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Original Research Article

Comparison of Pupil Size and Accommodative Facility Before and After Screen Use

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Abstract:

Purpose: In the era of ever rising digital screen use the symptoms and assessment of digital eye strain still does not have uniformity and there is no significant study to quantify or evaluate accommodative system derangements. Our study is to test the effect of digital screen use on accommodative facility and pupil size and to test the null hypothesis.

Methods: It is a hospital based prospective interventional study conducted from April to August 2022 in Medical and Paramedical students of a tertiary care centre in North Kerala.

Results: The average pupil size was 5.7±0.88 mm before and 5.7±0.85 mm after screen use. The accommodative facility was 7±2 cycles before and 9±2 cycles after screen use. Paired t test refuted the null hypothesis of screen use on accommodative facility and the null hypothesis of pupil size was proven ($p < 0.0001$).

Conclusion: Accommodative facility increases after short duration of screen use but more studies are required to assess the correlation of duration of screen use and the effect on accommodative facility to prove that it is an integral parameter to be evaluated in digital eye strain.

Keywords: Digital Eye Strain, Accommodative Facility, Screen Use.

Introduction

In recent years, there has been an unprecedented increase in the usage of Video Display Unit (VDU), including digital and electronic devices has increased exponentially among people of all age groups. Screen time is defined as viewing or using anything with a screen, including computer, television (TV), video games [2].

A study among the digital screen users of the UK revealed a screen time averaging at 4 hours and 45 minutes, whereas it was slightly higher at 5 or more hours by two-third of the United States of American adults aged 30–49 years. Moreover, 68% of computer use and 54% of online activities were reported by the age of 3 years in a multinational European study. Simultaneous use of two or more devices was found to be done by 87% of 20–29 years of individuals for social media and multitasking. [3] A constellation of differing types of ocular symptoms was evident with the use of the VDU which is grouped under Computer Vision Syndrome, including eyestrain, watering eyes, headache, tired eyes, burning sensation, red eyes, irritation, dry eye, foreign body sensation, blurred vision at near and double vision [4].The prevalence of digital eye strain shows a large variation ranging from 5-65% (In the pre-COVID 19 era) With the COVID lockdown scenario digital eye strain in children alone rose to 50-60% [5] with a need to include acute onset esotropia, vergence anomalies and even myopia progression as a consequence of digital eye strain [5].

Most of the validated questionnaires for vergence anomalies and accommodative dysfunction has not been widely evaluated. Moreover the normative data for each population may show differences. There is a lack of age and ethnicity specific normative data which makes discrepancies in diagnosis and management. Since there is an overlap of dry eye symptoms and binocular dysfunction symptoms in these patients there is a need to assess each component and understand the changes that happen during usage of digital devices as the world is currently dependent on them . Only an in depth understanding of the changes would help us formulate remedial measures so that the treatment and advices remain uniform. This study is aimed at evaluating the accommodative facility, which is one of the parameters tested in non-strabismic binocular vision disorders that tests the accommodation dynamics and pupil size changes to assess whether these are affected during digital device use.

Aims and Objectives of the Study:

1) To evaluate accommodative facility before and after half an hour of screen use

2) To determine pupil size before and after half an hour of screen use.

The readings before the screen use will be taken after a screen free period of 30 minutes which will be taken as the time to recover from visual fatigue. Null hypothesis (H0) is that accommodative facility and pupil size are not affected after screen use and pupil size does not change. Alternate hypothesis is that accommodative facility and pupil size are influenced after screen use (H1)

Materials and Methods

The study is a hospital based prospective interventional study conducted in the Ophthalmology outpatient department of a Tertiary care hospital in North Kerala after institutional ethics committee approval. It included Medical a Paramedical students who volunteered for the test and gave an informed consent, in the age group of 18-30 years. Those with known dry eye disease on medication, contact lens use, continuous use of topical medications for any ocular disease, atopic dermatitis, history of ocular surgery, strabismus and myopia more than -5 dioptres were excluded from the study.

A sample size of 109 was calculated assuming 10% of the subjects in the selected population have the factor of interest and considering a margin error of 5% and confidence interval of 95%. The study was initiated after the clearance of the scientific committee and ethical committee of the institution from April 2022 to August 2022. The selected individuals underwent a complete evaluation with visual acuity, refraction, slit lamp evaluation and a record of their approximate daily usage of digital screen use were made. A resting period of 30 minutes without near work was kept before testing pupil size and accommodative facility. Pupil size was measured in a dark room with the Antares pupillometer available on the corneal topography machine before and after the task. Accommodative facility is the capacity of the eye to stimulate and relax accommodation and this is tested by interposing plus and minus lenses in front of the eye using a flipper or accommodative rock. In our study we used +2.0 dioptre and -2 dioptre lenses and binocular accommodative facility was done in ambient light using a word rock card which contains N10 and N8 font size at 40 cm and the subject is asked to keep the words in clarity through the plus and minus lenses and to tell as soon as they are clear. The number of words read in one minute is noted down. Accommodative facility is calculated in cycles per minute. One cycle is focusing through a plus and minus lens .The task is first explained to the patient and the accommodative facility is checked before and after screen use. Subjects were allowed to use their own mobile phones with the brightness settings regularly used by them and they were allowed to play the game of Candy crush saga for 30 minutes.

