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Original Article

Effects of Document Holder on Postural Neck Muscles Activity among Computer Users: A Preliminary Study

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ABSTRACT

Background: Computer users are exposed to work related neck disorders due to repetitive movement and static posture for prolonged period. Viewing document and typing simultaneously are one of the contributing factors for neck disorders.

Methods: This preliminary study was conducted to evaluate the effects of the document holder on the postural neck muscles activity among computer users. Nine healthy participants with pre-defined inclusion and exclusion criteria were recruited for the study. Neck muscles activity were analyzed using the surface electromyography (EMG) in five different document location such as flat right, flat left, flat center, stand right and stand left during a 5 min typing task.

Results: The mean and standard deviation results showed a least amount of muscles activity using a document holder compared to without document holder. Nevertheless, the statistical analysis showed no significant differences between the using of a document holder.

Conclusions: The effects of document holder on head excursion and neck muscle activity is recommended in clinical neck pain population.

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Introduction

Neck and upper limb symptoms are the common problem among computer users[1]. The occurrence of neck pain among computer users has been highly related to work associated risk factors in the office[2]. Based on the statistics by the task force on neck pain, an average of 36 to 57.5 of every 100 computer users were confirmed of having neck pain[3]. Subsequently, a tremendous increase in the incidence of neck pain has also caused an extensive economic cost due to expenditure on the healthcare, work absenteeism, insurance coverage and burden on health care support[4]. For example, in Netherlands, only 23% of expenses were used for direct cost such as injury and healthcare whereas 77% of the expenses were spent on indirect cost such as work absenteeism and decrease of productivity for a total of $US 686 million approximately[5]. In addition, chronic occupational disorders if left untreated, may lead to mental health disorders such as anxiety and depression[6]. Several factors cause work related neck disorders including working in a static posture for an extended period, repetitive job task movement such as typing and viewing document, sustained sitting postures, over excursion of neck muscles and poor alignment of head as well as neck for long hours[7,8].

The job task to view computer screen and documents during typing demands the computer users to sustain the neck in a forward bent posture for a prolong period[9]. Adding more, the repetitive movements at work for an extended duration of time to view the document and typing, significantly contribute to neck pain[9]. People with neck pain had muscle imbalances in the neck and upper shoulder region, abnormal posture and developed muscle tension in the long run[10]. The abnormal posture and increase in muscle tension may precipitate the onset of muscle stiffness and increase the pain in the neck and shoulders which may lead to detrimental work related musculoskeletal disorders[11,12]. Even though medication and therapeutic measures have been taken to prevent the occurrence of neck pain, computer users still experience the recurrent episodes of neck pain because of the poor workstation ergonomics and lack of information on postural education. Hence, a thorough knowledge is requisite on the modifiable work related risk factors in the work environment to prevent the recurrence of neck pain among computer users.

A document holder is an ergonomically designed office item important at the work environment of computer users during the typing task. It is used to hold any written or printed document to be viewed by the computer users while typing. The document holder reduces the neck and shoulder symptoms by holding the head and neck in an upright

position[13]. The neutral position adopted by the computer users while using a document holder reduces the cervical extensors load and strain on cervical structures gradually[13–16]. Consequently, the natural curve of the spine is maintained and computer users may work productively as document holder reduces the muscle fatigue working for long hours[17]. However, the above studies had not considered the effect of document holder on the upper quadrant muscles that contributes to neck pain during occupational typing task.

Work related risk factors such as prolonged static neck and poor upper limb postures together with viewing different screen angles and typing task have been associated with continuous low-level muscle activity in the neck-shoulder stabilizers[17,18]. Over excursion of neck and upper limb muscles, has contributed to neck pain. However, the changes that may happen in neck while using a document holder is a matter of contravention.

The aim of this study was to evaluate the effects of the document holder on the postural neck muscles activity among computer users. It will enhance the knowledge of ergonomists and clinician on the effects of document holder.

Methods

Subjects

An experimental study design with repeated measure method was adopted in this study. This preliminary study was conducted among 9 healthy participants aged between 20 - 32 yr participants, recruited by convenient sampling method from the public university predefined to the given inclusion and exclusion criteria. Selected participants worked for a minimum of 4 h daily on computer. Participants with a history of cervical fracture or trauma, cervical surgery, idiopathic scoliosis and those who required bifocal or graduated glass during a computer use were excluded from the study[13]. The participants were recruited in the absence of any neck pain during the last 7 d prior to the experiment or on the day of testing[13]. If the participants complained about the neck pain in past 12 mo, it should had been resolved at least 3 mo before the study[17].

