The Assessment of Accommodation and Convergence System in the Bank Employees

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Article information	Abstract
	Background: Regarding the high outbreak rate of the eye disorders and problems particularly accommodation disorders and convergence insufficiency in computer users, the study tries to determine the convergence, accommodation system, condition, fusion reserves and vision dimension in bank employees (who work with computers) and the control group (who are not computer users) and then to compare the mentioned parameters in the two groups. **Materials and Methods**: In this cross-sectional and observational study a total of 44 bank employees and 44 people as the control group members were selected randomly. Initially, refractive problems were reformed, and then accommodation, convergence and vision dimension evaluative tests were conducted. The test included measuring the near point of convergence, jump convergence, phoria, accommodation range (one eye, both eyes), ease of accommodation (one eye, both eyes), positive and negative related accommodation, near fusion versions and TNO. **Results**: Our results showed that there was a not significant difference among the near point of convergence, jump convergence, near phoria, accommodation range (one eye and both eyes), ease of accommodation (one eye, both eyes), positive and negative related accommodation in bank employees and control group. **Conclusion**: Regarding the studies, the outbreak rate of accommodation and convergence disorders is higher in bank employees than the control group which would be due to over working with computer within a fixed interval. *Copyright © 2013 Zahedan University of Medical Sciences. All rights reserved.*

Introduction

Today computers have become a vital tool for people and more and more users are using it every day. If the computer users or people who often work with it so not observe the visual standards during working, they will suffer from a visual problem called computer vision syndrome (CVS). Bank employees constitute a great range of computer users who on the average spend six hours/ day working with computer [1].

There is no precise statistics about CVS outbreak rate in Iran. However, it has been estimated very high in bank employees and accountants who work with computers and also people who use internet and computer games for long hours [2].

CVS can bring about either direct or indirect eye problems for users which decrease their work efficiency. Various computer related problems are visual problems such as blurred vision, slow refocusing, losing words place while reading, squint, closing eye up and changes in understanding color changes, out of which blurred vision is the most common disorder. The fixed blurred vision usually is the result of the unimproved refractive problems or presbyopia. The blurred vision cause can be related to match spasm or general accommodation disorders. The slow refocusing generally is the result of

the decreased accommodation range or lack of ease of accommodation. Another cause of the occasional blurred vision is the dry eye. Eye problems caused by the dry eye are excessive blinking, burning, itching, red-rimmed eyes, runny eyes and achy eyes. If your monitor is located higher than the standard height, then you will suffer from dry eye after a while (the computer screen center must be placed at least 4-9 inch lower than user's eye horizon). Stenopeic problems include headache, eyestrain which can be due to the unimproved refractive defects, presbyopia, accommodation disorders, non-compensatory heterophoria, weak convergence, and daze. Light sensitivity problems, light blinking, daze, and light sensitivity out of which the workplace light is the most common cause of light sensitivity. Daze due to workplace surfaces, windows or small distance between room's lamp and monitor or the input light from windows can bring about light sensitivity disorders and its upcoming problems. Binocular vision disorders along with heterophoria are fatigue, headache, blurred vision, squint, and body general fatigue. When there is heterophoria, a great deal of neuromuscular efforts is needed to keep eyes parallel [2]. Vision dimension measures the sensory fusion and must be practiced for patients who have not

yaw angle or whose yaw angle is small [3]. Vision dimension level is analyzed regarding the binocular vision level in most patients. If the vision dimension is good, then the binocular vision is good too, but the opposite is not always true [4]. Patients with binocular vision problems suffer from low vision dimension. Kolker et al. reported that long with increasing number of the computer users in companies and houses, optometrists face more people who refer them because of vision problems due to working with computers. In this study, it was evident that the accommodation disorders are more common than other visual disorders [5].

Schaiman indicated that a large share of the American population will spend their time using computers as the result of fast development and ever-increasing use of computers in companies, schools and even in homes. He also demonstrated the high rate of accommodation disorders and binocular vision disorders in compute users and emphasized on the necessity and importance of evaluating accommodation system and binocular vision in computer users [6]. Therefore, the study aims at analyzing the accommodation and convergence system as well as vision dimension in bank employees.

