Monocular Impairment in Video Display Terminal Operators
A Case Series

■ **Jose Luis R. Villa M.D.**
■ **Nadia Rodriguez, Diplomature: Optic and Optometry**

Iberia Airlines, Health Service
Madrid, Spain

Abstract

This study examined the clinical findings of visual display terminal (VDT) users who presented with monocular symptoms. The sample consisted of 35 people performing sustained work at VDTs. Each subject underwent an evaluation that included: visual acuities, determination of refractive status, ocular motor testing, the stability of fixation, degree of suppressions of simultaneous binocular perception, and ocular health status. These findings were compared to a control group of 100 subjects who did not habitually use a VDT. Significant signs of unstable fixation/suppression were found with symptomatic subjects, as compared to the controls. We also found initial visual acuity differences between the two eyes of the VDT user group, but no significant refractive differences. Phoria measures were not significantly different between the two groups, but binocular fixation stability and suppression significantly predicted symptoms. The ergonomic analysis indicated that the various positionings of the VDT, keyboard and text could be a cause of the anomalous binocular responses. Symptoms and simultaneous perception measures reduced, or even returned to normal, when a recommended workstation layout was followed.

Key Words

ergonomics, fixation stability, Maddox Wing Test, monocular symptoms, phoria, refractive status, simultaneous perception, suppression, synoptophore, visual acuity, visual display terminal (VDT)

INTRODUCTION

Computer science and the corresponding use of video display terminals (VDT) is a present reality. Although it is hard to establish an accurate number of VDT users, there are reported to be millions of web pages and over 700 million people are using the Internet.[1] People who frequently use computer screens have been shown to exhibit visual symptoms.[2-6] Studies have investigated the occurrence of binocular and accommodative disorders,[7,8] variations in refraction,[9-12] pupillary modifications,[13,14] convergence range,[15,16] the dry-eye syndrome,[17] visual fatigue[18] and health complaints[19] of VDT operators. The ergonomic practices of VDT users have been reported.[20-22] These studies however, generally failed to consider the presence of any monocular symptoms.

VDT operators who presented to the Iberia Airlines Health Service Ophthalmological Department reported monocular ocular symptoms that appeared to be related to VDT usage. These symptoms included:

"I recently noticed poorer vision in my right eye."

"Sometimes I have blurred vision in my right eye."

"I do not judge depth well and have trouble parking a car."

"I see little lights on my right side."

"My left eye hurts."

"The problem is in my right eye, it hurts and it bothers me."

We also frequently found that even the best corrective lenses did not improve visual acuity of the impaired eye to that of the fellow eye. Through the analysis of these initial cases, an apparently predominant common characteristic of these patients was a work station with papers angled to the right or to the left of the monitor and keyboard. Other reports revealed the screen was in the frontal position, but was twisted. Still others reported that their habitual work pattern was with their eyes/head twisted.

Evans[23] indicated that proper functioning of binocular vision without symptoms depends on: i) the anatomy of ocular structures, ii) the motor system, and iii) the sensory system through which the brain receives and integrates the two monocular signals. Evans hypothesized that asymmetry of the subjects' visual axes, in relationship to the screen and/or papers could precipitate monocular symptoms.

No other studies were found in the literature that targeted VDT use as a potential cause of monocular disturbances. Consequently, we designed a study to investigate the occurrence of the following conditions in a sample of consistent VDT users with monocular symptoms:

I) visual acuity and/or refractive asymmetries
II) greater than expected phorias
III) suppressions
IV) instability of fixation

METHODS

Subjects

All subjects were employed by IBERIA Airlines. The experimental sample was composed of 35 subjects from the administrative staff (25 females and 10 males) who presented to the IBERIA Health Service Clinic between January 1, 2000 and December 30, 2003. At the intake, each subject reported some type of monocular symptom. Their ages ranged between 30 and 60 years, with a mean age of 45.74 years (Standard deviation= 9.6 years). All these subjects worked with a VDT an average of at least 4 hours daily, and were designated as sustained users, based upon the Spanish Health Service task classifications.[24] Subjects with a previous history of strabismus, amblyopia, ocular surgery, ocular trauma and/or retinal pathology were excluded from the study.

