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Original Research Article

Visual problems among video display terminal (VDT) users

Kamlesh Gendalbhai Damor[1], Shalaka Chakravorty[1,*], Heena Radadiya[1], Ashwini Sapre[1]

[1]*Dept. of Ophthalmology, GMERS Medical College and Hospital, Vadodara, Gujarat, India*

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ABSTRACT

Purpose: To evaluate ocular problems, major symptoms and their associations among Video Display Terminal users.

Materials and Methods: 100 subjects as cases and 100 subjects as controls were taken. Cases worked on computer for minimum of two hours per day while persons using computers for less than two hours a day were considered for Control group.

Results: The difference in positive fusional vergence, near point of convergence and amplitude of accommodation between two study groups was statistically significant. Dry eye was significant manifestation among cases. Three most commonly reported symptoms were Blurred vision (96 %), tired eyes (93 %) and Headache (86 %).

Conclusion: Most of VDT users has abnormalities associated with accommodation and vergence dysfunctions. Dry eye is a significant factor associated with use of VDTs causing ocular discomfort. Duration of VDT use is directly related to the severity of the symptoms due to VDT use.

1. Introduction

Increased use of computers has given rise to the problems associated with its use. The condition resulting due to prolonged use of computer is referred to as “computer vision syndrome” (CVS) or “video display terminal syndrome” (VDT). During work on VDT (Video display terminal) eyes have to adapt between the surrounding environment and the VDT which leads to asthenopic symptoms.[1,2] The level of discomfort appears to increase with the amount of computer use.[3,4] This study was conducted to identify the major ocular, visual and systemic symptoms; and find out their associations among VDT users.

2. Materials and Methods

It is an observational cross-sectional study in which 100 subjects as cases and 100 subjects as controls were taken.

2.1. Inclusion criteria

Subjects are enrolled in the study on the basis that they worked on computer for minimum of two hours per day having age range from 18 to 36 years.

2.2. Exclusion criteria

Subjects with best corrected vision less than 6/9 (20/30), presbyopia, any ocular pathology, any systemic disease causing dry eye, strabismus, contact lens wearers and unwilling to participate in the study were excluded from the study.

* *Corresponding author*.
E-mail address: shalaka_01@yahoo.in (S. Chakravorty).

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2.3. Assessment

The assessment involves structured questionnaire concerning subjective symptoms and determination of the ophthalmologic routine status. Medical history was recorded to exclude any systemic disease, ocular disease or use of medication.

2.4. Visual acuity

Monocular visual acuity was measured and recorded with an internally illuminated Snellen's chart at distance of 6m under normal lighting condition. Near visual acuity was measured at 35-40 cm.

2.5. Ophthalmic examination

All subjects underwent a complete ophthalmic examination of anterior segment with slit lamp and posterior segment with direct ophthalmoscopy and indirect binocular ophthalmoscopy.

2.6. Refraction

Static and subjective refraction was done in every subject. Dynamic retinoscopy was carried out at 35-40 cm by monocular estimation method.

2.7. Cover test

Ocular alignment was assessed by means of cover test at six-meter distance and at 40 cm distance. No movement on cover test was considered as orthophoria. Exophoria was considered significant when outward latent deviation exceeded four prism diopters at distance and six prism diopters at near. Esophoria was considered significant when inward deviation exceeded two prism diopters at distance and four prism diopters at near.

2.8. Positive fusional vergence

Vergence amplitude was measured at 40 cm with the help of horizontal prism bars placing base out before subject's one eye and increasing power of prism gradually unless subject will notice first break point.

2.9. Near point of convergence

Near point of convergence was measured with Royal Air Force rule at primary gaze by moving the single dot target on the rule along the scale towards the eye. Convergence of 8-10 cm was considered normal; more than 10 cm was considered as defective.

2.10. Amplitude of accommodation

Amplitude of accommodation was measured on Royal Air Force rule with N6 target letter. Normal value of amplitude of accommodation was calculated by the Hofsetters formula [Amplitude of accommodation = 16-(Age/ 4)].

Tear film breakup time: Tear film breakup time (TBUT) was measured using fluorescein strip. TBUT is the time interval measured between the last blink and the appearance of the first dry spot. Less than 10 sec was considered abnormal. Average TBUT value of both eyes was used for calculating results.

Schirmer's test II: Schirmer's test II was carried out to calibrate amount of basic tear secretion using Whatman-41 filter paper 5 minutes after instillation of 2 % lidocaine eye drop. Wetting scale of less than 6 mm in 5 minutes was considered abnormal. Schirmer's score was calculated by adding wetting scale of both eyes. Schirmer's score of ≤12mm was diagnostic of dry eye.

