**DIGITAL ASTHENOPIA - PORTUGUESE GROUP OF ERGOPHTHALMOLOGY SURVEY**

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**ABSTRACT**

Purpose - Given the increasing use of electronic devices, and the increase complaints with its use, we intend to evaluate the prevalence of manifestations of dry eye and ocular fatigue in a population of individuals, who use the computer daily to perform all their tasks, as well as to correlate these complaints with the number of hours of digital use as well as their possible improvement with behavioral measures and use of tears drops.

Material/Methods - A total of 77 individuals (154 eyes) were evaluated on 2 separate days with a 1-month interval. They completed two questionnaires: OSDI and PEG Eye Fatigue. An objective ocular surface assessment was performed: Schirmer test without anesthetic, DR-1a Dry Eye Monitor™, hyperemia evaluation, lacrimal break up, presence of keratitis and lesions in the conjunctiva, as well near accommodation point and near convergence point. After the first evaluation, the subjects were divided into 2 groups: group A (< less 2 hours of computer working) and group B (> 2 hours of computer working). To the latter were explained some environmental measures to reduce complaints and recommendation of use of artificial tears.

Results - There was a statistically significant difference in the majority of the parameters evaluated in the group B, in relation to the morning period (group A) - tear film (p = 0.032), hyperemia (p <0.001), BUT (p <0.001), keratitis (p <0.001), conjunctival lesion (p = 0.002) and accomodation point (p <0.001). In the evaluation – one month later - there were no statistically significant differences in any of the parameters analyzed in the group A, and in group B there was a decrease in most parameters at the end of that period - Shirmer test (p = 0.005), lacrimal film (p = 0.022), keratitis (p <0.001), conjunctival lesion (p = 0.005) and fatigue score (p <0.001).

Conclusions - This survey highlights the increased overall level of awareness that we need to have to face the rapid and wide-scale changes driven by the emergence of digital techonology and, more particularly, its impact on user’s vision and posture. We concluded that the longer we use the electronic devices (more than 2 hours) the higher are the complaints and ocular surface changes rates. The enviromental and ocular strategies can attenuate or even eliminate the discomfort caused by this syndrome, and increase professional performances and quality of life.

**1. INTRODUCTION**

With the increasing use of electronic devices - computers, tablets, smartphones or game consoles – there is an increased effort for near vision and all this entails: increased accommodation/convergence, increased visual attention and decreased blinking with dry eye symptoms. If this effort is pronounced and/or maintained (more than 2 hours a day) failure of the adaptation mechanisms will occur, with exhaustion of the ocular muscles (intrinsic and extrinsic muscles) and subsequent visual fatigue (asthenopia) leading to incapacity to accomplish the tasks that were intended – **Digital Asthenopia (DA)**[[1]](#endnote-1)[[2]](#endnote-2). This study intends to evaluate the prevalence of manifestations of dry eye and ocular fatigue in a population of individuals who use the computer daily to perform all their tasks in a outsourcing services company called **Konecta™**. It is also intended to assess whether the increase in the number of hours of computer use is associated with an equal increase in ocular surface changes, as well as whether the implementation of behavior changes and administration of tear drops - sodium hyaluronate - may attenuate the same.

**2. MATERIAL AND METHODS**

In this study we examined employees of an outsourcing service company - Konecta™. All participants gave written informed consent; there was no financial compensation.

**Inclusion Criteria** – All participants had a best-corrected visual acuity of 5/10 or better, and a refractive error less than 5.0 diopters of sphere and less than 3.0 diopters of cylinder. All participants were older than 18 years.

**Exclusion Criteria** – Individuals were excluded if they had any disease and/or were taking any medication that causes dry eye syndrome (e.g. Sjogreen’s syndrome, anti-depressive medication, etc).

A total of 77 individuals (154 eyes) were evaluated on 2 separate days with a 1 month interval. The two evaluations were carried out in a similar way by the same researchers and by the same order of observation.