As for ethical issues, the first author briefed the study procedures to the participants. A written informed consent was obtained from the participants prior to the experiment. The study received ethical approval from Universiti Kebangsaan Malaysia institutional Ethics Committee with ethical code NN-059-2014.

Workstation

A standardized computer workstation based on Occupational Safety and Health guidelines was set up before evaluating with the various document locations[19]. The working desk was at the range of 600-750 mm. The screen was positioned in the center of a range of not less than 400 mm with the upper edge of the screen at a height lower than the eye level. A chair with an adjustable height and good backrest were provided. The working arrangement such as position of the screen, keyboard, document and document holder were identical for all the participants. The procedure for typing task was adopted from an established protocol[13]. The typing protocols were developed by instructing the participants to type a short story in the word document on the computer screen. The participants were asked to type in normal pace and any typing errors made were ignored. Such a typing protocol was followed in order to induce a natural way of typing task without any extra attention required from the participants during typing. The document was placed on five different document locations and the participants were instructed to type from the document placed in each location. Five document locations adopted were flat left; flat right; flat center; stand left and stand right. Table 1 shows the description of each location that was used in the study.

Table 1: Document location and the positions

Document location	Positions
Flat left	Document were kept on a flat surface on the left side of the participants beside the keyboard
Flat right	Document were kept on a flat surface on the right side of the participant beside the keyboard
Flat center	Document were kept on a flat surface between the keyboard and screen in front of the participants
Stand left	Document were kept on a document holder on the left side of the participants beside the keyboard
Stand right	Document were kept on a document holder on the right side of the participants beside the keyboard

Surface electromyography (SEMG)

The muscle activities of the neck and upper limbs were studied using surface electromyography (SEMG) by measuring the muscle amplitude (root mean square). An eight-channel surface electromyography (MYO420 EMG unit, Motion Lab Systems Inc, USA) was used to record the activity patterns of upper trapezius, lower trapezius, and anterior deltoid and cervical extensor muscles in this study. Eight pairs of 10 mm Ag/ AGCI diameter electrodes were used to assess the four muscles.

The electrode placement area was cleaned with abrasive gel and alcohol and shaved if necessary to reduce the skin impedance[20,21]. The electrodes were placed parallel on the muscles with an inter-electrode distance of 2.5 cm according to the locations based on the recommendations for surface EMG for non-invasive assessment of muscles (SENIAM) (Table 2)[22]. The subjects were explained briefly about the normalization movements for each muscle for familiarization prior to the MVC. Subjects were asked to perform three maximum voluntary contractions with 2 min rest between each contraction based on the established studies protocol on SEMG[21,23,24]. The average of the 3 contractions was taken for the normalization for the typing task activity and the EMG data were expressed in percentages (% MVC).

Table 2: Electrode placement for each muscle based on the SENIAM Guidelines:

Muscle	Placement
Cervical erector spine (CES)	Lateral to C5 spinous process
Upper trapezius (UT)	In the mid-point between the tip of acromion process to the spinous processes of C7 line
Lower trapezius (LT)	In two third of the line between the trigonum spine of scapula to the spinous processes of T8 line
Anterior deltoid (AD)	Distal and anterior from the tip of acromion process with a distance of one finger width

Procedure

The participants were instructed to sit in an upright position with the arm supported and foot rested on the floor

in the standardized computer workstation. Each participant typed for 5 min in each of the locations respectively. The duration of 5 min to test the muscle activity was decided based on a previously recommended protocol.[13] The participants were restricted from using mouse and spelling error was ignored. The participants were told to type on their normal pace of typing speed to minimize the errors related with typing speed and typing force[24]. The measurements of EMG were taken for each participant with a period of 5 min rest between each document location[13]. A single researcher assessed all the participants. The SEMG data signals were processed with a high pass filter at 10 Hz, a low pass filter at 500 Hz, amplified (gain, 1000) and sampled at 2000 Hz. The final data were processed through the Myon ProEMG software, USA and expressed in terms of root mean square (RMS).

Statistical analysis

The sample size was calculated for repeated measure design and 9 subjects (9 subjects x 5 document location – 45 measures) was considered as an adequate sample size for this study. Data were analyzed using statistical software package SPSS (Version 20.0, Chicago, IL, USA). The significance level set was at 0.05 with 95% confidence limits in all of the analyses. The data were normally distributed based on the Shapiro-Wilk test. The mean of each trial between the different document locations was compared. For statistical analysis, one-way repeated measure ANOVA was used to test statistically significant differences between muscle activities in different document locations.