2.11. Structured questionnaire

A self-administered questionnaire was used to collect symptoms and its intensity. Structured questionnaire includes four sections concerning duration of computer use, intensity of ocular symptoms (watery, feeling of dryness, itching, Pain behind eye, Aching, soreness, and tiredness), visual symptom (Blurred vision and Doubled vision), and systemic symptom (Shoulder pain, Neck pain, Back pain, and Headache). The symptom scores are ranked on intensity rating as 0 = none or asymptomatic, 1 = very mild, 2 = mild, 3 = moderate, 4 = intense, and 5 = very intense. The subjects were asked to state the occurrence of symptom and specify the hours at which they did VDT work, performed other work, or took breaks. Symptoms are entered in to statistical analysis using this intensity rating scale.

2.12. Statistical analysis

The data was coded and entered into Microsoft Excel spreadsheet. Descriptive statistics included computation of percentages, means and standard deviations. The independent t test (for quantitative data within two groups) was used for comparison of all clinical indicators. Chi-square test used for qualitative data whenever two or more than two groups were used to compare. Level of significance was set at P≤0.05.

3. Results

Mean of age was found 26.60±3.502 among cases and26.83±3.327 among controls. Thus, statistically no significant difference of age was observed between the groups (P=0.63) [Tables 1 and 2]

68 male and 32 female were included in case group while 73 male and 27 female were included in control group. Thus, statistically no significant difference for distribution of gender was observed between the groups (P=0.43). [Table 3]

Table 1: Age Distribution of Patients

Age Group in Years	Case	Control
20-25	42	42
26-30	43	43
> 30	15	15
Total	100	100

Table 2: Comparison of age among study groups

Groups	n	Mean age	Std. Deviation	Mean differences	P value
Case	100	26.60	3.502	0.23	0.63
Control	100	26.83	3.327		

Table 3: Comparison of gender among study groups

		Gender		Total	P value
		F	M		
Groups	Case	32	68	100	0.43
	Control	27	73	100	
Total		59	141	200	

Although number of patients with Exophoria were higher in case group it is statistically not significant (P=0.81). [Table 4]

In cases, 4 % of subjects were having normal positive fusional vergence (35-40 Δ) while 96 % were diagnosed with reduced positive fusional vergence (<35 Δ). In controls, 74 % of subjects were having normal positive fusional vergence (35-40 Δ) while 26 % were diagnosed with reduced positive fusional vergence (<35 Δ). The difference of positive fusional vergence observed between the groups was statistically significant (P=0.001). [Table 5]

In cases, 58 % of subjects were having normal near point of convergence (8-10 cm) while 42 % were diagnosed with defective near point of convergence (>10 cm). In controls, 99 % of subjects were having normal near point of convergence (8-10 cm) while 1 % were diagnosed with defective near point of convergence (>10 cm). The difference of near point of convergence observed between the groups is statistically significant (P=0.001). [Table 6]

The difference of amplitude of accommodation observed between the groups is statistically significant (P=0.006). [Table 7]

In cases, 21 % of subjects were having normal tear film break-up time (≥10 seconds) while 79 % were diagnosed with abnormal tear film break-up time (<10 seconds). In controls, 97 % of subjects were having normal tear film break-up time (≥10 seconds) while 3 % were diagnosed with abnormal tear film break-up time (<10 seconds). The difference of tear film break-up time observed between the groups is statistically significant (P=0.001). [Table 8]

In cases, 73 % of subjects were having normal Schirmer's score (≥12 mm) while 27 % were diagnosed with abnormal Schirmer's score (<12 mm). In controls, 99 % of subjects were having normal Schirmer's score (≥12 mm) while 1 % were diagnosed with abnormal Schirmer's score (<12 mm). The difference of Schirmer's score observed between the groups is statistically significant (P=0.001).[Table 9]

Distribution of symptoms among cases was as shown in Table 10 .

On comparing various symptoms among study groups statistically significant difference was found for Watery eyes, Dry eyes, Aching eyes, Sore eyes, Tired eyes, Blurred vision, Double vision, Back pain, Headache.[Table 11]

Cases were divided according to their average hour of computer use into two groups;

Group 1: Persons using computer for average 4-6 hours/day (total number of cases 44)

Group 2: Persons using computer for average 7-9 hours/day (total number of cases 56)

Symptoms which were significant between two groups are watery eyes, dry eyes, aching eyes, tired eyes, blurred vision, neck pain, back pain, headache.[Table 11]

