Craniocervical flexion performance in computer users: An observational study

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Abstract

Study aim: To compare the performance of deep cervical flexors (DCF) among computer users (CU) and non-users using the craniocervical flexion test (CCFT).

Material and methods: Eighty nine computer users and 100 non-users were recruited for evaluation of their craniocervical muscle performance. The activation score and performance index were assessed using the CCFT. Comparison of craniocervical flexor performance between the two groups was evaluated using the Mann Whitney test. A Chi-Square test was used to test the association between age, years of work and craniocervical flexion. Significance was set at $p \leq 0.05$.

Results: The median activation score was lower among computer users (median pressure-24 mmHg as compared to non-users (median pressure-28 mmHg) ($p < 0.01$). The performance index among computer users was lower when compared to non-users. Also, age ($p < 0.001$) and the years of work experience ($p = 0.006$) were associated with the DCF performance.

Conclusion: CU have lower activation and endurance of the DCF compared to non-users. The endurance of the DCF was associated with the age and years of computer usage.

Keywords: Deep cervical flexors – Craniocervical flexion test – Work related musculoskeletal disorders – Neck pain

Introduction

A good posture is one in which all the body parts are maintained and aligned equally from the midline [8, 12, 43]. Minute alterations or deviations from this posture can increase the stress on the supporting structures [22, 47]. A forward head posture (FHP) is one such deviation of posture in which the head is relatively anterior to the trunk [34, 35, 40, 56]. It presents as an anterior translation of the cervical vertebrae with a hyperextended upper cervical spine [33]. It includes an upper cervical extension with or without lower cervical flexion [49] and tends to cause increased stress on the surrounding structures [20].

FHP is common among computer users (CU) and occurs due to constant gazing at the computer screen [20, 48, 49]. A cervical posture into extension was the most prominent postural deviation noted in this population [7, 57]. As the task of computer usage demands constant sitting, positions

have to be maintained for long hours [11, 55]. Different sitting postures influence the head on neck posture and cervical muscle activity [9]. Prolonged sitting leads to a non-neutral position of the spine, causing low levels of constant muscle activation, thus increasing the spinal loading and reducing the spinal mobility [1, 44, 48].

An altered neck posture adversely affects the muscle recruitment and movement patterns of the cervical muscles [11, 16]. An FHP causes the increased thickness of the neck muscles, including the sternocleidomastoid, possibly suggesting increased activation of the superficial muscle [5]. The superficial muscles flex the lower cervical spine and have a different role compared to the deep cervical flexors [54]. The deep cervical flexors, including the longus coli, longus capitis, rectus capitis anterior, and lateralis, have a primary function of flexion of the upper cervical spine while supporting the motion segments of the cervical spine [38]. They are also important stabilizers of the head on neck posture [17].

Altered muscle recruitment patterns are associated with the development of symptoms in CUs with the mean activation of the cervical extensors compared with the flexors being more [4, 5]. This cervical extension predisposes a computer user to develop upper extremity and neck symptoms [8, 41]. The extent and direction to which the spine posture is altered directly increase the chances for developing upper extremity and neck symptoms in individuals using computers [7]. Studies in the past have established the importance of the deep cervical flexors in the maintenance of neck posture and neck stability [38, 54]. However, to our knowledge, no study has quantified the strength of craniocervical flexors in CU. Hence the present study aimed to quantify the strength and endurance of craniocervical flexors in CU and control group using the craniocervical flexion test. We hypothesized that a lesser ability to perform the test would give evidence of the sign of impairment of craniocervical flexion in this population.

Materials and methods

The study protocol was approved by the Institutional Ethics Committee (IEC), Father Muller Medical College Hospital, Mangalore, India. A convenient sample of 189 participants with and without defined hours of computer use were recruited. All participants were provided detailed information about the study procedures and signed written informed consent. CU from two information technology centres in Mangalore, Karnataka, India, were contacted through emails, posters, and advertisements. The employees who were willing to participate in the study and who fulfilled the inclusion criteria were recruited.

We defined computer user as an individual with no history of neck pain and a minimum of one year experience of computer use for a frequency of more than 15 hours per week [18]. The control group which consisted of participants with no history of neck pain were recruited from the local community through word of mouth and advertisements. Exclusion criteria for both the groups included (1) history of neck or shoulder pain for the last two years, (2) pain on palpation of the cervical region, (3) cervical, thoracic or shoulder surgeries (4) associated pain like headaches and TMJ (temporo-mandibular joint) dysfunction. A physiotherapist with clinical experience in the testing procedures performed the evaluations. Participant demographics included age, and for CU, the duration of work and years of work were noted down.

