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# Neck pain and visual system disorder: what is the relationship?

*Dolor de cuello y trastorno del sistema visual: ¿cuál es la relación?*

*Dor cervical e distúrbio do sistema visual: qual a relação?*

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**Abstract**

Continuous use of digital devices without rest periods makes individuals more vulnerable to oculomotor disorders. These dysfunctions can lead to adaptive cervical postural changes. It was proposed here to evaluate the correlation between convergence insufficiency, visual attention and neck pain. Fourteen college students with neck pain and 14 without neck pain were evaluated in terms of convergence insufficiency, visual attention and neck mobility. There was difference between the groups in the Royal Air Force (p=0.03), in the Convergence Insufficiency Symptom Survey (p=0.01) and in the flexion (p=0.016) and right and left neck tilt movements (p= 0 .14) and (p=0.28). There was no difference in time and performance of the bell cancellation test (p=0.17). The group with neck pain showed signs of convergence insufficiency with a point close to convergence above the normal value of 10 centimeters and a high score in the Convergence Insufficiency Symptom Survey. The group without neck pain performed within normal limits. Although the sample was of convenience and the individuals only performed clinical evaluations, the results are promising in demonstrating the presence of convergence insufficiency in the group with neck pain.

**Descriptors:** Neck Pain; Pain; Ocular Motility Disorders; Binocular Vision; Eye Health.

**Resumen**

El uso continuo de dispositivos digitales sin períodos de descanso hace que las personas sean más vulnerables a los trastornos oculomotores. Estas disfunciones pueden conducir a cambios posturales cervicales adaptativos. Aquí se propuso evaluar la correlación entre la insuficiencia de convergencia, la atención visual y el dolor de cuello. Catorce estudiantes universitarios con dolor de cuello y 14 sin dolor de cuello fueron evaluados en términos de insuficiencia de convergencia, atención visual y movilidad del cuello. Hubo diferencia entre los grupos en la Royal Air Force (p=0,03), en la Convergence Insufficiency Symptom Survey (p=0,01) y en los movimientos de flexión (p=0,016) e inclinación del cuello hacia la derecha e izquierda (p= 0,14) y (p=0,28). No hubo diferencia en el tiempo y rendimiento de la prueba de cancelación de campana (p=0,17). El grupo con dolor de cuello mostró signos de insuficiencia de convergencia con un punto cercano a la convergencia por encima del valor normal de 10 centímetros y una puntuación alta en la Encuesta de Síntomas de Insuficiencia de Convergencia. El grupo sin dolor de cuello se desempeñó dentro de los límites normales. Aunque la muestra fue de conveniencia y los individuos solo realizaron evaluaciones clínicas, los resultados son promisorios al demostrar la presencia de insuficiencia de convergencia en el grupo con cervicalgia.

**Descriptores:** Dolor de Cuello; Dolor; Trastornos de la Motilidad Ocular; Visión Binocular; Salud Ocular.

**Resumo**

O uso contínuo de dispositivos digitais sem períodos de descanso torna os indivíduos mais vulneráveis às disfunções oculomotoras. Estas disfunções podem levar a alterações posturais cervicais adaptativas. Propôs se aqui avaliar a correlação entre insuficiência de convergência, atenção visual e cervicalgia. Foram avaliados 14 universitários com cervicalgia e 14 sem dor cervical em relação a insuficiência de convergência, atenção visual e mobilidade cervical. Houve diferença entre os grupos no *Royal Air Force* (p=0,03), no *Convergence Insufficiency Symptom Survey* (p=0,01) e nos movimentos de flexão (p=0,016) e de inclinação cervical direita e esquerda (p= 0,14) e (p=0,28). Não houve diferença no tempo e desempenho do teste de cancelamento dos sinos (p=0,17). O grupo com cervicalgia demonstrou sinais de insuficiência de convergência com ponto próximo de convergência acima do valor de normalidade de 10 centímetros e escore alto no *Convergence Insufficiency Symptom Survey*. O grupo sem cervicalgia apresentou desempenho dentro dos padrões de normalidade. Embora a amostra seja de conveniência e os indivíduos tenham realizado apenas avaliações clínicas, os resultados são promissores ao demonstrarem a presença de insuficiência de convergência no grupo com dor cervical.