The control group consisted of 100 consecutive individuals who reported for vision care. None were sustained VDT users, but performed various duties at IBERIA. This group comprised of 50 males and 50 females with an average age of 34.7 years, and a standard deviation of 5.6 years. None of these individuals reported any type of monocular symptom.

Table 1.
Symptoms reported by impaired VDT users

1 Monocular ocular irritating symptoms. (n=9):
   - A. ocular pain referred to one eye or laterally at the forehead (n=3)
   - B. ocular dry sensitivity (n=1)
   - C. red eye (n=2)
   - D. drooping eye (n=1)
   - E. heaviness or pressing sense over one eye ("I feel my right eye as being smaller;" "I feel left eye is emerging from the orbit.") (n=2)

2. Asthenopic symptoms. (n=6):
   - A. ocular fatigue ("I feel my left eye is tired, as if I needed to keep it closed.") (n=3)
   - B. vision oscillation ("Through one eye sometimes I see and sometimes I do not."(n=2)
   - C. subjective VA lost: ("As the work day progresses my left eye loses vision.") (n=1)

3. Monocular unclear vision: (n=19)
   - A. far vision (n=11)
   - B. far and near vision (n=4)
   - C. near vision (n=4)

4. Subjective disturbances in the visual field: ("When I wear my glasses, I see better towards the left (or right) than with the fellow eye.") (n=2)

5. Spatial perception disturbances: (n=8)
   - A. difficulties for identifying road signals, especially at night (n=2)
   - B. floating letters (n=2)
   - C. stereopsis distortion (characters move in and out from the signal board" (n=1)
   - D. difficulty parking a car, particularly in the direction of the more impaired eye (n=3)

6. Difficulties adjusting the optical correction corresponding to the impaired eye (n=4).

PROCEDURES

Determination of monocular symptoms

The monocular symptoms for the subjects were recorded and classified into six categories. See Table 1.

Ergonomics

All subjects were questioned concerning their workplaces in terms of:

I) Position of the VDT with regard to the subject's frontal plane
II) Position of text material with regard to the keyboard
III) Position of the head with regard to the VDT.

Additionally, the subjects simulated the above positions at a workstation.

Ocular health evaluation

The external and internal examinations were performed by the same clinician (RV) using a biomicroscope for the external examination and a direct ophthalmoscope for the internal examination. Ocular motility was assessed by monocular and binocular versions in the cardinal positions of gaze. Subjects in the experimental and control group who were diagnosed with any type of ocular disease and/or defects of ocular motility were eliminated from the study.

Visual acuities and refractive status

Distance visual acuity (VA) testing was accomplished with Marquez optotypes at 5 meters (similar to Snellen test). Near VA was determined using a Jaeger Card at 40 cms.

A Topcon model RM -A7000B autorefractor[a] was used to determine the subjects' refractive status. Our criterion for anisometropia was =/> 0.75D. Previous authors defined anisometropia as from 0.50D to 1.00D difference between the two eyes. [25]

Binocular posture, suppression and fixation stability testing

A Maddox wing test[b] was used for near binocular posture (phoria). This stereoscopic device dissociates the two eyes by means of a septum.[23] Horizontal and vertical rows of numbers are seen by the left eye. The right eye sees vertical and horizontal arrows. The reported position of the arrows indicates the amount of vertical and horizontal phorias. The criteria values adopted for the Maddox wing data at 33 cm were those established by the European air regulations.[26] Binocular imbalances were specified as esophoria greater than six prism diopters, exophoria greater than 10 prism diopters, and hyperphoria greater than one prism diopter.

We utilized a synoptophore to detect suppression and/or unstable binocular fixation. [23] Macular slides, subtending 3º at the nodal point were the targets. These slides tested simultaneous perception. The most used target during this study was the lion in the cage, but occasionally the star in the moon was used. The two dissimilar images were presented, one to each eye. The smaller target (lion or star) was the macular target and the other target (cage or moon) was the peripheral target. The peripheral target subtended approximately 10º (Figure 1).