Results

All the participants were right hand dominant. The mean (SD) of the age was 25.38 (5.37). All of them prefer the computer screen positioned in the center. The preferred document location was between the screen and keyboard for all the participants. Seven participants had used document holder previously. Six participants exercises more than two times a week whereas the rest once or sometimes in a week.

Table 3 shows the mean and standard deviation of the postural neck muscle activities. The least muscle activity was seen in the stand right position followed by flat center. High muscle activity could be seen in both flat right and flat left. Figure 1 shows the detailed graph on the mean and standard deviation of the muscle activity based on each location. Generally, the mean and standard deviation shows high muscle activity without the document holder. When the results were examined statistically, there were no significant differences between the muscle activities based on the five document locations (Table 3).

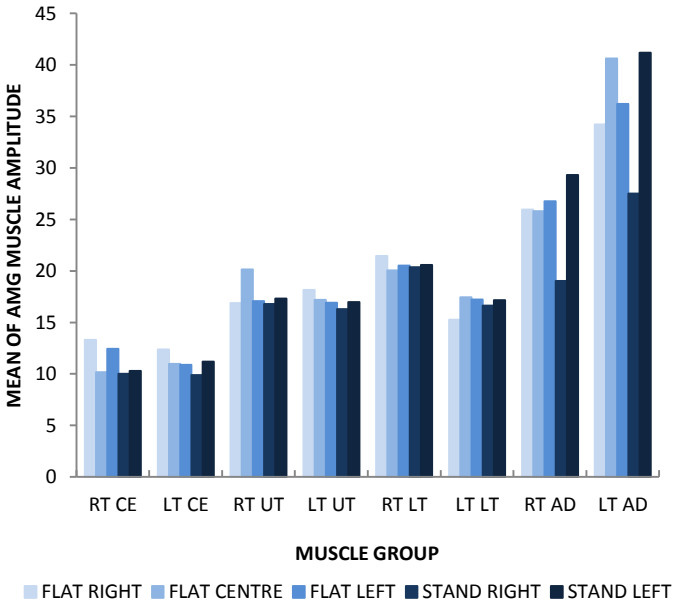

Figure 1: The effects of document position on muscle activity in 5 different document locations

Table 3: Values of EMG amplitude for muscle contraction for five-document placement

	Mean ±SD EMG of muscles					Repeated measure	
Group	**Flat right**	**Flat center**	**Flat left**	**Stand right**	**Stand left**	**F**	***P* value**
Right Cervical Extensor	13.32 ±3.36	10.18 ±5.25	12.44 ±3.92	10.03 ±5.42	10.28 ±5.83	2.519	0.061
Left Cervical Extensor	12.38 ±4.03	10.98 ±5.05	10.87 ±5.00	9.89 ±4.70	11.20 ±5.27	0.899	0.476
Right Upper Trapezius	16.87 ±9.60	20.15 ±5.90	17.08 ±6.47	16.78 ±8.01	17.32 ±9.09	0.577	0.681
Left Upper Trapezius	18.15 ±6.36	17.18 ±10.86	16.92 ±8.52	16.30 ±8.23	16.98 ±11.90	0.398	0.685
Right Lower Trapezius	21.46 ±12.45	20.04 ±10.88	20.53 ±11.20	20.35 ±12.00	20.58 ±11.90	1.084	0.381
Left Lower Trapezius	15.28 ±19.30	17.45 ±20.40	17.21 ±10.30	16.64 ±10.20	17.17 ±10.60	1.289	0.295
Right Anterior Deltoid	25.95 ±3.74	25.81 ±11.44	26.75 ±11.20	19.04 ±11.60	29.30 ±6.58	2.491	0.063
Left Anterior Deltoid	34.22 ±16.36	40.63 ±23.18	36.21 ±19.30	27.51 ±17.20	41.20 ±25.40	1.519	0.220

Discussion

The purpose of the study was to evaluate the effects of document holder on neck muscle activity among computer users during typing task. From the mean and standard deviation, it can be interpreted that the lowest muscle activities between the document locations were on the stand right position. The highest muscle activities were seen in flat left and flat center position. Muscle activity has a significant effect on the angle of screen and document position[16]. Prolong head position elevates the activity of neck muscles with prolong neck flexion causing more strain on the cervical structures[20,25–27]. Therefore, the placement of the document holder may reduce the muscle-firing pattern and reduce the continuous low threshold load on the cervical structures among the computer users.