Materials and Methods

Relying on the necessary coordination followed by the university research deputy, we referred to various branches of the Saderat Bank in Zahedan City and selected randomly 44 employees (37 men and 7 women) of the Saderat Bank employees working in Zahedan (age average: 32.3 years) and 44 administrative employees with the same age average were selected as the control group. Initially all refractive defects were improved completely and then accommodation, convergence system, fusion reserves and vision dimension were evaluated in the bank employees and control group through the following tests.

A pencil tip was approached to the patient's eye in order to determine the near point convergence (NPC). Initially, patient's correction, if any, was placed on their face then the target was approached from a 50-cm distance and alongside the midline with 3-5 cm/s to their nasal bridge and he/she was asked to report whenever the target is seen in two shapes (subjective method)., or when we observed eyes movement outside, the point was specified and the distance between the point and the outer cantus was recorded in terms of cm as the patient's near convergence point (NCP) (objective method). For analyzing the jump convergence status of patients, a pencil was placed 15 cm from the patient's eye and another pencil was placed alongside the midline 50 cm from the eye and the patient was asked to focus from the far target to the near target in order to let us to analyze their normal or abnormal actions.

The near heterophoria was determined using prism and alternate cover test for 40 cm distance. Our selected target was a vertical row equal to 20.30 minimized Snellen chart. The Push-up method was used to measure the accommodation range. In this method one of the patient's eyes is closed and the patient with their open eye looks at a detectable target. He/she is asked to report the first permanent blurred point while the item is approached him/her with 5 cm/s from the 50-cm distance, then the distance between eye and target is measured in terms of cm.

For analyzing the ease of the accommodation, a consistent target with the patient's vision was placed 40 cm from the patient. After using the tester lenses (+2, -2), responses and accommodation stimulation were recorded in terms of cycle/min. For measuring the positive and negative relative accommodation, the patient was asked to look at a target placed 40 cm from him/her with their best visual acuity. The test is carried out binocularly in which the negative related accommodation (NRA) is measured. In this method, a +0.25 lens was added in front of both eyes simultaneously and the patient was asked to keep obvious letters. Gradually more lenses were added to the initial +0.25 until the patient reported a fixed blur which shows the NRA of patient. Then the point is reset and similar stages are repeated for the negative lens which shows the positive related accommodation (PRA). Monocular estimated method (MEM) was used to measure the accommodated lag. In this method, the target is stuck to the retinoscope face and the patient is asked to look at the accommodated target, then the patient's eye reflex was examined using the retinoscope.

The prism bar was used to determine the fusion reserves. In this method, the patient looks at a near target through their best visual acuity and the best correction, then the prism is placed in front of the eye inwardly (negative fusion reserves) and the patient is asked to report any kind of blur. Any blur longer than two seconds was recorded as the blurred point. Then the prism power was increased and the first fixed squint point (longer than 5 seconds) was recorded as the squint point. Prism power was decreased step-by-step until the patient reported a unique target which is called restoration of binocular single vision. The mentioned steps are repeated to measure positive fusion reserves while the prism is located outwardly and the measured values are recorded [7- 8].

Stereopsis level was measured using TNO test. TNO test is able to measure a wide range of stereoscopic vision [4]. The test exclusively measures the global dimension vision. The patient looks at the screening pages including a butterfly and geometrical shapes from 40 cm while pushing a green-red glasses. The measuring pages include a circle out of which a 60-degree part has been disparted and the patient was asked to show the disparted part. The disparity range in this test varies from 15-480 arc-second [9]. After collecting the necessary information, data were analyzed using t-test and χ^2 test.

Results

In this study, 44 employees (37 men and 7 women) of Zahedan Saderat Bank branches (age average: 32.3 years) were selected randomly and 44 people with the same age average were selected as the control group. The average near convergence point in employees and control groups

were 10.46±3.11 cm and 8.23±2.06 cm, respectively. The independent t-test shows a significant difference between the average near convergence point in both groups (p=0.001). The average binocular NCP in employees and control groups were 5.68±1.95 DP and 6.85±1.35 DP, respectively. The independent t-test shows a significant difference between the NCP in both groups (p=0.020).