**Subjective Assessment** - All subjects were asked to complete two questionnaires: 1. Ocular surface disease index (OSDI) questionnaire which evaluates complaints related to ocular surface disturbances secondary to dry eye (0 to 100% scale); 2. and a second questionnaire that adresses the eye fatigue – Portuguese Group Ergophthalmology (PGE) questionnaire (score of 0-16) as follow:

OSDI QUESTIONNAIRE

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| During the last week, have you noticed any of the symptoms below? | Every days | Most of the days | Half of the days | Sometimes | Never |
| 1. Light Sensitivity? | 4 | 3 | 2 | 1 | 0 |
| 1. Sore eyes or watery eyes? | 4 | 3 | 2 | 1 | 0 |
| 1. Pain / burning eyes? | 4 | 3 | 2 | 1 | 0 |
| 1. Blurred vision? | 4 | 3 | 2 | 1 | 0 |
| 1. Decreased vision? | 4 | 3 | 2 | 1 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| During the past week, have eye problems affected any of these tasks? | Every days | Most of the days | Half of the days | Sometimes | Never |
| 1. Reading? | 4 | 3 | 2 | 1 | 0 |
| 1. Driving at night? | 4 | 3 | 2 | 1 | 0 |
| 1. Work at your computer, use your tablet or mobile phone? | 4 | 3 | 2 | 1 | 0 |
| 1. Watch TV? | 4 | 3 | 2 | 1 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| During the last week, did you experience eye discomfort in any of the situations? | Every days | Most of the days | Half of the days | Sometimes | Never |
| 1. With wind? | 4 | 3 | 2 | 1 | 0 |
| 1. In places with low humidity or dry weather? | 4 | 3 | 2 | 1 | 0 |
| 1. In places with air conditioning? | 4 | 3 | 2 | 1 | 0 |

PEG QUESTIONNAIRE

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| During the past week, have you felt any of the complaints listed below? | Every days | Most of the days | Half of the days | Sometimes | Never |
| 1. Blurred vision at night, especially for reading? | 4 | 3 | 2 | 1 | 0 |
| 1. Difficulty focusing at distance when you are long times working at the computer? | 4 | 3 | 2 | 1 | 0 |
| 1. Ocular strain, pressure or headaches? | 4 | 3 | 2 | 1 | 0 |
| 1. Neck, shoulder and back pain after using computer? | 4 | 3 | 2 | 1 | 0 |

**Objective Assessment** - Objective assessment was performed in both eyes and consisted of:

1. Schirmer test without anesthetic - Normal values of test is > 15 mm in <5 minutes and abnormal if <15 mm in> 5 minutes;

2. DR-1a Dry Eye Monitor™ by KOWA – that allows an objective evaluation of lacrimal film through an optical interference phenomenon, and classifies the tear break test in a non-invasive manner (NI BUT ). Classification of 1 to 4, where 1 means existence of good tear film, and 4 means bad tear film);

3. Biomicroscopy with hyperemia evaluation (present or absent), lacrimal break up time (BUT) (normal if> 10 seconds, altered if <10 seconds), presence of keratitis and lesions in the conjunctiva (evaluated according to the Oxford scale, from 0 to 5, in that 0 is unchanged and 5 with many changes);

4. Accommodation and convergence – near accommodation point, measured with RAF ruler, normal or altered for age according to ruler scale, near convergence point measured in cm with RAF ruler, normal if <10cm, altered if > 10cm.

After the first evaluation, the subjects were divided into 2 groups: **GROUP A** (first 34 observations, included individuals with less than 2 hours of computer working) and **GROUP B** (the remaining 43 observations, corresponding to the rest of population study, and that were the ones with more than 2 hours of computer working). To the latter were explained some environmental measures to reduce complaints (change environment humidity in the air conditioner, choose right condition regarding to lights, screen positioning and pauses during computer activity - rule 20/20/20 stop - every 20 minutes during 20 seconds should look to an object 20 feets (6 meters) away) and therapeutic measures for dry eye reduction, with recommendation of use of artificial tears (sodium hyaluronate 0.15% - Hyabak™ Théa laboratories) whenever they have dry eye complains.