Results

109 students were evaluated in the study of which 69 were females and 40 were males. The mean age was 21.87±2.02 years. The data obtained from the proforma were entered in Microsoft Excel. And analysis was carried out using SPSS Version 20. The paired t test was done to test the hypothesis. The results are given in Table 1.

The mean accommodative facility was 1.95 before the screen use and 2.46 was after the task A statistically significant test (p value <0.0001) obtained here disproves the null hypothesis. i.e, the mean accommodative facility was increased with the use of screen for a short span of 30 minutes use. Therefore accommodative facility and screen use definitely affects the accommodative facility. On comparing the pupil sizes before and after the task, statistically the differences were negligible.

Table 1: Group 1 is before the screen use and Group 2 is after screen use. SD – standard deviation.

Parameter		**Group 1 (Accommodation facility before task)**	**Group 2 (Accommodation facility after task)**	**95 % Confidence interval**	**Difference of means (Group 1-Group 2)**	**p value (2 tailed paired t test)**
Accommodative facility in cycles/minute	Mean	1.95	2.46	-0.78 to -2.21	-0.50	**<0.0001**
	SD	0.77	1.65			
(n=109)	Mean	5.65	5.67		-0.019	**0.719**
Pupil size	SD	0.911	0.917	-0.12 to 0.87		

Discussion

The commonly evaluated Non strabismic binocular vision anomaly parameters include Near point of convergence and accommodation, Negative relative accommodation and Positive relative accommodation, Accommodative amplitude, Accommodative facility and vergence amplitudes. From the results this study shows that there is an effect on the accommodative facility after a short period of screen use whereas the pupil size does not show a significant change. Rosenfield et al examined accommodative facility in 22 young, visually normal subjects, before and after a 25min desktop computer task. No significant change in monocular facility was observed, while binocular values improved somewhat post-task [6]. Our study also showed a similar result with a mean of 7±2 cycles before and 9±2 cycles after screen use. Other. Even though both studies have only a short duration of screen use, since there is a definite and statistically significant change in the accommodative facility, this parameter can be used to assess and document digital eye strain.

Accommodative facility or the ability to make rapid changes in accommodation response may be pertinent to computer use, as switching fixation from the screen to other material or into the distance occurs frequently. Among 153 symptomatic computer users examined at a specialist clinic, poor accommodative facility was the most common diagnosis, detected in 31 (20.3%) patients [7]. Indian studies have shown that binocular accommodative facility reduced significantly following smartphone usage [8]. This study had the subjects to read text material from the smartphone whereas our study employed the usage of a game as the task. This raises another question of whether the accommodative facility changes are different for reading and gaming. Answering these questions may give us the direction to measure digital eye strain and employ methods to modify the use of these gadgets which have become an integral part of our lives.

The lag of accommodation as studied by Wick and Morse among a small sample of young adults reported that lag (measured with an open view autorefractor) was approximately 0.33 D higher in 4 of 5 participants when reading from a VDT compared with printed material, although Penisten et al found similar lags (by dynamic retinoscopy) in printed and VDT conditions. More recently, Collier and Rosenfield reported a stable mean lag of approximately 0.93 D among 20 adults during a 30min laptop-based task [3].

However studies on correlation of time of screen use and the effect on accommodative facility are needed before concluding that accommodative facility is an effective marker of digital eye strain. After-effects have been reported in up to 33% of individuals following intense near work, where the pupil may retain a somewhat constricted state after task completion. Saito et al noted a reduced pupil diameter and increased amplitude of pupillary reflexes following a prolonged VDT task, postulating that spasms of the sphincter pupillae and ciliary muscle may be responsible [9].

Dynamic recording of pupil size and refractive error using an open137 view autorefractor as described by Gray et al could facilitate analysis of post-task pupil recovery when after-effects are present while also enabling the study of within task accommodative response (accuracy). However pupil size did not show a significant change in our study. The symptoms related to digital eye strain are all grouped together even though the causative disorder might be different. The symptoms have been grouped into 3 groups, ocular surface related, Accommodation or vergence related binocular visual disturbances and extraocular symptoms which includes neck pain and headache [5]. Since recently during the COVID-19 outbreak there is an increase in myopia and acute comitant esotropia the classification need to be broadened to include these entities.

Understanding the pathophysiology of each of the binocular single vision parameters during screen use is the need of the century as gadgets are a part of our daily life and we are largely dependent on them. It will also help us to address these issues based on the disorder that causes the eye strain symptom, quantify them and grade the severity [11]. There are no questionnaires based on accommodative dysfunction and digital eye strain and all the questionnaires are focussed mainly on convergence, since the most common binocular vision anomaly is convergence insufficiency with prevalence values of 2.25 to 33% [10].

The fact that accommodation and convergence are not independent factors influences the assessment to a large extent. The lack of normative data is another challenge since there 155 are not enough population based studies for the binocular single vision parameters.

However there have been pioneering works from Tamil Nadu which has helped to chart out normative data in school children concerning non strabismic binocular vision parameters [11]. This study is just an initial attempt to assess these parameters responsible for digital eye strain. Computer software's are also gaining popularity in assessing and managing binocular vision anomalies, which may help us in assessing these disorders better.

Conclusion

Charting out age specific normative data, assessing binocular vision anomalies and surface pathologies need to be an integral part of ophthalmic evaluation in the long run. More studies to assess the vergence and accommodation parameters, correlating the symptomatology and the causative disorder of binocular single vision will definitely help us to manage these patients better and even help us to prevent children from developing lifelong anomaly of binocular vision.

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