The macular slides allowed for detection of even slight central suppressions, although they are generally used with patients presenting with deep levels of suppression or amblyopia.[27,28] We used these targets to assess what were suspected to be more subtle binocular interferences. The

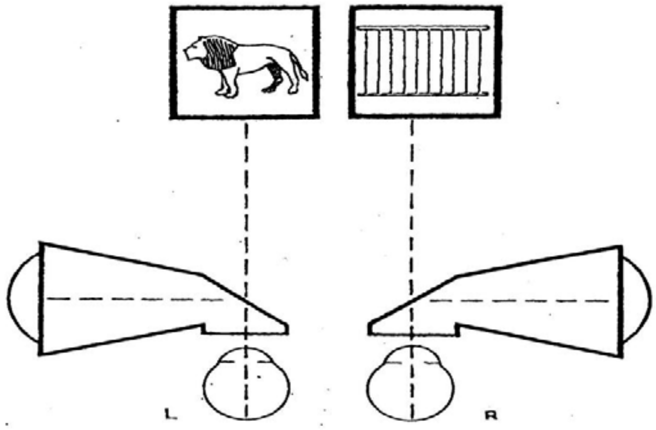

Figure 1. Scheme of the simultaneous perception test.

Table 2.
Comparison of refractive errors distributions between impaired and fellow eyes

	Impaired Eyes (*N*=35)	Fellow Eyes (*n*=35)
Spherical errors		
Emmetropia (-0.50 to +0.50)	7 (20%)	6 (17%)
Low hyperopia (+0.75 to +2.90)	8 (23%)	11 (31%)
Low myopia (-0.75 to -3.00)	12 (34%)	1 (31%)
Moderate myopia (-3.10 to -6.00)	2 (6%)	3 (9%)
High myopia (over -6.00)	1 (3%)	1 (3%)
Astigmatic errors		
Low cylinder 1.25 to 3.00)	5 (14%)	3 (9%)
	U=641	
	p =0.7419	

Table 3.
Abnormalities noted on external eye examination

1. prominent nasal septum (n=5)
2. linkage of prominent nasal septum with a short interpupillary distance (n=4)
3. linkage of prominent nasal septum and endophthalmus (n=4)
4. isolated endophthalmus (n=1)
5. prominent nasal septum and a short interpupillary distance and endophthalmus (n=1).

second author (NR) performed all binocular testing.

When the subject perceived both images, he/she noted the lion inside the cage. (Figure 1) If the macular target disappeared, either intermittently or permanently, a suppression of the eye viewing the macular target was recorded. Instability of fixation was considered to be present when the subject perceived one of the images to move consistently over a ten second viewing period.[27, 28] Suppression and instability of fixation have been considered to be related to a functional inhibition between the eyes. [29-31]

Since this binocular test is qualitative (results depend on the subject's description), quantifiable data could not accurately be established. Consequently, to more precisely determine the existence of the suppressing and/or unstable fixating eye, we alternated between the eyes, so that each eye was presented the macular target and, conversely, the peripheral target.

Facial anatomical evaluation

A qualitative judgment was made by RV when evaluating each subject's ocular motility in the cardinal directions of gaze, as to an abnormal facial structure that might account for binocular interference. This judgment was subjective, based upon the experience of the clinician.

Ergonomics

At the completion of testing, recommendations were made to each experimental subject for sounder ergonomic positions of him/herself in relationship to the various devices at the work station. A follow up examination was performed approximately one year after the workstation recommendations were initiated.

RESULTS

Statistical analysis of the data was performed using the Statgraphics Plus 5.1.[c]

Forty one subjects were examined in the designated time frame. Five subjects with an organic pathology and one case with decompensated esophoria were excluded from the group, leaving 35 experimental subjects with no previous reports of strabismus, amblyopia, ocular surgery/trauma, retinal pathology or apparent oculomotor dysfunction.

Symptomotology

The subjects' reported symptoms of visual discomfort are summarized in Table 1. Nine subjects reported monocular ocular irritating symptoms. Asthenopia (N=6) was associated with eye strain but also occurred alone. Others reported blurry vision (N=19), either at distance or near, or both, in one eye. Others noted spatial perception problems (N=8), including decreased stereopsis and print floating/moving on the page. Four others reported difficulty adjusting to a new corrective lens prescription.