**Statistical Analysis** – All variables have a non-normal distribution, so we employed non-parametric statistical inference methods: ‘Independent Mann-Whitney U Test’ to study possible differences related to treatment; ‘Related samples Wilcoxon Signed Rank Test’ to evaluate how variables change over time; ‘Chi-Square Test’ to evaluate how the variables change from morning vs. afternoon in the same day ). Since we employed non-parametric statistics we cannot calculate averages and standard deviations. To describe the population sample we used median (equivalent to the parametric mean) and IQR (Interquartile range, equivalent to the parametric standard deviation). Statistical analyses were performed using commercial available software (SPSS Statistics 24 IBM). Statistical significance was defined at P<0.05.

**3. RESULTS**

A total of 77 individuals (154 eyes) were observed, with a median age of 34 years and 59 were females (77%). More than half (58%) of individuals wear glasses and 12% wear monthly contact lenses.

In the **first evaluation** the median OSDI score is 29 and the ocular fatigue score is 7. Only 8% of subjects had alterations in the Schirmer test, 25% had alterations in the BUT, 18% had hyperemia. 44% had accomodation changes and 12% had convergence disabilities. There was a statistically significant difference in the majority of the parameters evaluated in the afternoon (group B) in comparing to the morning period (group A) - tear film (p = 0.032), hyperemia (p <0.001), BUT (p <0.001), keratitis (p <0.001), conjunctival lesion (p = 0.002) and accomodation point (p <0.001). There were no statistically significant difference in the Schirmer test (p = 0.303), near convergence point (p = 0.440) and ocular fatigue (p = 0.567) – table 1.

In the **second evaluation** – one month later - there were no statistically significant differences in any of the parameters analyzed in the group A – without behavioral intervention – table 2. In the group that received a leaflet with the recommendations described above - group B – most clinical parameters improved at the end of that period - Shirmer test (p = 0.005), lacrimal film (p = 0.022), keratitis (p <0.001), conjunctival lesion (p = 0.005), near convergence point (p = 0.001) and fatigue score (p <0.001). However, there were no statistically significant changes in near accomodation point (p = 0.056) and hyperemia (p = 0.038) or OSDI score (p = 0.492) – table 3.

|  |  |  |  |
| --- | --- | --- | --- |
| **FIRST ASSESSMENT** | **Group A** | **Group B** | **Test** |
| OSDI | 35/100 | 27/100 | p=0.440 |
| PGE Eye Fatigue | 7/16 | 7/16 | p=0.567 |
| Schirmer Test | 6% | 10% | p=0.303 |
| Tear Film | 2,71 ± 0,62 | 2,97±0,81 | p=0.032 |
| Hyperaemia | 6% | 29% | p<0.001 |
| BUT Test | 7% | 42% | p<0.001 |
| Keratitis | 0.03 ±1,70 | 0,79 ± 0,97 | p<0.001 |
| Conjunctiva | 0.03 ±1,70 | 0,37 ± 0.79 | p=0.002 |
| Accommodation | 77% | 20% | p<0.001 |
| Convergence | 12% | 12% | p=0.570 |

**Table 1** – Data from the first assement comparing group A vs. group B

|  |  |  |  |
| --- | --- | --- | --- |
| **GROUP A** | **1st Assessment** | **2nd Assessment** | **Test** |
| OSDI | 35/100 | 33/100 | p=0.492 |
| PGE Eye Fatigue | 7/16 | 6.5/16 | p=0.257 |
| Schirmer Test | 6% | 6.8% | p=0.082 |
| Tear Film | 2,71 ± 0,62 | 2,57 +-0,70 | p=0.119 |
| Hyperaemia | 6% | 6.8% | p=0.842 |
| BUT Test | 7% | 5.8% | p=0.066 |
| Keratitis | 0.03 ±1,70 | 0,11 ± 0,32 | p=0.083 |
| Conjunctiva | 0.03 ±1,70 | 0,07 +-0,26 | p=0.317 |
| Accommodation | 77% | 50% | p=0.004 |
| Convergence | 12% | 45,5% | p<0.001 |