**Descritores:** Cervicalgia; Dor; Visão Binocular; Transtornos da Motilidade Ocular; Saúde Ocular.

## Introduction

It is estimated that neck pain affects 10% to 20% of the population each year (with a global prevalence of 4.9%) being the fourth cause of disability worldwide[1]. Among the etiological factors, the most described conditions are muscle tension, arthritis, fractures, spinal cord compression, nerve injuries, neoplastic diseases, infections and inflammatory conditions[2].

More recently, visual alterations have figured as a possible coadjuvant factor in neck pain. According to a study[3], Accommodative disorders and non-strabismic binocular disorders increase musculoskeletal discomfort in the neck region so that both visual symptoms and muscle complaints coexist.

There is a relationship between cervical spine positioning and eye and head movements. There is mutual and precise coordination between the visual, sensory and oculomotor systems. Afferent information from the vestibular, visual and proprioceptive systems can alter muscle activation in the cervical region, leading to postural adaptations as a form of compensation during activities that require eye movement[4]. The visual system contributes to maintaining balance by helping to maintain head and trunk alignment[5]. Visual alterations can contribute to the maintenance of inadequate postures, generating overload for the cervical spine and causing pain[6]. Researchers[7] carried out an experimental study with the aim of investigating the impact of muscle activity in the cervical and scapular area during the application of oculomotor loads through ocular lenses for near and distant vision. Muscle activity was measured by electromyography. The results indicated that sustained accommodation by ocular lenses in near vision conditions, simulating an ergonomically unfavorable view, could possibly represent a risk factor for trapezius myalgia.

Different authors have reported the joint prevalence of visual and neck symptoms. Authors[8] established relationships between highly demanding visual situations and discomfort in the neck and shoulders. Domkin et al.[9] found that sustained contraction of the ciliary muscle is associated with increased activation of the trapezius muscle, which may contribute to the development of cervical musculoskeletal complaints. Richter et al.[7] reported the coexistence of the two symptoms in similar situations, contributing to the hypothesis of the relationship between visual dysfunction and muscle changes in the neck[10].

Currently, the continuous use of digital devices without periods of rest makes individuals more vulnerable to oculomotor disorders such as convergence insufficiency. These dysfunctions can lead to adaptive cervical postural changes that can cause musculoskeletal problems. Considering this hypothesis and the fact that visual alterations are little investigated in the clinical evaluation of individuals with neck pain, it was proposed here to evaluate the correlation between CI, visual attention and neck pain.

## Methodology

A cross-sectional study with a quantitative and qualitative approach was carried out. The research had a convenience sample, established in 28 university students who were recruited through advertisements on social networks. The previously established inclusion criteria were: age between 18 and 40 years, neck pain for the pain group and absence of pain for the control group, availability to participate in the study. Exclusion criteria were: history of eye surgery and continuous use of anxiolytics. All participants read and signed the Informed Consent Form, Approval Opinion of the Research Ethics Committee: 40506920200005382.3.2.

Data collection was carried out at the physiotherapy school clinic of the University Center of Associated Teaching Faculties (UNIFAE), by trained therapists. The Convergence Insufficiency Symptom Survey (CISS) questionnaire was applied, which is a 15-question instrument in which patients choose five response options: "never", "infrequently", "sometimes", "very often" and " ever". Each response option corresponds to a numerical value ranging from 0 points ("never") to 4 points ("always"). The 15 items are summed to obtain the total CISS score. The total score can range from 0 (least symptomatic) to 60 (most symptomatic, reporting "always" for all 15 symptoms). A CISS score greater than or equal to 16 is considered symptomatic[11].