Craniocervical flexion test: The neuromotor control of the DCF was assessed using the CCFT [29]. Its validity and reliability has been established in symptomatic as well as asymptomatic subjects [2, 23, 27, 31]. Furthermore, a systematic review by de Araujo in 2020, establishes its reliability and validity as an assessment tool [13]. This clinical test is based on the activation and isometric endurance of the deep cervical flexor muscles. A pressure biofeedback unit (Chattanooga Group, USA) was used to perform this test. With the participant in supine crook lying position, the pressure bag was placed under the suboccipital area, and the cuff was inflated to 20mmHg, which is the baseline pressure for testing the deep cervical flexors [28]. Before the test commenced, the participants were familiarized with the test procedures. The experiment began with each participant performing a nodding movement like saying “yes” for five incremental stages (22 mmHg, 24 mmHg, 26 mmHg, 28 mmHg, 30 mmHg) of increasing range and held at each stage for 10 seconds. The time was electronically monitored using a stopwatch, as depicted in figure 1. The examiner

Figure 1. Performance of the Craniocervical flexion test. The participant was in supine lying and performed incremental 5 stages of craniocervical flexion. The pressure cuff was inflated and placed under the suboccipital region

observed any trick movements that included excessive tucking of the chin or the activation of superficial cervical flexors during the procedure. A 30 second rest period was given after each stage.

The participant has to hold the neck isometrically in 5 increments of upper cervical flexion ('yes' like nod). The activation score was determined as the highest pressure level the participant achieved and held for 10 seconds. When the participant was unable to hold the position at a particular pressure for 10 seconds, the lower value was considered the activation score. [29]. The performance index, is a measure of the endurance of the DCF. Once the activation score is attained, the subject is asked to maintain that pressure level for a duration of 10 seconds. The number of times the participant maintains the activation score out of a maximum of 10 repetitions is the performance index. This was calculated by multiplying the pressure level achieved by the number of time the pressure was held and was considered as the endurance. [1, 23, 27, 29, 31, 42]. The activation score is indicative of the neuromotor activation of the DCF, while the performance index referred to the muscles endurance. Higher values (expressed in mmHG) indicate better neuromotor performance in terms of muscle activation and endurance [29].

Statistical analysis:

Statistical analysis was performed by SPSS version 16. Demographic characteristics were summarized using descriptive statistics. Baseline comparisons of age between

the groups were made using an independent sample t-test. Continuous data were reported using mean and standard deviations (SD). Performance index was expressed as median and interquartile ranges (IQR). The number of individuals that achieved a particular pressure level and held it for 10 seconds was considered for the analysis. A comparison CCFT scores between computer users and non – users was detected by a Mann Whitney U test. A Chi-square test was used to identify the relationship between the demographics and the activation and performance scores. Significance value was set at $p \leq 0.05$

Results

Table 1 depicts the demographic characteristics of the participants. 189 participants, 89 computer users and 100 controls participated. They had an average work experience of 4.84 ± 2.61 years, and their working hours per day averaged around 9 hours. The performance of the deep cervical flexors from the CCFT test was determined from the activation score and performance index (Table 2). The activation score showed significant difference between CU and the control group. The target pressure achieved was higher in the control group in comparison to the CU group.

The median performance index of the computer user group was 20 (IQR-12-30) as compared to 48 in the control group (IQR-40-56), ($p = 0.028$), as shown in Fig 2. Table 3 depicts the median activation score and

Table 1. Demographic characteristics of the participants (n = 189)

	Computer users (n = 89)	Non-users (n = 100)
Age in years (mean $\pm$ SD)	26.60 ± 2.65	25.4 ± 2.64
Gender (M/F)	43/46	52/48
Years of work (mean $\pm$ SD)	4.84 ± 2.61	–
Hours of work (mean $\pm$ SD)	9.19 ± 8.49	–

SD – standard deviation, M-males, F-females.

Table 2. Craniocervical muscle performance among participants (activation score and performance index)

Target pressure [mmHg]	Computer user (n=89)	Non users (n=100)	p-value
22	17	–	
24	33	1	$<0.001^*$
26	31	15	
28	8	52	
30	–	32	

Number that attained target pressure; *p-value – Mann Whitney U test

Figure 2. Comparison of performance index between computer users and non- users

Table 3. Age and gender wise distribution of Craniocervical flexion performance (activation score and performance index)

Age [years]	Gender	Computer user			Non users		
		Count N = 89	Activation score Median (IQR)	Performance index Median (IQR)	Count N = 100	Activation score Median (IQR)	Performance index Median (IQR)
20–25	Female	25	6(4–6)	24(12–32)	25	8(8–8)	48(40–64)
	Male	19	4(4–6)	20(16–24)	26	10(8–10)	56(46.50–70.5)
26–30	Female	20	4(2.50–6)	18(16–30)	23	8(8–8)	48(36–64)
	Male	25	4(4–6)	20(11–32)	26	8(8–10)	48(40–70.5)