**Table 2** – No significant differences in Group A when comparing initial evaluation with evaluation after 1 month

|  |  |  |  |
| --- | --- | --- | --- |
| **GROUP B** | **1st Assessment** | **2nd Assessment** | **Test** |
| OSDI | 27/100 | 23/100 | p=0.492 |
| PGE Eye Fatigue | 7/16 | 4.6/16 | p<0.001 |
| Schirmer Test | 10% | 0% | p=0.005 |
| Tear Film | 2,97±0,81 | 2,74±0,74 | p=0.022 |
| Hyperaemia | 29% | 13% | p=0.038 |
| BUT Test | 42% | 0% | P<0.001 |
| Keratitis | 0,79 ± 0,97 | 0,09 ± 0,29 | p<0.001 |
| Conjunctiva | 0,37 ± 0.79 | 0,04 ±0,21 | p=0.005 |
| Accommodation | 20% | 35% | p=0.056 |
| Convergence | 12% | 13% | p=0.889 |

**Table 3** – Differences in Group B initial evaluation and after 1 month

**4. DISCUSSION**

To the best of our knowledge this is the first study of digital asthenopia that includes both a subjective (questionnaire) as well as an objective assessment. Computer Vision Syndrome, or **Digital Asthenopia**, is a transient and nonspecific disturbance related to the use of digital devices. All these gagdets represent a great step forward, since they dramatically increase possibilities for exchange, interaction and cooperation, and facilitate acess to knowledge. However they cause this multifactorial syndrome, which is responsible for several ocular and visual symptoms associated with the varied and intense use of digital displays, whether for recreational purposes or in a work/schooling context. These devices have become an accepted part of everyday life, irrespective of age, social class or geographical area [[3]](#endnote-3) [[4]](#endnote-4) [[5]](#endnote-5). A north american study estimates that 90% of the 70 million american workers who use these devices do it more than 2 hours a day, and 60% more than 5 hours a day. One child out of four is exposed to screens over three hours a day. In the same study it is estimated that approximately 65% ​​of Americans citizens suffer from this syndrome to some degre[[6]](#endnote-6). The increasingly widespread use of these devices to perform an increasing number of everyday activities makes this syndrome clinically and statistically very relevant. This growing trend is not likely to be reversed any time soon, nor are the related ophthalmic problems. **Clinically** this syndrome is manifested by 5 groups of symptoms [[7]](#endnote-7) [[8]](#endnote-8) [[9]](#endnote-9), which are sometimes vague, or difficult to describe, and those who suffer from this disorder are often not aware of them: **1.** **Symptoms related to astenopia:** eyes strain, tired or sore eyes, headaches. The accommodative effort, during short distances activities, may be responsible for the development of myopia which is temporary (due to excessive accommodation – pseudo myopia), in fact the incidence of myopia in these users does not appear to be increase[[10]](#endnote-10); **2. Symptoms related to dry eye**: foreign body sensation, eye burning, red eye, tearing, contact lens intolerance[[11]](#endnote-11) [[12]](#endnote-12) [[13]](#endnote-13) [[14]](#endnote-14); **3. Symptoms related to visual fatigue:** distanceblur after near work, slowness in focusing for all distances and diplopia (less frequent and usually associated with a phoria - extrinsic muscle insufficiency); **4. Muscular symptoms:** neck and back ache are quite common in computer-using patients, and can often be due to inappropriate location of the display or inappropriate spectacle correction of presbyopia[[15]](#endnote-15)[[16]](#endnote-16) [[17]](#endnote-17) [[18]](#endnote-18). **5. Psychological symptoms:** Even more pervasive video gaming is associated with player immersion and strong screen flicker. These two situations can eventually stimulate systemic and endocrine functions, resulting in elevated cortisol levels. Overexposure to blue light emitted by screens can disrupt the secretion of melatonin and thus affect quality of sleep. The main repercussions have been found to affect: sleep, behavior, mood, motivation and learning.