Refraction

Ninety one percent of the subjects wore spectacles and 75% of them were presbyopic. Overall, there were no high levels of anisometropia. Seventy-seven percent (27 of 35) of the subjects exhibited a dioptric difference between the two eyes of </= 0.5 D. Eight subjects showed anisometropic values =/> 0.75 D. Four subjects had a higher dioptric measure of the eye corresponding to the monocular complaint, while in four others the monocular complaint was associated with the eye with the less dioptric value. Monocular blurred vision was not necessarily dependent on a higher dioptric value present in the more impaired eye.

Figure 2a.

Figure 2b.

Table 4.
Ergonomic details at workstation

1. Screen twisted or VDT placed laterally to the right or to the left in relation to the frontal plane gaze (n=22): 13 with left disposition, 9 placed to the right.
2. Oblique reading of texts placed at one side of the keyboard (n=9): 5 localized at left side, 4 at the right.
3. VDT located 90º to the left on an L-form shaped desk which forces body torsion and oblique view (n=4).
4. Adoption of a tilted position of the head with regard to the VDT screen (n=2).
5. Use of a widespread visual space (wide disposition of texts, keyboard, VDT, printer or calculator), with awareness and vision dominance to one side (n=2).

Refractive conditions were divided into classifications as shown in Table 2. The non-parametric Mann Whitney U test was used to compare the refractive values from the impaired and the fellow eyes. There was no significant difference in the distribution of spherical and cylindrical errors between the two eyes. (U=641; p=0.7419).

Visual acuity

Eighty percent of the impaired eyes had corrected VA less than 6/6 (20/20); 49% of the fellow eyes exhibited VA less than 6/6. Mean acuity of the impaired eyes was significantly decreased from that corresponding to the fellow eyes, (paired t test, t=5.509; d.f. =34; p<0.05).

Binocular vision

Binocular posture

The Maddox wing test for near vision was within the limits previously established: orthophoria: (n=13); esophoria (< /= to 5 prism diopters; (n=4); exophoria (< /= to 8 prism diopters (n=18), with stability of the arrow within +/-2 prism diopters.[26]

Fixation stability and suppression

Twenty nine experimental subjects (83%) exhibited fixation instability, while three did not. Three more subjects exhibited alternate suppression. Because of the suppression, it was not possible to evaluate the fixation stability of these three subjects. Only 18% of the control group of 100 subjects had unstable fixation; one control subject exhibited alternate suppression for a total of 19% showing a binocular dysfunction. The target instability and/or suppression for each group always were perceived in relation to the macular target.

The suppression/fixation instability data were combined in both the symptomatic group and the control group. They were then analyzed by non-parametric statistics. A Pearson's Chi-square test revealed significantly higher suppression/ fixation instability in the experimental group compared to the control group. (Chi^2= 124.52; d.f. =2; critical value K=5.991; p=<.001).

Facial anatomical evaluation

Forty three percent of the experimental subjects (15 of 35) exhibited facial structure details that might interfere with alignment of the visual axes in oblique gaze. Facial features that were judged included prominent nasal septums, short inter-pupillary distance and endophthalmus. Exact facial measures were not formally made. See Table 3.

Ergonomics

In 54% (19 cases) of the experimental group, the VDT or the papers were located opposite the symptomatic eye (Figures 2 a and b), whereas in 34% (12 cases) the VDT or papers were located on the same side to the symptomatic eye. In four cases, the workstation arrangement could not be clearly defined. See Table 4.

Second clinical testing

Seventeen experimental subjects (48%) completed a second evaluation approximately one year later (mean=13.46 months) by the same clinicians. Work overload and poor cooperation caused poor follow-up. All of these individuals had previously demonstrated binocular instability, and suppression of vision. Fifty nine percent (10) of these subjects now revealed binocular stability and lack of suppression on the synoptophore test.

Comparison of VA values between examinations showed that the number of impaired eyes improved their visual acuity from the first examination to the follow-up visit (Chi^2 = 48.5; df =16; p=<.001), while the fellow eye remained stable. The mean acuity of the impaired eyes improved from 0.84 (6/7.1) to 1.1 (6/5.6); this change was significant (paired t test; $t=3.26$; $df=16$; $p<.01$).

