



Original Article

A comparison of visual symptoms after reading text from computer screen and hard copy.

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Purpose: The basic purpose of this study was to evaluate the association of asthenopic symptoms with prolonged computer use or sustained near work and its comparison with hardcopy (printed material) and to find out the change in accommodation and convergence due to its association with asthenopic symptoms.

Method: A comparative cross sectional study was conducted in emetropes. This study consists of 30 young participants who performed test on computer screen and hard copy for consistent 40 minutes while the working distance was maintained at 30 cm. After completion of test they were asked to fill self-designed proforma with question regarding their visual discomfort after performing test from computer screen and hard copy.

Results: Overall percentage of change in visual symptoms was greater in computer users than hard copy. 40% participants reported blurring of vision and headache from computer and 30% from hard copy. In addition, 63.33% participants felt eyestrain and irritation in eyes from computer screen and 36.67% from hard copy. 53.33% felt discomfort in eyes from computer screen and 40% from hard copy. Results obtained through paired sample t-test revealed that there was a significant change in p-values of Near Point of Convergence (NPC) and Near Point of Accommodation (NPA). p-value of NPC obtained after reading from soft copy was 0.001 and p-value of NPA was 0.003 while the p-value of NPC obtained after reading from hard copy was 0.002 and 0.04 respectively.

Conclusion: Accommodation fatigue has a marked impact on visual discomfort while doing near work. Higher percentage of asthenopic symptoms was observed during computer screen. Moreover, use of modern Video Display Terminal (VDT) or computer screen still causes visual discomfort. Therefore, it is comparatively easy to read from hard copy than from computer screen.

Key Words: Blurred vision, computer vision syndrome, near vision, reading.



Introduction

Vision is a state of person being able to see. A visual function describes how the eye functions normally.¹ A clear vision is that in which image properly focuses on retina as like camera has to be focused to take clear picture. Computer display is an electronic visual display typically a thin film transistor liquid crystal display or flat panel light emitting diode display. Hard copy is anything that is printed on paper or production of any record in physical object or paper form. Near work are visual activities that take place at distance of 40 cm (16 inches) like reading a book.

According to American Optometric Association, computer vision syndrome is defined as combination of eye and vision problems associated with prolonged use of computer work. Computer vision syndrome occurs in 90% of computer users and its prevalence increases in individuals who spent more than 4 hours daily on video display terminals.² Sixty million people suffers from computer vision syndrome worldwide and one million new cases occur each year.³

For proper working at computer, eyes need to focus and during seeing at computer miosis, convergence and accommodation changes occur.⁴ Accommodation is a process in which convexity of crystalline lens increases when eyes changes focus from distance to near target. Accommodation increases during prolonged near work tasks and may cause myopic shift in eyes.⁵ Convergence is disjugate inward movement of eyes to focus on an object at close distance. Near work induced refractive changes refers to accommodative after effects. Due to this patient suffers from asthenopic symptoms. Mostly computer vision syndrome symptoms occur because visual requirement of task overreach the visual potential of individual to comfortably perform them.

Visual symptoms are not affected by size of text but distance has effect of accommodation and vergences on visual status that can causes asthenopic symptoms⁶. A study revealed that under certain conditions there was no marked difference of speed and no effect of prolonged reading from computer screen and paper; but eyestrain was markedly greater which also reduced with same position of computer screen and paper⁷.

Another study shows that a incomplete blinking during computer viewing may have association with visual symptoms but blink rate during computer viewing and paper reading has less marked difference.⁸ In this study there was strong association between prolong use of computer and visual symptoms. And also has relation with ocular surface diseases.⁹

Romanian scientific literature neglected the computer vision syndrome symptoms but some developed countries have guidance about its therapeutic and preventive measures.¹⁰ Reading from hard copy was found to be easy

than readings from different visual displays but magnitude of symptoms were different according to devices and their display designs, text layout and individual distinctions.¹¹

Mild oblique astigmatism has no effect on reading rate while reading on screen but people may suffer visual symptoms. So even small astigmatism must be corrected to relieve visual symptoms.¹² In this study it was found that early presbyopes who are not using their prescription are more prone to develop computer vision syndrome than those with prolong work on computer by using full prescription.¹³

Negative aspects of electronic devices versus hardcopy revealed increased visual symptoms by using Amazon kindle and slow reading speed and larger amount of accommodation lag was noticed with I pod as compared to reading from hard copy.¹⁴

Objectives

1. To evaluate the association of asthenopic symptoms with prolong computer use or sustained near work.
2. And to find out the change in accommodation and convergence due to its association with asthenopic symptoms.

Materials and Methods

A comparative cross sectional study was conducted in emetropes. Thirty young participants performed test on computer screen and hard copy for consistent 40 minutes at working distance of 30 cm. After completion of test they were asked to fill self-designed proforma with question regarding their visual discomfort after performing test from computer screen and hard copy. All the data was entered and analyzed using Statistical Package for Social Science (SPSS Version 22.0). Descriptive statistics was done to make the graphs and Paired sample t-test applied to find the p-values.

