of the pre-test acuity line is measured as the PSRT. Normal range is upto 40 seconds. PSRT increases with age but is independent of pupil size, ametropia and visual acuity.[4] Despite the fact that it is easy to perform and is readily available for clinical use, it is underutilized. This study was conducted to assess macular function in different diseases of macula by using the Photostress test.

## MATERIALS AND METHODS

This is a comparative, clinical, observational, cross sectional study which was duly approved by the institutional ethics committee. It was carried out in Ophthalmology Department of a Medical College and teaching hospital during the period August 2011- July 2013. Written informed consent was obtained from participants, prior to enrolment in the study.

***Inclusion criteria:***

- Male and female subjects above 20 years of age
- Subjects with a diagnosis of Maculopathy
- Persons under treatment with drugs known to cause macular toxicity e.g. antitubercular drugs, chloroquine therapy
- An equal number of age and gender matched subjects with normal eyes were enrolled as controls

***Exclusion criteria:***

- Individuals with media opacities, neurophthalmic disorders and glaucoma

Demographic data, detailed history and clinical examination findings was captured on a predetermined proforma. All participants underwent a detailed ocular examination of both eyes. Photostress test by flash exposure of fovea using 3.5 volts halogen bulb of Welch Allyn ophthalmoscope held at 3 cms for 10 seconds.[4]

Results were tabulated and statistically analyzed using Fischer's exact test and Chi Square Test to ascertain association between various parameters. A p-value of $<0.05$ was considered statistically significant. Data analysis is done using SPSS (Statistical package For social sciences) for Windows, version17, was used for analysis.

## RESULTS

A total of 411 participants from ages ranging from 21 to 84 years, mean age being 55.29 years. Group-A comprised of 211 participants (123 males and 88 females) with maculopathies. A total of 178 patients had bilateral involvement of the eyes while 33 had unilateral involvement (389 eyes). Group-B comprised of 200 patients (101 males and 99 females) with normal eyes (400 eyes).

**TABLE I: TYPES OF MACULOPATHIES**

| Type of Maculopathy | Number of patients | Percent |
|---|---|---|
| BRVO with Macular Oedema | 4 | 0.5 |
| Cellophane Maculopathy | 3 | 0.4 |
| CNVM | 1 | 0.1 |

| | | |
|---|---|---|
| CSCR | 2 | 0.3 |
| CSME | 56 | 7.1 |
| CME | 6 | 0.8 |
| Diabetic Maculopathy | 70 | 8.9 |
| Dry ARMD | 198 | 25.1 |
| Juxtafoveal Telangiectasia | 2 | 0.3 |
| Macular Detachment | 4 | 0.5 |
| Macular Dystrophy | 8 | 1.0 |
| Macular Fan (Gr IV HTR) | 2 | 0.3 |
| Macular Haemorrhage | 3 | 0.4 |
| Macular Hole | 3 | 0.4 |
| Macular Pucker | 1 | 0.1 |
| Macular Scar | 17 | 2.2 |
| Myopic Macular Degeneration | 4 | 0.5 |
| Wet ARMD | 5 | 0.6 |
| Total | 389 | 100 |

**Table II: Photostress Test In Group A And B Patients**

| | | PSRT in seconds | | | Total |
|---|---|---|---|---|---|
| | | 1 - 20 | 21 - 40 | > 40 | |
| Group-A | Cellophane maculopathy | 2 | 0 | 1 | 3 |
| | Diabetic maculopathy | 60 | 8 | 2 | 70 |
| | Dry ARMD | 165 | 19 | 14 | 198 |
| | Juxtafoveal telangiectasia | 0 | 2 | 0 | 2 |
| | Macular dystrophy | 6 | 2 | 0 | 8 |
| | Macular hole | 2 | 1 | 0 | 3 |
| | Macular pucker | 0 | 1 | 0 | 1 |
| | Macular Scar | 10 | 5 | 2 | 17 |
| | Myopic macular degeneration | 2 | 2 | 0 | 4 |
| | BRVO with macular oedema | 1 | 3 | 0 | 4 |
| | CNVM | 0 | 0 | 1 | 1 |
| | CSCR | 0 | 0 | 2 | 2 |
| | CSME | 30 | 11 | 15 | 56 |
| | Cystoid macular oedema | 2 | 2 | 2 | 6 |
| | Macular detachment | 2 | 0 | 2 | 4 |
| | Macular fan (Gr IV HTR) | 0 | 0 | 2 | 2 |
| | Macular haemorrhage | 1 | 1 | 1 | 3 |
| | Wet ARMD | 1 | 2 | 2 | 5 |
| | Total | 284 | 59 | 46 | 389 |
| Group-B | WNL | 387 | 7 | 6 | 400 |
| | Total | 387 | 7 | 6 | 400 |