DISCUSSION

This preliminary case series study's data suggests that ergonomic factors in the workplace are implicated in the development of visual symptoms and visual anomalies, particularly in the area of binocularity. The binocular anomalies most evident in these cases were suppression and binocular instability; these conditions often are not measured routinely in the course of the optometric or ophthalmological examination.

The impetus for this study was our observations that persons who did a considerable amount of work on the computer tended to report various monocular symptoms. We are unaware of other reports associating sustained computer use with monocular symptoms.

We found that these monocular symptoms were not particularly related to refractive condition. Intuitively, one would have expected that anisometropia might be a cause of these symptoms, but this study does not support a relationship between the refractive status of the two eyes and symptoms, including anisometropic.

Visual acuity, initially, was reduced significantly in the eye that was impaired. It is interesting, however, to note that upon subsequent examination (one year), the visual acuity of the impaired eye improved significantly while the fellow eye stayed the same. We propose that this may be attributed, in part, to the ergonomic modifications that were suggested to the patient at the initial visit.

Not all subjects in the experimental group had the same symptoms or the same intensity of symptoms. The work task intensity, the time expended in working with VDT`s and the individual's initial degree of binocularity may account for the variability of the symptoms. Even though our data suggests that ergonomic factors might have a bearing on the findings, a more representative study is needed.

There was not a significant relationship found between phoria tests and the monocular symptoms. The phorias, as measured by the Maddox Wing Test, did not show any relationship to monocular symptoms. The wide range of horizontal phoria measures acceptable to the European air regulations (6 prism diopters esophoria to 10 prism diopters exophoria at 33 cm) is somewhat lenient.[26] Perhaps more critical phoria criteria would have identify more binocular vision deficiencies.

Our data suggests that suppression and/or binocular instability, as measured with the synoptophore, differentiated the symptomatic group from the control group. The relationship demonstrated agreement between the impaired eye and the side of the body reporting the monocular symptoms. Further, when ergonomic recommendations were introduced and followed, the subsequent yearly examinations indicated that both the symptoms and anomalous binocular patterns improved. These recommendations included positioning all working media as frontal as possible and the avoidance of incorrect head postures. Monocular vision rehabilitation procedures were utilized with the impaired eye. Six individuals did not follow the ergonomic recommendations and the abnormal binocular measures remained. In one case, the suppression changed from a unilateral suppression to an alternation. These observations certainly lend credence to the clinician introducing ergonomic recommendations as part of the visual prescription.

There do appear to be variables that might cause the VDT user not to exhibit symptoms or signs. One factor could be insufficient time or intensity of VDT use to cause symptoms or signs. Another cause could be that the initial condition of the individual's binocularity may impact the manifestation of signs. The more intact the binocular system is at the beginning of the unfavorable postural position, the greater the possibility that the symptoms and signs will not manifest themselves or will be of a sub-clinical nature. This factor possibly can be evaluated and predicted by more intensive measurement of fusional ranges, facility and stability.

The position of gaze was difficult to define by some of the operators. This did not allow the establishment of a completely accurate linkage between symptoms and eye position (right or left) or the lateralized position of devices and papers at the work station. In this regard, recent studies related to the introduction of Varilux Ipseo personal lenses, indicates that a spectrum of possibilities exists between people who principally move their eyes, and those who mostly twist their head when reading.[32] It has been reported that the extent of head movements is almost twice that of eye movement under free viewing conditions.[33] Photography, or some type of permanent record of habitual head position when at the computer, could be useful for further such an investigation.[33-36]

We noted factors such as a habitual face tilt or the presentation of anatomical dissociation (prominent nasal septum isolated or combined with small pupillary distance/endophthalmus) when present. There were, however, no clear trends or patterns providing support that anatomical factors significantly contributed to the problem of working with a tilted gaze.

Further investigation of the relationship between monocular signs and symptoms, binocular function and ergonomics within the workplace is clearly needed. Others have proposed different variables to be considered. These include anomalies in the ocular sensory system as a possible cause.[23] A loss of clarity of the optical image in one eye could then impact the development of suppression and/or binocular instability.[37] It is likely that the unsound postural relationships contribute to binocular instability, suppression and reduced visual efficiency.