The Near Point of Convergence was evaluated with an adaptation of the Royal Air Force ruler. The test started with the ruler at the height of the nose and the marker at 30 cm, being slowly approached towards the nose[12].

The Snellen decimal scale was used to measure distance visual acuity (6m). Visual attention was assessed using the Bell Cancellation test, which consists of a sheet of paper measuring 21.5 x 28cm, with seven columns. Each column presents thirty-five distracting figures (example: bird, apple, car) and five target stimuli (bells). The objective of this test is to find all the bells on the sheet, drawing a circle around them, in a maximum time of five minutes[13]. Cervical changes were assessed using the visual analogue pain scale and cervical goniometry. Comparison was made between the groups.

Data analysis appropriated descriptive statistics. For quantitative variables, measures of central tendency (mean) and dispersion (standard deviation) were calculated. For values measured on an ordinal scale, we chose to use a non-parametric test for independent samples - Mann-Whitney U test for comparison between groups. The significance level was set at 5% ($p < 0.05$).

## Results

The study included 28 university students, 14 with neck pain (GC) (24.5 ± 4.5 years) and 14 without neck pain (GSC) (24.8 ± 6 years), whose sociodemographic and clinical profile is shown in Table 1.

There was no difference between the groups in terms of visual acuity assessed using the Snellen decimal scale $p > 0.05$ (Table 2). Regarding visual attention assessed by the Bell Cancellation Test (TCS), there was no difference in time (p=0.17) or performance (p=0.7) although the CG was slower (143sec) in relation to the GSC (178eg).

There was difference in flexion ROM (p=0.01), left and right rotation (p=0.02) and (p=0.03) and right and left cervical inclination (p= 0.01) and (p =0.02).

There was a difference in relation to the close point of convergence evaluated by the ruler adapted from RAF (GC) 11cm and (GSC) 7.2cm (p=0.03). There was also a difference between the groups in the CISS (GC) 22.2 and (GSC) 11.6 points (p=0.01).

**Table 1.** Characteristics of the study sample. São João da Boa Vista, SP, Brazil, 2022

| | GC (N=14) | GSC (N=14) |
|---|---|---|
| **GENDER (H/M)** | 9 M/5H | 6 H/ 8 M |
| **AGE (YEARS)** | 24,5±4,5 | 24,8±6,2 |
| **WEIGHT (KG)** | 66,66±18,31 | 76,55±12,22 |
| **BMI (KG/M²)** | 25,14±6,22 | 26,86±10,68 |
| **HEIGHT (CM)** | 1,64±0,073 | 1,69±0,093 |
| **GLASSES (YES/NO)** | 6 SIM/ 3 NÃO | 4 SIM/ 5 NÃO |

Note: CG: Group with neck pain; GSC: Group without neck pain; M: Women; H: Men; KG: Kilograms; BMI: Body Mass Index; M²: Meters squared; CM: Centimeters; N: Number of people.

**Table 2.** Comparison of evaluation results. São João da Boa Vista, SP, Brazil, 2022

| | GC (N=9) | GSC (N=9) |
|---|---|---|
| SNELLEN (AOD) | 5,62±1,59 | 6,62±1,84 |
| SNELLEN (AOE) | 5,66±2,12 | 6,55±2,40 |
| RAF (CM) | 11±3,74 | 7,27±2,01* |
| ADM (FLX) | 37,77±6,66 | 52,22±13,94* |
| ADM (ROT D) | 58,88±16,91 | 73,88±17,63* |
| ADM (ROT E) | 58,88±16,91 | 68,33±12,74* |
| ADM (INC D) | 27,77±9,39 | 37,22±9,71* |
| ADM (INC E) | 31,66±10 | 33,33±7,50* |
| TCS (AC) | 33,55±2,12 | 34,33±1,11 |
| TCS (SEG) | 143,66±28,77 | 178,33±52,38 |
| TS (AC) | 49,44±1,33 | 46,66±4,89 |
| CISS (PTS) | 25,44±15,28 | 12,44±13,23* |