**Table III: Correlation Of Photostress Test With Age In Group-a**

| Age group (in years) | PSRT (in seconds) | | | Total | P-value |
|---|---|---|---|---|---|
| | ≤ 20 | 21 - 40 | > 40 | | |
| ≤ 30 | 7 | 3 | 7 | 17 | 0.003 |
| 31 - 40 | 30 | 4 | 2 | 36 | |
| 41 - 50 | 41 | 9 | 7 | 57 | |
| 51 - 60 | 119 | 19 | 11 | 149 | |
| > 60 | 87 | 24 | 19 | 130 | |
| Total | 284 | 59 | 46 | 389 | |

**Table IV: Correlation Of Photostress Test With Age In Group- B**

| Age group (in years) | PSRT (in seconds) | | | Total | P-value |
|---|---|---|---|---|---|
| | ≤ 20 | 21 - 40 | > 40 | | |
| ≤ 30 | 81 | 1 | 0 | 82 | < 0.001 |
| 31 - 40 | 106 | 0 | 0 | 106 | |
| 41 - 50 | 79 | 1 | 0 | 80 | |
| 51 - 60 | 87 | 3 | 0 | 90 | |
| > 60 | 34 | 2 | 6 | 42 | |
| Total | 387 | 7 | 6 | 400 | |

## DISCUSSION

411 patients were enrolled in the study out of which 211 patients (123 males and 88 females) with Maculopathy (389 eyes) were allotted to Group-A and 200 patients (101 males and 99 females) without any clinical evidence of Maculopathy (400 eyes) were allotted to Group-B. The ages of the patients ranged from 21- 84 years and the mean age was 55.29 years. The prevalence of Maculopathy was greatest (37%) in the 41-50 years age group.

In Group-A, various types of Maculopathies seen in the study were Age related macular degeneration (ARMD) dry(25%) and wet(0.6%), Diabetic maculopathy with and without CSME (7.1%% and 8.9% respectively), Cystoid macular oedema (0.8%), CSCR (0.3%), CNVM (0.1%), Myopic macular degeneration (0.5%), BRVO with macular odema (0.5%), Juxtafoveal telangiectasia (0.3%), Serous macular detachment (0.5%), Macular dystrophy (1%), Macular fan in Grade IV Hypertensive retinopathy (0.3%), Cellophane maculopathy (0.4%), Macular haemorrhage in anemic retinopathy (0.4%), Macular hole (0.4%), Macular scar (2.2%) and Macular pucker (0.1%). The majority of cases had dry ARMD (25.1%) followed by Diabetic maculopathy without CSME (8.9%) and with CSME (7.1%).

In eyes with macular disorders, the recovery from a flash exposure of the fovea has been seen to be prolonged as compared to normal eyes. [4] In the present study, the Photostress test showed prolonged recovery time (>40 seconds) in 46 eyes in Group-A patients. Range of variation was 3-70 seconds in Group-A patients with a mean of 18.76 seconds and standard deviation of 15.68 seconds.

In Group-B, the range was 3-53 seconds with a mean of 9.20 seconds and standard deviation of 7.18 seconds. Although prolongation of recovery time was noted in 6 patients in this group, this prolongation could suggest the presence of an underlying subclinical phase of maculopathy and these patients should be closely followed up over time. However, it is also noted that in the present study the cut off time was taken to be 40 seconds while in other studies, the cut off time has been taken to be 60 seconds in the study carried out by SRK Malik, Gurbax Singh et al.[5]

Sensitivity of Photostress test is 11.83% in maculopathies. Photostress test also showed a positive correlation with age in Group A (p value 0.003) and Group-B patients (p value <0.001). This association between age and Photostress test in both the Groups is significant as determined by Fisher's exact test.