This study suggests that binocular function of VDT users can be preserved by ergonomic modification. To meet the needs of VDT users, clinicians should perform a comprehensive assessment of the vision system that includes examination of binocular fixation stability and suppression. Therapies should carefully consider the refractive condition, the extra ocular muscle balance as well as the individual sensory fusion responses. Whatever the optical prescription, it should be combined with attention to the environmental conditions. We recommend a workstation layout as follows:

1. the screen should be located in front of the operator,
2. the keyboard should be aligned and centered with the eye-screen axes,
3. text should be viewed as frontally as possible,
4. the desk or table on which the VTD is placed should measure no less than 80 cm in depth. This depth should facilitate the screen, the papers and keyboard alignment. Flat VTD screens that are now being introduced should

be encouraged, since they facilitate the ideal ergonomic arrangement.

SUMMARY

One the basis of our findings with subjects who work on a computer for on average of four hours per day, we suggest that:

1. Poor posture with regard to positioning of body to the VDT, and/or the keyboard and or the text does not appear to be related to refractive or phoria measurements. However, the ergonomically unsound posture does appear to be related to a significant decrease in visual acuity in one eye and a higher incidence of visual symptoms in the impaired eye.
2. There appears to be a relationship between that monocular symptomatology and the incidence of suppression and/or binocular instability. The hypothesis that the habitual adoption of a lateral gaze when working with VDT`s could interfere the normal sensory state, particularly of one eye, is supported by these findings.
3. When ergonomic recommendations were introduced, the binocular findings (suppression and unstable binocular fixation) significantly decreased and there was also a significant increase in the visual acuity of the impaired eye.
4. There were no clear trends or patterns that would support anatomical (facial) factors significantly contributing to the problem of working with a tilted gaze.
5. This study points to several specific studies that might be scrutinized to further refine the impact of posture and ergonomics of the workplace and particularly VDT use, as it impacts visual signs and symptoms.

The authors have no financial or other interests in the instruments or devices used or discussed in this study.

Sources

a. Topcon America. Paramus, New Jersey
b. Sussex Vision. Lancing, West Sussex, United Kingdom
c. http://www.statgraphics.net/