Results

Table 1. NPC Before and after Reading from Computer Screen

		NPC after reading from computer screen in cm						Total
		6.00	7.00	8.00	9.00	10.00	11.00	
Before reading	5.00 cm	1	0	0	0	0	0	1
	6.00 cm	0	4	3	1	0	0	8
	7.00 cm	0	1	5	6	0	0	12
	8.00 cm	0	0	0	3	0	0	3
	9.00 cm	0	0	0	3	1	1	5
	10.00 cm	0	0	0	0	1	0	1
Total		1	5	8	13	2	1	30

Out of total population, 14/30 persons showed 1 cm

increase in NPC while 10/14 showed 2 cm. increase, 1/30 showed 3 cm increase, while 5/30 show no change. And change observed is significant before and after reading from computer screen through paired sample t-test ($t = -8.729$ with p -value 0.001).

Table 2. NPA Before and after Reading from Computer Screen

		NPA after reading from computer screen in cm						Total
		cm.	8.00	9.00	10.00	11.00	12.00	
Before Reading	7.00	1	0	0	0	0	0	1
	8.00	1	2	1	0	0	0	4
	9.00	0	1	6	2	0	0	9
	10.00	0	0	4	5	4	0	13
	11.00	0	0	0	0	1	0	1
	13.00	0	0	0	1	0	1	2
Total		2	3	11	8	5	1	30

This table shows the variation in NPA value before and after test. In this test 16/30 showed an increase of 1 cm, 7/30 showed 2cm. increase while 6/30 showed no change and 1/30 showed a decrease of 2 cm in NPA. The change observed is significant through paired sample t-test ($t = -5.887$, p -value was 0.003)

Table3. NPC Before and After Reading from Hard Copy

		NPC after reading from hard copy in cm						Total
		6.00	7.00	8.00	9.00	10.00	11.00	
Before Reading	5.00 cm	1	0	0	0	0	0	1
	6.00 cm	0	7	1	0	0	0	8
	7.00 cm	0	1	7	3	1	0	12
	8.00 cm	0	0	1	2	0	0	3
	9.00 cm	0	0	0	4	1	0	5
	10.00 cm	0	0	0	0	1	0	1
Total		1	8	9	9	3	0	30

This table shows the variation in NPC value before and after test. In this test 18/30 showed an increase of 1 cm, 4/30 showed 2cm. increase, 1/30 showed 3 cm increase while 7/30 showed no change in NPC. The change observed is significant through paired sample t-test ($t = -5.887$, p -value

was 0.003

Table 4. NPA Before and after Reading from Hard Copy

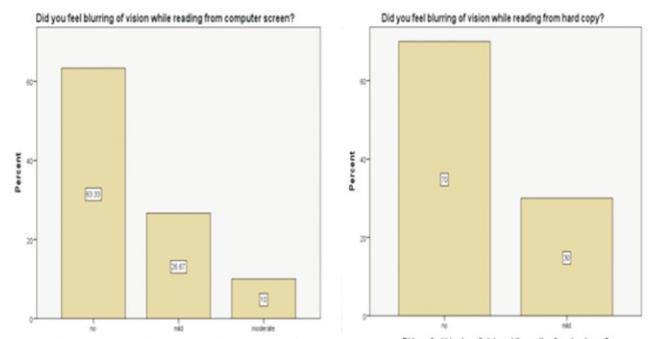
		NPA after reading from Computer Screen in cm						Total
		cm.	8.00	9.00	10.00	11.00	12.00	
Before Reading	7.00	1	0	0	0	0	0	1
	8.00	1	2	1	0	0	0	4
	9.00	0	2	6	1	0	0	9
	10.00	0	2	5	5	1	0	13
	11.00	0	0	0	1	0	0	1
	13.00	0	0	1	1	0	0	2
Total		2	6	13	8	1	0	30

In this test 14/30 showed an increase of 1 cm, 3/30 showed 2cm. increase while 9/30 showed no change and 3/30 showed a 1 cm decrease and 1/30 show 2 cm decrease in NPA. The change observed is significant through paired sample t-test ($t = -5.887$, p -value was 0.003)

The Wilcoxon signed-rank test for change (before- and after-) in NPA values for hard copy and computer shows Z value -3.7198 and W value of 0 giving $p \leq 0.05$

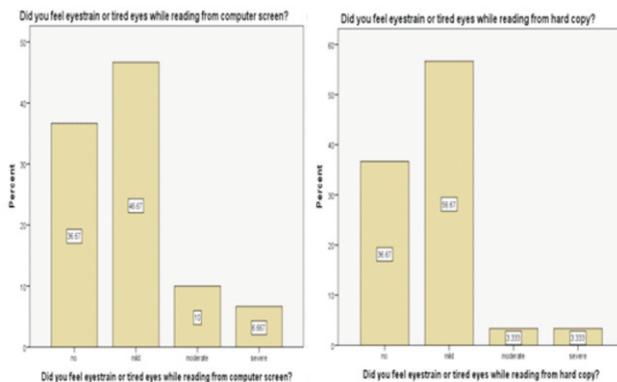
The corresponding value for change (before- and after-) in NPC values for hard copy and computer shows Z value -2.505 and W value of 0 giving $p \leq 0.05$