The findings of this study bear out the results of the other studies carried out by Bharati Lavinginia[6] , SRK Malik, Gurbax Singh et al[5] and V E Natsikos, J C Dean Hart[7] wherein PSRT was markedly prolonged in maculopathies.

In 1980 V E Natikos and J C Dean Hart used a standard West German Zeiss fundus camera connected to a flash generator set to study PSRT in 50 normal individuals and 27 patients of CSCR. The study showed that PSRT was grossly prolonged in patients with CSCR for first few weeks after the onset of symptoms and gradually returned to normal by 5 months. [7]

In 1983, Glaser JS, Savino PJ, Sumers KD, et al used photostress test by subjecting macula to 10 seconds of ordinary penlight to distinguish optic nerve conduction defects from macular disease[8] Lavingia B studied 500 eyes. Photostress test was performed using Heine direct ophthalmoscope kept at 15 cm distance from the eye for 30 seconds. In this study average recovery timewas between 15-52 seconds and recovery time increased beyond 5 minutes in diseased conditions of macula. [6]

In 1990, Suresh Kumar Verma and Akhoury S.B Sahai used Olympus electronic flash Guide No. 20 in meters with 100 ASA with 1/2000 second to perform photostress test to study cases of CSCR. 100 normal subjects and 50 cases of CSCR were studied. In normal subjects the recovery time after macular dazzling test was 10-54 seconds and in eyes with CSCR it was between 10-15 minutes.[9]

In 2003, Schmitt NJ, Grover DA and Feldon SE used the Eger macular stressometer(EMS) for early screening of ARMD and in 2006, J S Wolffsohn et al used EMS to measure PSRT. The EMS consists of a Thyristor photo flash linked to a digital timer and a near acuity chart. Patients with vision best corrected by their reading prescription, read the smallest logMAR near acuity line of capital letters at 40 cm (illuminated by 900 lux) using binocular vision. The EMS was then moved to 15 cm and the patients binocularly exposed to the flash while looking into its centre (visual angle 14.2° horizontally and 6.8° vertically). The reading chart was immediately repositioned at 40 cm and time until the patient could read print one line (0.1 logMAR) larger than their pre-exposure visual acuity was measured. The measurement was repeated after a 10 minute recovery period to allow retinal re-adaptation following bleaching.[10],[11],[12] The study by Schmitt NJ et al found EMS recovery time distributions did not differ between ARMD, cataract, diabetic retinopathy, and glaucoma groups. They suggested that the EMS in its current form was not a sensitive screening tool for ARMD.[10]

SRK Malik, Gurbax Singh et al[5] studied 60 normal cases and 20 cases of macular and optic nerve pathology using the Photostress test. The macula of the eyes under this study was dazzled with an electric ophthalmoscope 15mm from anterior surface of the eye for 5-25 seconds, 30 seconds and more than 30 seconds. They determined that the ideal time for dazzling the macula was 30 seconds. In normal eyes, PSRT varied from 10-60 seconds. The PSRT was not increased in eyes with optic nerve disorders. The PSRT test is also useful in distinguishing between visual impairment due to maculopathies as against due to optic nerve diseases.

## CONCLUSION

From the present study of 789 eyes it is concluded that Maculopathies had a higher prevalence amongst males (M:F =1.4:1). Maculopathy was commonly observed in the age group of 41-50 years (37%). Dry ARMD (25.1%) and Diabetic maculopathy without CSME (8.9%) were the most prevalent forms of maculopathies in this study. Photostress test was positive in 46 eyes with maculopathies. Sensitivity of Photostress test is 11.83% in this study. There was a statistically significant correlation between the test and presence of maculopathy ($p<0.001$).

This study suggests that even though the sensitivity of Photostress test is low, it is easily available and easy to perform and is not time consuming.

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