4. Discussion

4.1. Age distribution

P. Ranasinghe et al. enrolled 2210 participants into the study with the aims to describe the prevalence of CVS and its associated factors. They reported mean age 30.8 ± 8.1 years with age range from 18 to 60 years in their study. A majority (48.1 %) of the study population belonged to the age category 20–29 years.[5]

In Cross-sectional descriptive study Shrivastava SR et al. enrolled 200 software professionals to estimate prevalence of health problems among them. The mean age of study subjects was 28.23 ± 4.3 years with 48.5% of subjects being in the age group of 20-39 years.[6]

Table 4: Comparison of cover test result among study groups

		Cover test		Total	P value
		Orthophoria	Exophoria		
Groups	Case	67	33	100	0.81
	Control	86	14	100	
Total		153	47	200	

Table 5: Comparison of positive fusional vergence for near in Δ among study groups

Groups	N	Mean	Std. Deviation	Mean differences	P value
Case	100	24.85	4.17	10.2	0.001 (S)
Control	100	35.05	3.85		

Table 6: Comparison of near point of convergence in cm among study groups

Groups	N	Mean	Std. Deviation	Mean differences	P value
Case	100	10.41	1.69	1.89	0.001 (S)
Control	100	8.52	0.61		

Table 7: Comparison of amplitude of accommodation among study groups

Groups	N	Mean	Std. Deviation	Mean differences	P value
Case	100	8.86	1.12	0.4	0.006 (S)
Control	100	9.26	0.906		

Table 8: Comparison of tear film break up time (sec) among study groups

Groups	N	Mean	Std. Deviation	Mean differences	P value
Case	100	8.41	1.46	3.89	0.001 (S)
Control	100	12.3	1.48		

Table 9: Comparison of Schirmer's score (mm) among study groups

Groups	N	Mean	Std. Deviation	Mean differences	P value
Case	100	14.78	3.03	10.52	0.001 (S)
Control	100	25.3	3.14		

Table 10: Distribution of symptom scores among cases

Symptoms	Symptoms reported for at least once	Total score
Ocular symptoms		
1. Watery eyes	48 %	91
2. Dry eyes	72 %	145
3. Itchy eyes	46 %	46
4. Pain behind eyes	5 %	5
5. Aching eyes	56 %	75
6. Sore eyes	37 %	38
7. Tired eyes	93 %	168
Visual Symptoms		
8. Blurred vision	96 %	192
9. Double vision	12 %	12
Systemic symptoms		
10. Shoulder pain	4 %	4
11. Neck pain	9 %	9
12. Back pain	22 %	26
13. Headache	86 %	143

Table 11: Comparison of Symptom of patients among study groups

Symptom	Groups	Mean score	Std. Deviation	Mean differences	P value
Watery eyes	Case	0.91	1.11	0.76	0.001 (S)
	Control	0.15	0.35		
Dry eyes	Case	1.45	1.22	1.11	0.001 (S)
	Control	0.34	0.51		
Itchy eyes	Case	0.46	0.52	0.04	0.57
	Control	0.42	0.49		
Pain behind eyes	Case	0.05	0.21	0.02	0.47
	Control	0.03	0.17		
Aching eyes	Case	0.75	0.75	0.46	0.001 (S)
	Control	0.29	0.45		
Sore eyes	Case	0.38	0.508	0.15	0.02 (S)
	Control	0.23	0.44		
Tired eyes	Case	1.68	0.87	1.42	0.001 (S)
	Control	0.26	0.44		
Blurred vision	Case	1.92	0.77	1.8	0.001 (S)
	Control	0.12	0.32		
Double vision	Case	0.12	0.32	0.11	0.001 (S)
	Control	0.01	0.10		
Shoulder pain	Case	0.04	0.19	0.01	0.702
	Control	0.03	0.17		
Neck pain	Case	0.09	0.28	0.06	0.07
	Control	0.03	0.17		
Back pain	Case	0.26	0.52	0.22	0.001 (S)
	Control	0.04	0.19		
Headache	Case	1.43	0.85	1.24	0.001 (S)
	Control	0.19	0.39		

In the present study mean age of study cases was 26.60±3.50 years with 85 % of patients between 20 to 30 years of age [Tables 1 and 2].

4.2. Sex distribution

In a study to assess the prevalence of computer vision syndrome (CVS) among medical and engineering students by Logaraj M et al. 47.6% (198/416) were females while 52.4% (218/416) were males.[7]

Thomas J et al. evaluated the prevalence of ocular symptoms among computer professionals in a university setting in South India in which 43.6% (168/385) were males and 56.4% (217/385) were females.[8]

In the present study 68 out of 100 (68.0%) were male and 32 out of 100 (32.0%) were female [Table 3].