Fig.No.1 Feeling of Blurred Vision



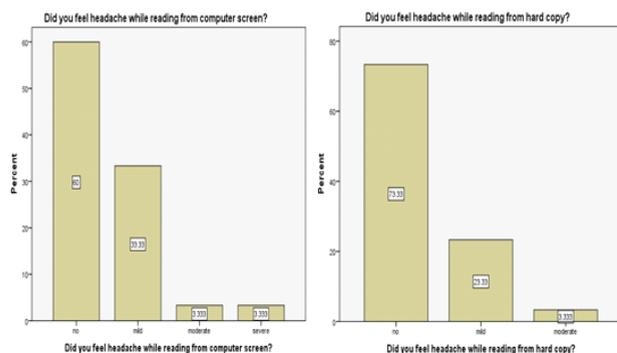
This bar chart shows that more than 50% of people showed mild to moderate blurring while reading computer screen, while less than a third reported blurring while reading from text

Fig.No.2 Feeling of Eye Strain



About 2/3 or respondents felt eye strain after hard copy as well as after computer but it was mainly of a mild nature for the former.

Fig. No.3 Headache



40% of the respondents felt headache while reading from computer screen as compared to 27% while reading from text

Discussion

The purpose of this study is to compare the variation in visual symptoms while reading from computer screen versus hard copy. With the change in visual symptoms a difference in the change of near point of convergence and near point of accommodation values was also observed. But if we consider the results of visual symptoms observed after reading from soft copy then 36.67% participants observed blurring of vision while looking at the text from computer and the 30% participants experienced the same symptom while reading from hard copy. 40% of participants experienced blurring of vision while looking at distance after test from soft copy and 38% participants from hard copy. Eighty percent of participants felt difficulty in refocusing after reading from soft copy while 50% felt these symptoms after reading from hard

copy, 63.33% felt irritation in eyes while reading from soft copy and 36.67% felt the same symptoms when doing task from hardcopy, 63.33% felt eyestrain during doing task from softcopy and same from hardcopy.

Forty percent participants felt headache when reading from computer screen and 26.67% from hard copy, 50% felt sensitivity to light while reading from computer screen and 13.33% from hard copy, 53.33% participants felt discomfort in eyes while reading from computer screen and 40% from hard copy. As few questions were asked related to visual symptoms and it was observed that percentage of symptoms was relatively greater in participants when they were reading from computer screen than from hardcopy. As a previous study also reported that while doing near work on computer screen and on hard copy asthenopic symptoms were more prominent in computer users than hardcopy.⁶

A previous study in which change in visual symptoms was reported during visual display unit use revealed that 43% participants reported headache while performing work on computer screen. 62% reported itching in eyes, 60% with blur vision after performing task from computer screen. Most common symptom subject presented was tired eyes during task that was up to 60%.¹⁴

Accommodation and convergence changes occur while doing near work and visual fatigue because sustained near work causes change in near point of convergence and near point of accommodation as presumed in recent studies.²⁹ In this study as change in NPC and NPA was also observed additionally with visual symptoms and a remote change was seen in both values before and after reading from computer and hard copy. 43% participants showed a change of 1 cm of NPC after reading from computer screen and 33% showed a change of 2 cm. While reading from hard copy, 56.66% showed a change of 1 cm and 13.33% showed a change of 2 cm in NPC. A change in NPA from computer screen was 53.33% participants had a change of 1 cm and 23.33% showed a change of 2 cm and change observed during hard copy was 46.66% showed a change of 1 cm and 10% showed a change of 2 cm. The change in p-values of NPC during soft copy was .001 and from hard copy was .002. P-value of NPA after reading from computer screen .003 and from hard copy was .004 derived through paired sample t-test. Some studies have shown a positive relationship between near work and change in near point of convergence and near point of accommodation values. Because continues reading causes a change in both values.

As in this study, the reading distance was not measured objectively and participants did the task with their normal reading distance but few recent studies revealed that no accommodation and convergence is exerted by viewing visual display unit 50-70 cm away. Some studies proved that lesser visual symptoms are produced while seeing screen

from 90-100 cm away.¹⁵

The association of visual symptoms with age and gender has not been much discussed in recent studies. Some studies presumed that asthenopic symptoms are greater in older age people and in females.¹⁶

Conclusion

The basic purpose of my study was to observe the effect of accommodation and convergence on exposure to near work and to compare the visual symptoms while reading from computer screen and hard copy. Result demonstrated that accommodation fatigue and change in near point of convergence and near point of accommodation values have a marked impact on visual discomfort while doing near work but higher percentage of symptoms while performing task on computer screen shows that even use of modern visual display terminal or computer screen still causes visual discomfort as shown in result. It is easier to read from hardcopy than from computer screen.

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