Table 1 shows the average fusion reserves in both control and case groups. The independent t-test did not show any significant difference between the two groups in terms of the fusion reserves (p<0.05).The average stereopsis levels were 138.75±126.45 arc-second and 126.47±108.13 arc-second in case and control groups. The independent t-test did not show any significant difference between stereopsis in both of the employees and controls (p=0.626).

For bank employees group, 24 people showed normal jump convergence and 20 people showed abnormal jump convergence; while in the control group 37 and 7 people showed normal and abnormal jump convergence, respectively. The χ^2 test showed a significant difference between the jump convergence state in employees and control groups (p=0.003). Figure 1 indicates employees and control members' phoria condition, the χ^2 test showed a significant difference between the phoria of subjects in both groups (p=0.001).
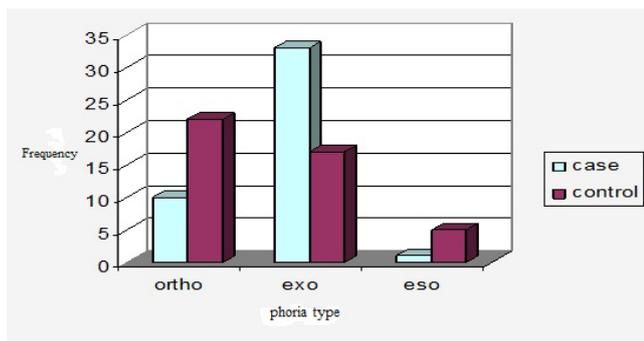

Fig 1. People phoria condition in both employees and control groups

Discussion

In an analysis on 44 bank employees (computer users) and 44 control subjects (administrative employees), statistically significant differences were found in near convergence point (NCP), near accommodation point, ease of accommodation, NRA and PRA of both groups, as the NCP (cm) in bank employees was more than that in the control group. Likewise, the NAP, ease of accommodation, NRA and PRA (diopter) in bank employees were less than those in the control group. Culline et al examined computer users through convergence and accommodation evaluative tests and they found that the ease of accommodation of binoculars is drastically low. Likewise getting away the near convergence point and decreased AC/A ratio was seen in people with exodeviation. They allotted such disorders to extra-working with computers from a fixed distance [2].

In this study, we demonstrated that the exophorial outbreak rate in the bank employees is higher than that in the control group. The results are consistent with the Culline et al [2]. Decreased accommodation range and also farther accommodation point can be some causes of increased near exophoria which may bring about convergence insufficiency and hence the increased near exophoria. Similarly, our results indicated that jump convergence abnormalities rate is higher in bank employee than the control group. It is consistent with Kolker et al [5].

Our results also showed that fusion reserves in the bank employee's binocular point is less than that in the control group while the difference was not statistically significant. Culline et al. examined computer users and showed that fusion reserves have been decreased. Futyma [2] proposed a study called evaluation of visual disorders in computer users. The study tried to analyze the effect of watching computer monitor for long term on accommodation, convergence, vision dimension and near and far visual acuity. In this study, accommodation, convergence, vision dimension and far and near visual acuity of 50 employees who worked with computer six hours per day were compared, their results did not show any change in the studied parameters in both groups [10]. The results of this study also did not show any significant difference in the average stereopsis in both groups. Yeow indicated that visual performances such as vigilance, convergence and accommodation condition of user computer were similar to people who did not work with computer [11].

In our study, the average accommodation lag in bank employees and control group did not show any significant difference which seems due to overworking with computer and underestimating the visual standards during working with computers. Watten et al. analyzed the relationship between the visual acuity, working with computer in near distance and oculomotor performance in a 43-member group (average age: 24 years old).