N = Total number of subjects; IQR-interquartile range.

performance index, age and gender wise. The relation between the performance index and age was highly significant, $\chi^2 (112, N = 89) = 180.394, p < 0.001$. This indicates that the DCF endurance was dependant on the age. Also, the relation between the years of work experience and the performance index was significant, $\chi^2 (196, N = 89) = 249.8, p = 0.006$

Discussion

This study aimed at identifying and understanding the performance of the deep cervical flexors between CU and

non-users. It is based on the anatomical action of the deep cervical flexors, against the pressure biofeedback. This is a simple, reliable clinical test for assessing the cervical spine's muscle impairments requiring minimal instrumentation [1, 23, 24]. These deep cervical flexors, mainly the longus capitus and longus colli, have an anatomical action of reducing the cervical lordotic curve [38, 39].

Our study revealed that the activation score of the deep cervical flexors by the computer users was significantly less than that of the control group. This establishes our hypothesis of prolonged sitting and constant neck postures affecting the activation of the neck core muscles. The possible mechanism for this has been explained in similar

studies wherein the postural neck muscles demonstrate an increased muscle activation. Jull and Falla, in their study, affirmed the inverse relationship between the superficial neck flexors and DCF, as, with increased activation of the superficial neck muscles, there was a reduced activation of the DCF [30]. This could indicate the presence of altered muscle activation strategies. Studies suggest that physically stressful work conditions increase the electromyography activity in the postural neck muscles [50]. It has even been established in computer users that there is an increased motor response as the psychological work stressors increase. However, this response was noted in the superficial neck muscles [53]. We assume that the altered muscle strategies due to prolonged static postures cause this change. Similar studies have also explained some motor mechanisms associated with increased activation of the postural muscles, even in asymptomatic computer users [48–50]. A similar compensatory strategy must have occurred in our group of computer users. However, compensatory strategies vary from subject to subject [19].

In our study, age showed no association with the activation score but showed a significant association with the performance index ($p < 0.001$). When performed on adolescent and young adults, a similar association of age and muscle performance was identified [25]. However, some studies found age having no association with the neck muscle performance [32]. There was no association with gender and the performance of the DCF in our study. These findings are similar to those previously established, indicating no influence of gender on the performance in the CCFT test [10, 31]. Years of work was also associated with cervical muscle performance. This could be due to maintaining constant postures which may cause an enhanced coactivation of the supporting muscles, and has been supported by studies associating more work hours at the computer with the development of musculoskeletal pain [45].

Several authors have identified neck muscle impairments in neck pain patients [10, 15, 26] and the effect of strengthening the DCF on neck pain [3, 4, 6, 21, 28, 51]. However, to our knowledge, this is the first study to quantify the neck muscle performance in the asymptomatic population of an ergonomically vulnerable group. Our results identify cervical muscle impairment in computer users that may predispose an individual to neck dysfunction. Also, the reduced performance index suggests decreased deep cervical flexor endurance. It can be hypothesized that CU adopt a posture of cervical extension, which may reduce the activation of the deep cervical flexors [41].

Exercises are considered as a primary intervention for patients with neck pain [21, 46]. Studies demonstrate the effectiveness of cervical motor control training in individuals with neck pain [14, 37, 52]. The results of this study can be used as a basis for exercise prescription to improve DCF performance as an ergonomic intervention for all

employees exposed to computers for a long duration of time. The strengthening of DCF has been proven effective in reducing disability and symptoms of the neck and upper extremity, which can also correct the neck slope angle [10, 16]. Longitudinal studies may explore the effectiveness of cervical motor control training in preventing neck pain in individuals using visual display units.

Future studies could screen computer users at regular intervals in order to identify impairments in posture and deep cervical performance. Since our study was a one time evaluation and suggests weakness of the DCF a regular screening is warranted.

Limitations

We did not perform a sample size calculation. However, we feel that our number was sufficient to be able to explore our hypothesis. Our population consisted of users who were young. Hence we cannot generalize our results to an aging population. We did not measure superficial muscle activity during CCFT using electromyography. This could have affected our results. However, we feel that CCFT is an excellent clinical method to assess the performance of the craniocervical flexors objectively.

Conclusion

Computer users have lower activation and performance of the deep cervical flexors compared to non-users. Additionally, the age and years of work experience affected muscle endurance in this population. The study findings pave the way for a potential role in strengthening the cervical muscles in an asymptomatic population of computer users.

Conflict of interest: Authors state no conflict of interest.

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