Note: CG: Group with neck pain; GSC: Group without neck pain; CM: Centimeters; N: Number of people; AOD: Right eye hits; AOE: Hits left eye; ROM: Range of motion; FLX: Flexion; ROT D: Right rotation; ROT E: Left rotation; INC D: Right slope; INC E: Left slope; TCS: Bell Cancellation Test; AC: hits; SEG: Seconds; TS: Test slides; TUG: Timed Up and Go; CISS: Convergence Insufficiency Symptom Survey; pts: points.

## Discussion

This study aimed to evaluate the presence of binocular dysfunctions such as convergence insufficiency and its relationship with pain in the cervical region. The results showed that individuals with neck pain showed more signs of convergence insufficiency both in the PPC assessed by the RAF and in the CISS. In addition, a small relationship between neck pain and visual attention was also demonstrated. Another point was the reduction of cervical ROM in the group with pain.

Regarding visual attention, it was found that the average number of correct answers was 33 in the group with pain and 34 in the GSC, respectively. The referred results indicate that both groups presented a number of correct answers between the normal values (32 ≤ correct answers ≤ 35) defined in the literature[14]. Although no difference was observed between the correct answers, the execution time of the bell cancellation test was longer in the group of individuals with pain and with more HF symptoms. These values are in line with the results of the study by Scheiman et al.[15] who described that an increased PPC or a decreased fusional convergence can lead to alterations in the mechanisms of visual attention, namely in the response time and in the control of fixation when performing a task.

The difference in HF signs observed between the groups in this study is consistent with previous studies that demonstrated the relationship between dysfunctions of the visual system and alterations of the musculoskeletal system in the cervical region[8,16]. Sánchez-González et al.[10] evaluated binocular function and confirmed the relationship between non-strabismus binocular disorders and musculoskeletal disorders of the neck. Giffard et al.[17] showed the relationship between convergence insufficiency and neck pain. Matheron et al.[18] reported a rotation of the head in an attempt to compensate for the vertical deviation produced by a prism placed in front of the eye.

In this context, alteration of the cervico-ocular reflex in subjects with neck pain could modify the tonus of the extraocular muscles, leading to changes in the amplitude of fusion vergences and binocular alterations[6].

It should also be considered that reduced amplitudes of horizontal fusional vergence in both directions, convergence and divergence reduce the area of binocular vision, which can be compensated for by twisting the head. Maxwell et al.[19] and Irsch et al.[20] reported that binocular dysfunction was reduced with head tilt. The head can be placed in a position where reflexively there is a decrease in the tone of the affected eye muscles. This postural adaptation would be good for improving vision, but it would lead to joint and muscle dysfunctions in the neck, giving rise to cervical pathology if maintained over time. Seen in this way, neck pain would be an effect resulting from the attempt to improve visual acuity. Cervical pathology may be the result of permanent compensation to improve visual comfort[21]. Headache secondary to occupational functions and may also be related to visual changes[22].

Considering the relationship observed between changes in the visual system and neck pain, future research may propose interventions with visual therapy programs in individuals with neck pain who have symptoms of non-strabismic binocular dysfunction. It is suggested that individuals with neck pain be evaluated for the presence of symptoms of convergence insufficiency.

**Conclusion**

The CG showed signs of HF with a point close to convergence above the normal value and a CISS score indicative of HF. The GSC performed within normal limits. Although one should consider the limitations of the study as a convenience sample and use of simple and clinical assessment instruments, the results are promising in demonstrating the presence of HF in the group with neck pain. Based on these findings, it is suggested that oculomotor disorders be investigated in future studies and considered in the neck pain rehabilitation process.

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