References

1. Rozas J. Magazine de información de Essilor nº. Cuaderno de Internet VII. 2004:65:25-8.
2. Knave BG, Wibom RI, Voss M, Hedstrom LD, Bergquist UO. Work with video display terminals among office employees. I: Subjective symptoms and discomfort. Scan J Work Environ. Health 1985;11:457-66.
3. Rosner M., Belkin M. Video display units and visual function. Surv Ophthalmol 1989;33:515-22.
4. Bergqvist UO, Knave BG. Eye discomfort and work with visual display terminals. Scand J Work Environ Health.1994;20:27-33.
5. Cole BL, Maddocks JD, Sharpe K. Effect of VDUs on the eyes; report of a 6 year epidemiological study. Optom Vis Sci 1996;73:512-28.
6. Eichenbaum JW. Computers and eye strain. J Ophthalmic Nurs Technol 1996;15:23-6.
7. Shen CS, Chiu SB, Wang AH, Ko LS Accommodation and visual fatigue in VDT work. Acta Ophthalmol Suppl 1988:185:175-6.
8. Scheiman M. Accomodative and binocular vision disorders associated with video display terminals: diagnosis and management issues. J Am Optom Assoc 1996;67:531-9.
9. Dain S, Chan T, Williams L. Visual and ocular changes in VDU operators. Public Health 1985;99:275-87.
10. Yeow PT, Taylor SP. Effects of long-term visual display terminal usage on visual functions. Optom Vis Sci 1991;68:930-41.
11. Gur S, Ron S. Does work with visual display units impair visual acuity after work? Doc Ophthalmol 1992;79:253-9.
12. Sheedy JE. Vision problems at video display terminals: a survey of optometrists. J Am Optom Assoc.1992;63:687-92.
13. Saito S, Sotoyama M, Saito S, Taptagaporn S. Physiological indices of visual fatigue due to VDT operation: pupillary reflexes and accommodative responses. Ind Health 1994;32:57-66.
14. Ukay K, Tsuchiya K, Ishikawa S. Induced pupillary hippus following near vision: incidental occurrence in visual display unit workers. Ergonomics 1997;40:1201-11.
15. Nyman KG, Knave BG, Voss M. Work with video display terminals among office employees. IV Refraction, accommodation, convergence and binocular vision. Scand J Work Environ Health 1985;11:483-7.
16. Tyrrell RA, Leibowitz HW. The relation of vergence effort to reports of visual fatigue following prolonged near work. Hum Factors 1990;32:341-57.
17. Sotoyama M, Jonai H, Saito S, Villanueva MB. Analysis of ocular surface area for comfortable VDT workstation layout. Ergonomics 1996;39:877-84.
18. Speeg-Schatz C, Hansmaennel G, Gottenkiene S ,Tondre M. On screen work and visual fatigue and its course after ophthalmologic management. J Fr Ophthalmol 2001;24:1045-52.
19. Stammerjohn LW Jr, Smith MJ, Cohen BG. Evaluation of work station design factors in VDT operations. Hum Factors 1981;23:401-12.
20. Hunting W, Laubli T, Grandjean E. Postural and visual loads at VDT workplaces. I. Constrained postures II. Lighting conditions and visual impairments. Ergonomics 1981;24:933-44.
21. Jasthinsky W, Heuer H, Kylian, H. Preferred position of visual displays relative to the eyes: a field study of visual strain and individual differences. Ergonomics 1998;41:1034-49.
22. Jaschinsky W, Heuer H, Kylian HA. A procedure to determine the individually comfortable position of visual displays relative to the eyes. Ergonomics 1999;42:535-49.
23. Evans Bruce JW. Pickwell`s Binocular Vision Anomalies 4th ed. Oxford, UK: Butterworth-Heinemann, 2002:4-5.
24. Instituto Nacional de la Salud e Higiene en el Trabajo. Protocolo de Vigilancia Sanitaria Específica (PVD). Ministerio de Sanidad. 1999;46:73.
25. Stevens PR. Anisometropia and amblyopia. The Brit Orthopt J 1960;176:66-7.
26. Joint Aviation Authorities. JAR-FCL 3—Flight Crew Licensing (Medical) Visual requirements: 3.220 (f). 2000;1.
27. Cashell GT, Durren I. Handbook of Orthoptic Principles 4th ed. NY:Churchill Livingstone,1980:8.
28. Pratt Johnson J, Tilson G. Management of Strabismus and Amblyopia. New York: Thieme, 2001:32-5.
29. Stidwill D. Orthoptic Assessment and Management. Oxford, UK: Blackwell Scientific Publications, 1990:10-34.
30. Cline D, Hofstetter HW, Griffin J. Dictionary of Visual Science. Radnar, PA: Chilton Book Co, 1990:664.
31. Griffin J, Grisham D. Binocular anomalies, 3rd ed. Boston: Butterworth-Heinemann, 1990:33.
32. Devie P,,Jouvanceau C Varilux IpseoTM.La estrategia ojo/cabeza y la personalización fisiológica. Voir. Magazine de información de ESSILOR.; nº 2004;65:18-20.
33. Biquer B, Prablanc C, Jeannerod M. The coordination of the eye, head and arm movements during reaching at a single visual target. In: d'Ydewakke G, ed. Visual and motor functions. Advances in eye movement research, Vol 5. Amsterdam: van Ransbergen,1982:423.
34. Venkatadri G, Farkas LG, Kooiman J. Multipurpose anthropometric facial anglemeter. Plast Reconstr Surg 1992;90:507-10.
35. Crumley RL, Lanser M. Quantitative analysis of nasal tip projection. Laryngoscope 1988;98:202-8.
36. Nechala, P, Mahoney J, Farkas LG. Digital two-dimensional photogrammetry; a comparison of three techniques of obtaining digital photographs. Plast Reconstr Surg 1999;103:1819-25.
37. Rowe FJ, Noorian CP. Concomitant esotropia following sixth cranial nerve palsy. The British Orthopt J 2002;59:58.

Corresponding Author:
Jose Luis R. Villa, M.D.
Sandalo 3 3º J
28042 MADRID Spain
joseluisrvilla@gmail.com

Date accepted for publication:
November 6, 2006