4.3. Cover test

Iribarren R et al. investigated for the relationship between amount of computer work and presence of phoria in 100 office workers. Subjects were involved in 5.84± 2.02 daily hours in computer use, and 2.87± 2.13 daily hours in reading. No associations could be found between the near point phoria and the amount of near work or the asthenopic symptoms.[9]

Gur reported presence of heterophoria in 34.4% computer users than in control.[10]

In the present study 33 out of 100 patients were found having exophoria and no patient with esophoria was found in cases. No significant association could be found between the near point phoria and computer use [Table 4].

4.4. Positive fusional vergence

Gur reported low fusional vergence in 46.9 % of persons using computer compared to persons not using computers.[10]

Watten et al. measured positive and negative vergence ranges at near both at the beginning and end of an 8 hours of workday. They observed significant decreases in both parameters, implying that computer use decreased one's ability to converge and diverge appropriately.[11]

In contrast, Nyman et al. found no significant change in positive or negative fusional vergence at near after 5 hours of VDT work. They also reported no significant change in either distance and near heterophoria or the near point of convergence following the work period.[12]

In present study, positive fusional vergence among cases was found 24.85 ± 4.17 which was significantly decreased compared to the subjects in control group [Table 5]. Low fusional vergence was significant cause of ocular and visual symptoms among VDT users.

Table 12: Comparison of Symptom according to average hour of computer use/day among case groups

Symptom	Average hours of computer use/day	Mean score	Std. Deviation	Minimum	Maximum	P value
Watery eyes	4-6	1.36	1.22	0	3	0.001 (S)
	7-9	0.55	0.87	0	3	
Dry eyes	4-6	0.93	1.021	0	4	0.001 (S)
	7-9	1.86	1.227	0	4	
Itchy eyes	4-6	0.45	0.504	0	1	0.92
	7-9	0.46	0.538	0	2	
Pain behind eyes	4-6	0.05	0.211	0	1	0.85
	7-9	0.05	0.227	0	1	
Aching eyes	4-6	0.55	0.663	0	2	0.01 (S)
	7-9	0.91	0.793	0	2	
Sore eyes	4-6	0.39	0.538	0	2	0.91
	7-9	0.38	0.489	0	1	
Tired eyes	4-6	1.18	0.724	0	3	0.001 (S)
	7-9	2.07	0.783	0	3	
Blurred vision	4-6	1.50	0.731	0	3	0.001 (S)
	7-9	2.25	0.640	1	3	
Double vision	4-6	0.11	0.321	0	1	0.86
	7-9	0.13	0.334	0	1	
Shoulder pain	4-6	0.02	0.151	0	1	0.44
	7-9	0.05	0.227	0	1	
Neck pain	4-6	0.00	0.000	0	0	0.005 (S)
	7-9	0.16	0.371	0	1	
Back pain	4-6	0.02	0.151	0	1	0.001 (S)
	7-9	0.45	0.630	0	2	
Headache	4-6	0.82	0.582	0	2	0.001 (S)
	7-9	1.91	0.721	0	3	

4.5. Near point of convergence

Amalia H, et al. studied various etiologies of asthenopia in computer users and reported convergence insufficiency (CI) as a cause of muscular asthenopia found in in 4.3% of the asthenopia group of their study.[13]

Gur reported presence of convergence insufficiency in 28.1% computer users than in control.[10]

Yeow PT et al. found no difference between VDT users and nonusers over 2 year period of the NPC in the same office environment. NPC declined with age in this study but no significant difference was observed between the two groups.[14]

In the present study mean of near point of convergence among cases was found 10.41±1.69 which was significantly reduced compared to the controls [Table 6]. Convergence insufficiency due to computer use was a significant cause for visual and ocular symptoms in the present study.

4.6. Amplitude of accommodation

Trusiewicz D et al. reported that prolonged work at computer terminals has been associated with diminished amplitude of accommodation and could be the cause of eye-strain in computer operators.[15]

Gur S et al. measured near point of accommodation in VDT users and nonusers in the beginning of the day at the start of the week and again at the end of the day 4 days later. The amplitude of accommodation amplitude was reported to be decreased significantly for VDT users (by 0.69 D) than nonusers (0.18 D) between the first examination and the second examination 4 days later.[10]

Similarly in the present study mean of amplitude of accommodation among VDT users found 8.86 ± 1.12 which was significantly decreased (by 0.40 diopters) compared to non-VDT users [Table-7].