From the **assessment we made on the first day**, and when comparing the objective evaluation between the morning group vs. the afternoon group, we found more manifestations of dry eye and ocular fatigue in this last group. That probably reflects the longer time of screen exposure. The longer and more frequent one uses digital devices, the more one is affected by ocular or physical symptoms.

Despite the vague nature of its symptomatology, it can be reduced or even eliminated if the syndrome is diagnosed and treated. We have to adopt a multidisciplinary approach to reduce asthenopia complaints. In the treatment of DA it is relevant to consider the correction of associated ocular pathologies, as well as the patient’s education with respect to strategies to adapt to their usual environment: **1. Ocular strategies** - Detection and correction, in an ophthalmology appointment, of any refractive error, binocular vision and accommodation problems as well as dry eye is important. Sometimes the use of special lenses with low-magnification in the bottom part of the lens, with concomitant use of filters for the blue light as well as antireflective filters is thought to be associated with a reduction in patient’s complaints[[19]](#endnote-19). In patients with presbyopia, use of progressive lenses with a extended channel for intermediate viewing, or occupational lenses, in order to correct close and intermediate distances is needed. Counseling work breaks is also important: regular pauses looking for far objects while working with these devices, is related to a decrease of fatigue symptomatology, as it allows relaxation of the circular fibers of the ciliary muscle as well an increase in blinking. The 20-20-20 rule states that you should pause every 20 minutes during 20 seconds looking at a distance of 20 feet (≅6 meters). It is also advisable to provide artificial tears to be used as needed; **2. Enviromental strategies**: Avoid dry environments, strong air flows, dust or fumes. Regulate the temperature and airflow of air conditioning and heating systems. Constant luminous intensity throughout the visual field eliminating glare from lights[[20]](#endnote-20). The computer display should be at 35-40 cm distance from the user’s eye, and the top of the display should be near eye level, if less than 40 years old or higher than 40 years old and if occupational glasses are used, or little lower if progressive glasses are used[[21]](#endnote-21) [[22]](#endnote-22). The size and contrast of characters on a computer screen must meet criteria established by the visual performance of the normal eye. Upright posture while maintainig the normal convex curvature of the lower spine can be important to long term comfort, and arms should be supported by chair arm rests to avoid tension across the shoulders.

Top of Form

Bottom of Form

The reduced clinical complaints and the objective resuts **after 1 month**, in **Group B**, in which we intervene (environmental measures, pauses and use of lubricants) demonstrates their importance in the prevention and treatment of this syndrome.

**5. CONCLUSION**

This portuguese survey highlights the increased overall level of awareness that we need to have to face the rapid and wide-scale changes driven by the emergence of digital techonology and, more particularly, its impact on user’s vision and posture. There are solutions today to reduce it but they depend on its cause. We concluded that the longer we use electronic devices (more than 2 hours) the higher are the complaints and ocular surface changes rates. We don’t have to cut out all screen time, but a few changes to how we use our devices can be easier on our eyes. The enviromental and ocular strategies can attenuate or even eliminate the discomfort caused by this syndrome, and increase professional performances and quality of life. Consumer awareness campaigns are an important means of highlighting the risks and symptoms related to the use of digital displays, and offer an offer the opportunity to stress the need for regular ophthalmologic exams.

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    **Submission Compliance**

    1. I declare that all authors had a substantial contribution for this manuscript.
    2. I declare that all authors approve the final version of the manuscript.
    3. I declare that the manuscript is not under review of any other journal, and that it has not been published complete or partially in any other journal.
    4. I declare that the manuscript has been previously presented.

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    Curso Ergoftalmologia no Consultório/Escritório – Estudo ‘Astenopia Digital’ Konecta

    Susana Henriques, Fernando Trancoso Vaz

    Vilamoura 07 Dezembro 2017

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    SIGNATURES

    1. Fernando Trancoso Vaz \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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