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EFFECT OF COMPUTER USAGE ON ELECTROOCULOGRAM PATTERN

OPTHALMOLOGY

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ABSTRACT

This study was aimed at drawing a comparison between the Arden ratio and blink rates obtained through EOG reading. The study was designed to record the EOG pattern of the individuals while reading the hard copy of a matter and digital copy of the same in the computer during dark and bright illumination. The results were analysed. The statistical analysis was done. Analysis of the Arden ratio showed a statistically significant ratio with a P-Value 0.026. An Arden ratio less than 1.85 is considered pathogenic. The analysis of blink rate was not statistically significant due to small sample size and small duration of computer usage.

KEYWORDS:

EOG, Arden ratio, Blink rate

Introduction

Computers and other electronic media have become an integral part of every individual in this modern world, which has adverse effects on the health of those who constantly use them. As per recent investigations electronic gadgets attract children from age 8 -18 years to spend more than 4-7 hrs/day which cause computer vision syndrome (CVS)[1].

Electrooculogram (EOG) is a device commonly used in psychophysiological laboratories, to measure the electrical potential difference between the front and back of the eye. In "Electrooculography", angular position of the eye is measured relative to the head[2]. It records standing corneal retinal potential that exists between retina and cornea[3]. EOG is one of the easy and cost effective methods using which the effect of CVS on the visual ability of an individual can be analysed. Even though many studies have been conducted in the past to study EOG patterns and computer usage, none have compared and correlated the effect produced by usage of computers on EOG pattern. In recent times, print media is replaced by visual media, which makes it necessary to compare them. Jatinder Bali et.al., have studied the effect of extensive usage of computers and mobile computing devices on health of humans and concluded that CVS is not caused by a single factor but is of multi factorial causation[1]. Mark Rosenfield, analysed the principal ocular causes for CVS and proposed that this may be due to a decrease in blink rate and blink amplitude[4]. Hari Singh et.al., reviewed the techniques used for eye tracking and concluded that EOG is a good choice to be used in the human computer interaction applications due to its good stability, accuracy and cost[5]. Arden et.al., analysed the EOG variations and concluded that an Arden ratio less than 1.85 is pathogenic[6]. Here, we tried to compare and analyse the EOG pattern, ocular strain, blink frequency and Arden ratio produced while reading the hard and soft copy of a book in light and dark illumination. Also an analysis regarding the variation in blink frequency in hardcopy and softcopy was recorded.

Procedure:

A comparative cross sectional study was performed on 40 individuals who were mainly medical students / software professionals in the age group of 20-35 years, who use computers for a minimum of 4 hrs/day, with Best corrected visual acuity (BCVA) 6/6 -6/9. Individuals with ocular disease, eye disorders and high refractive errors were excluded. We used AD Instruments Power Lab 26T with appropriate transducers and accessories for measurements. The apparatus was connected as shown in Figure 1.

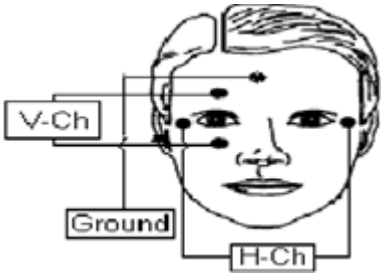

Figure 1

As the protocol demands, experimental procedure was explained to the subjects and their consent was obtained before performing the experiment. Using a standard questionnaire, required data was collected from them. The subjects were screened by an ophthalmologist before being included for the study. The connections were made. The skin was rubbed with wet towel before placing the electrodes. The subject was made to read from hardcopy and softcopy at a constant comfortable distance. Myopics were asked to use glasses while reading from hardcopy and softcopy. The subject was asked to read the hardcopy of a matter, in illumination for 10 minutes and in dark for 15 minutes. After giving a rest for 15 minutes, similar procedure was followed with digital copy of the same.Using the instrument the EOG pattern as well as the blink rate was recorded. The Lab Chart Reader was set to measure the peak and trough potential for calculation of Arden ratio as represented in Figure 2.

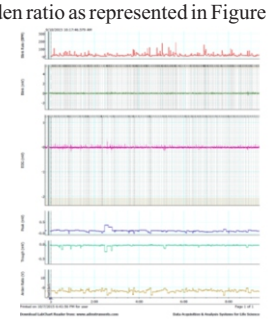

Figure 2

Arden ratio was calculated using the formula,

$$Arden\ Ratio = \frac{Peak\ Potential}{Trough\ Potential} \quad (Normal\ value > 1.85)$$

Observations and results

The main analysis includes 40 subjects. The subjects taken for this study include both sexes, between the age group 20 to 35 yrs. Subjects with normal vision and myopic vision were used for this study. The data obtained was analysed statistically and the comparison between different variables were studied using the "Independent t-Test ", where the results are said to be statistically significant if P-Value < 0.05.