Table 1. The average level of the fusion reserves in control and case groups

	Prism base up to the point of opacity	Inside the prism rule double point	Prism base into recovery point	Prism rule out blurred to the point	Prism rule out double point	Prism rule out recovery point
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Bank employees	12.75±3.19	15.72±4.30	8.80±3.07	12.55±4.07	16.66±4.30	8.80±3.07
Control group	12.09±3.28	15.80±4.55	8.55±2.83	13.00±3.28	16.93±4.55	8.55±0.21
p-Value	0.585	0.582	0.693	0.630	0.797	0.693

They examined NCP an NAP, PRA and NRA two times, one in the morning before starting the work and another at the end of the working day. Their results showed a significant difference at the end of the working day in contrast to the early day [12].

Barar et al. declared that CVS includes a set of problems to which people will face during working with computers which are eyestrain, headache, blurred vision, dry eye and sensitivity, slow refocusing, photophobia, squint and sensitivity to light. They continued that these problems are underestimated in their country because of lack of enough information about them and the real causes of these problems never have been discovered. While in most developed countries there are special centers for diagnosing and treating and preventing problems and controlling periodically problems of computer users [13]. In this study, we analyzed higher outbreak of the accommodation and disorders among computer users than their peers who did not work with computer. This issue needs more studies on workplaces and standardizing their working condition in order to decrease such disorders.

Propositions to the computers users: 1) observing a proper working distance during working with computer; 2) Having the best sight (improving the refractive defects) regarding the working distance; 3) placing monitors at lower levels, at least at the initial position in order to decrease the eye disorders; 4) using computers which do not need protectors or using protector for monitor screen; 5) setting screen contrast and letters size; 6) using copy holder at the right side of your monitor during typing because this position strengthens binocular sight coordination and stability [14; 7] training correct blinking process; 8) Training accommodation disorders by optometrist and practicing orthoptic exercises if necessary based on the accommodation disorder type; 9) Consultation with optometrist for solving visual problems.

Authors' Contributions
All authors had equal role in design, work, statistical analysis and manuscript writing.

Conflict of Interest
The authors declare no conflict of interest.

References

1. Sheedy JE, Shaw-McMinn PG. Diagnostic and treating computer related vision problems. California: Butherworth Heinemann; 2003.
2. Collins MS, Brown B, Bowman KJ, Caird D. Task variables and visual discomfort associated with the use of VDTs. Optom Vis Sci 1991; 68:27-33.
3. Wright KW, Spiegel PH. Pediatric ophthalmology and strabismus. 2nd ed. San Francisco: Springer-Verlag; 1995: 159-160.
4. Griffin JR, Grisham DJ. Binocular anomalies diagnosis and vision therapy. 4th ed. Amsterdam: Butterworth-Heinemann; 2002: 49-92.
5. Kolker D, Hutchinson R, Nilsen E. Comparison of tests of accommodation for computer users. Optometry. 2002 Apr; 73(4):212-20.
6. Scheiman M. Accommodative and binocular vision disorders associated with video display terminals: Diagnosis and management issues. J Am Optom Assoc. 1996 Sep;67(9):531-9.
7. von Noorden GK, Campos EC. Binocular vision and ocular motility. 6th ed. Philadelpheia: Mosby; 2002: 71-72, 85, 96, 202.
8. Evans B, Doshi S. Binocular vision and orthoptics investigation and management. Amsterdam: Butterworth-Heinemann; 1999: 4-30
9. Rutstein RP, Daum KM. Anomalies of binocular vision diagnostic and management. USA: Elsevier; 1998: 125.
10. Futyma E, Prost ME. Evaluation of the visual function in employees working with computers. Klin Oczna. 2002; 104(3-4):257-9.
11. Yeow PT, Taylor SP. Effects of short-term VDT usage on visual functions. Optom Vis Sci. 1989; 66(7):459-66.
12. Watten RG, Lie I, Birketvedt O. The influence of long-term visual near-work on accommodation and vergence. J Hum Ergol. 1994; 23(1): 27-39.
13. Barar A, Apatachioaie ID, Apatachioaie C, Marceanu-Brasov L. Ophthalmologist and "computer vision syndrome. Oftalmologia. 2007; 51(3):104-9.
14. Rachel V. Work and the eye. 2nd ed. Boston: Butterworth Press; 2001: 122.