4.7. Tear film break-up time and Schirmer's score

Bhargava R et al. evaluated 750 subjects with mean daily VDT usage of 7.24 ± 2.76 hours. The mean TBUT in cases was 11.26 ± 1.68 (range 4-14) which was significantly reduced compared to controls with mean TBUT of 15.68 ± 2.62 (range 8-18). The mean Schirmer's score in cases and controls was 24.64 ± 8.62 (range 5-28) and 32.76 ± 7.68 (range 6-35) mm, respectively.[16]

In a study to evaluate change in tear film characteristics in VDT users significant change in TBUT and Schirmer's score was found at the beginning and the end of the working

day.[17]

In a study to evaluate possible correlation between computer use and dry eye syndrome in persons who spend more time using computers by Gajta A et al. 50 subjects who use VDTs for 8-10 hours were compared to control group. The results of the tear film break-up time measurements significantly shorter TBUT in the cases as compared to controls. TBUT was found abnormal (<10 seconds) in 90% of cases. Schirmer's score was found abnormal (<10mm) in 87% of cases.[18]

Similarly in the present study also TBUT and Schirmer's test were conducted and found to be significantly decreased compared to the control group [Table-8,9]. Tear film break-up time among cases was found 8.41 ± 1.46 which was 3.89 seconds less than control group [Table 6]. Schirmer's score among cases was found 14.78±3.03 which was 10.52 mm less than control group [Table 9]. It suggested that dry eye was a significant factor associated with use of VDTs causing visual and ocular discomfort.

4.8. Distribution of symptom

Correlation between VDT use and symptoms in computer workers has variable reports. Some studies have stated that there was a relationship between VDT use and subjective symptoms among VDT users.[19–22] While some other studies have not shown the correlation between them.[2,23] In our study various symptoms were seen significantly associated with VDT use [Table 10].

Bhanderi DJ et al.[24] did a community-based cross-sectional study of 419 subjects who work on computer for varying period of time to study the prevalence of asthenopia among computer operators and its association with various epidemiological factors. Among the 419 subjects studied, 194 (46.3%) suffered from asthenopia during or after work on computer. Asthenopia was not found to be associated with age or duration of computer use by Bhanderi DJ et al.[24] In our study, asthenopic symptoms were significantly associated with VDT use and found to be increased due to computer use [Tables 11 and 12]. Marginally higher proportion of asthenopia was noted in females compared to males by Bhanderi DJ et al.[24] While in our study, asthenopia was not found to be associated with gender of the subjects. [Table 3]

Garg P et al.[25] conducted an observational study on 913 subjects to assess the magnitude of ocular problems faced by computer users. Of the total subjects, 81.48% were symptomatic. In our study all the subjects in case group were having at least one of the symptoms of questionnaire. In the study by Garg P et al.[25] the most common symptoms were eyestrain (59.8%), tired eyes (39.53%), watering (42.05%), sore eyes (40.85%), headache (50.93%), and head, neck and back pain (48.95%). The most common symptom in our study were blurred vision (96%), tired eyes (93%), headache (86%), dry eye (72%) and aching eyes (56%) [Table 10]. In the study by Garg P et al.,[25] a direct correlation was seen between working hours on computers and occurrence of ocular symptoms. Similarly, a direct correlation was seen between working hours on computers and occurrence of ocular symptoms in our study [Tables 11 and 12].

N Shantakumari et al.[26] enrolled 500 university students studying in Ajman, UAE to evaluate the pattern of computer usage and related visual problems. The most common visual problems reported were headache (53.3%), burning sensation (54.8%) and dry/tired/sore eyes (48%). The most common symptom in our study were blurred vision (96%), tired eyes (93%), headache (86%), dry eye (72%) and aching eyes (56%) [Table 10].

A review by Kanitkar et al.[27] showed that duration of computer work is directly related to eye symptoms, and longer duration tends to result in long-lasting complaints, well after VDT work is finished. Our study also revealed similar results. A direct correlation was seen between longer working hours on computers and occurrence of ocular symptoms in our study [Tables 11 and 12].

5. Conclusion

Most of VDT users has abnormalities associated with accommodation and vergence dysfunctions. Dry eye is a significant factor associated with use of VDTs causing visual and ocular discomfort. VDT users has a high incidence of ocular and visual symptoms. Duration of VDT use is directly related to the severity of the symptoms due to VDT use. To identify the root cause of potential health problem, further study can be conducted considering work place environment that can have an effect on causing ocular, visual and systemic abnormalities associated with VDT use.

6. Conflict of Interest

The authors declare that there are no conflicts of interest in this paper.

7. Source of Funding

None.

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Author biography

Kamlesh Gendalbhai Damor, Senior Resident

Shalaka Chakravorty, Resident

Heena Radadiya, Associate Professor

Ashwini Sapre, HOD

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