Table 1 – Mean Arden Ratio

MEAN ARDEN RATIO		
Hard Copy (S.D)	**Soft Copy (S.D)**	**P – Value**
2.79 (0.83)	2.40 (0.67)	0.026

It was seen that there is a significant difference between the Arden ratio of hard copy and soft copy (P-value=0.026). The Arden ratio for hard copy is found to be greater than the Arden ratio for soft copy with the values 2.79 and 2.40 respectively as represented in Table1.

The blink rates during hardcopy and softcopy reading were represented in Table 2. Even though the P-values were above 0.05 in the above cases (i.e.) they were not statistically significant, yet the differences in values can be clinically attributed.

Table 2 – Blink Rate

Hard copy (mean)		Soft copy (mean)	
Light	**Dark**	**Light**	**Dark**
22.20	25.10	24.15	24.64

Discussion

EOG is an important diagnostic tool using which a number of parameters like Arden ratio and blink rate can be calculated. The detailed analysis of the Arden ratio between hardcopy and softcopy reading showed a statistically significant difference between Arden ratio of hardcopy and softcopy. It was observed that the Arden ratio value obtained during hardcopy reading was greater than that obtained during softcopy reading. This is also clinically significant since Arden ratio less than 1.85 is considered pathogenic. The lower value of Arden ratio during the usage of softcopy may be correlated with increased accommodative strain in the eyes. It may also have a correlation with CVS, but has not been proved yet. It is possible that with prolonged use of computers, the Arden ratio may further decrease and cause damage to the eyes of the users. Thus suitable measures have to be taken to prevent the decrease in Arden ratio by alternate methods of reading or by making a few changes in the manner in which computer is used, for instance with frequent short breaks in between computer usage etc.

Upon detailed analysis of blink rate, a number of factors such as distance, duration of usage, intensity of illumination were taken into consideration. Though the comparison of the blink rates was not statistically significant, the small differences in the blink rates can be attributed clinically.

On further analysis, it was found that the blink rate was comparatively lesser for softcopy reading in dark than hardcopy reading in dark. This shows that there is a progressive decrease in blink rate in softcopy reading which maybe an important causative agent for CVS. A number of subjects used in the study complained of ocular problems like blurred vision and headaches on prolonged use of computers. In such individuals the blink rates in softcopy reading showed a decrease with computer usage. Thus to prevent the symptoms of CVS, it is suggested that frequent breaks must be taken that have been shown to increase comfort and relax the accommodative system[7]. Taking a small break of about 5-10 minutes duration frequently is considered to be a better option than taking a longer break every 2 or 3 hours[8]. Another reason for CVS maybe the small working distances during computer usage when compared to hardcopy usage. Another symptom that few subjects in the study complained was dryness on prolonged computer usage. The dryness of the eyes may be attributed to certain environmental factors like dust in the atmosphere, dry air-conditioned interiors and draught from ventilation fans, etc.

On analysing the blinks further, a comparison was made between the blink rates during hardcopy and softcopy readings in illumination and dark respectively. In both cases it was found that the blink rates were greater in dark than in light (reading was 1st in illumination followed by reading in dark). This may be due to drowsiness wherein the frequency of blink rate increases and amplitude decreases. Further studies are required to analyse the association of blink rate to drowsiness.

A comparison between the blink rate during hardcopy reading and softcopy reading in illumination showed that the blink rate is slightly greater in softcopy reading. This may be due to the increase in number of incomplete blinks. A study has found that the number of incomplete blinks is greater during computer usage than hardcopy reading[9]. Incomplete blinks are partially useful than reduced blink rates in decreasing the symptoms of CVS.

Conclusion

This study was mainly aimed at comparison of the Arden ratio during reading of hardcopy and softcopy. In our study which consists of 40 subjects with normal vision as well as myopics between the age group 20-35 yrs, it was seen that there was a statistically significant difference between hardcopy and softcopy arden ratio. The p-value was 0.026 by Independent t-Test method. Out of 40 subjects, 30 of them had a lower Arden ratio in softcopy when compared to hardcopy. Prolonged use of computers may cause a further decrease in Arden ratio below 1.85 and may cause a potential risk of developing CVS. This may be due to the increased ocular strain during computer use and may also be associated with decreased blink rate. Further studies have to be conducted to confirm the above findings so that the harmful adverse effects during computer usage can be reduced.

Also the blink rates recorded were analysed. Though they were statistically not significant, a clinical correlation may be made between blink rate and CVS. On prolonged use, the blink rates were found to be reduced in softcopy reading when compared to hardcopy reading. Reduced blink rate is considered as the most important cause for CVS. Also a few subjects who were involved in the study had ocular problems like dry eyes, burning sensation, headache on prolonged computer use. Thus an important measure to reduce symptoms of CVS in prolonged computer users is to increase the blink rate so that the ocular surface is moist and dryness is prevented. Further studies have to be conducted for a longer duration of computer usage and with more number of subjects. The exact cause for decrease in blink rate has to be determined and must be corrected so as to reduce the symptoms and occurrence of CVS in long term computer users.

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