The cervical extensors (CES) are the main muscle which controls the dynamic ipsilateral movement of neck lateral flexion and rotation[27]. CES muscles are conversely employed by both asymptomatic and symptomatic computer users during their job task[17]. Thus, CES were taken to compare the muscle activity during different document location. Based on our results, a high muscle activity of both right and left CES seen on the flat right and flat left document position. This might be due to the prolonged static posture of the computer users on the flexion position of the neck and in addition to repetitive rotation movement viewing the document. Several studies presented the incidence of neck pain with repetition of

stress and constant static loading on cervical structures with increased degree of flexion and rotation of the head and neck[27,28]. In the current study, a low CES mean muscle activity was seen on the stand right document position. A past study that investigated the position of the document holder also supported reduced load of the neck extensor musles.[13] Thus, the current study findings are comparable with previous findings as both showed reduced muscle work when a document holder was used during the typing task. This evidently suggests that typing without using a document holder increases the muscle activities of the cervical extensors, which may eventually contribute to the development of neck pain. With only few limited studies available on the topic of the effects of document holder on head excursion and neck muscle activity, further studies are definitely needed to establish the benefits of document holder in day-to-day practice.

Upper trapezius (UT) accounted as one of the important muscle in occupational task especially computer related job[10,13,17]. The current study has also taken upper trapezius as one the main muscle in analyzing the muscle activity. A very high muscle activity could be seen on the flat right and flat center; whereas the lowest UT activity was seen in the stand right position, followed by the stand left and flat center position. The static load of the UT as well as the repetitive movement could possibly increase the muscle activity of UT in the EMG reading. Prolonged muscle activity in static condition as well as repetition of movement increases the static muscle tension[10]. Low muscle activities of UT have been seen on the stand right position compared to other positions. Few past studies justified the findings of decreased muscle activity of upper trapezius as they reported an increase in trapezius muscle EMG activities when the screen or document placed in lower angle or without document holder[16,20,26]. It implies that using a document holder may decrease the muscle load to upper trapezius.[16] Thus, according to our findings, using a document holder may decreases the muscle activity UT and hence, it should be considered by computer users.

The lower trapezius (LT) is indicated as one of the static scapular stabilizer in supporting the spine and shoulder girdle during typing tasks[17]. The lower part of trapezius helps in taking the load and tension of the upper trapezius in a continuous static workload during computer task[29]. Although, stand right comparatively shows the lowest muscle activity in the right lower trapezius, there are no significant statistical differences in the lower trapezius comparing different document placement. Hence, document holder may be considered in reducing neck strain during computer task as lower trapezius work as the strain reliever for the upper trapezius in prolong typing task viewing document.

The anterior deltoid (AD) is one of the main agonist in the upper arm and dynamic mover of the shoulder joint during the forward flexion movement in the upper arm during typing task[17,30]. Based on the study results, both the right and left anterior deltoid shows large muscle activity compared to other muscles. These could be possibly due to the continuous typing task by the subjects and the anterior deltoid is the dynamic mover of the upper arm. The lowest muscle activities of the anterior deltoid have been seen in the stand right position followed by stand left. Hence, the results support that typing without document holder increases the muscle activities and fatigue the muscles in the end.

The prolonged low level sustained static muscle tension during the typing task results in the increase of muscle firing during electromyography reading[31]. The awkward posture and static muscle load on the cervical structures while viewing computer screen or document leads to pain and fatigue[32]. Adding more, the repetitive movement of the computer users in viewing the document and typing for a prolong period of time in an awkward posture of the neck and shoulders exposes the computer users to the risk of neck pain disorders[31,33]. The use of a document holder in viewing the document possibly might help to reduce the strain and stress on the cervical structure and promote better ergonomic workstation for the computer users.

The main limitation of the current study is the small sample size. Nevertheless, the design of the study warrants repeated measure design which gives an adequate number of sample size been measured. Another limitation may be the short duration of the typing task of 5 min during which the muscle activity was tested. We acknowledge that it may be possible that the muscle activity will differ in case of prolonged typing task of longer duration. However, the decision for selecting a shorter duration was supported by a previously established protocol that was followed in current study. Further studies with larger sample size investigating the effects of document holder on head excursion and neck muscle activity is warranted to make recommendations in clinical practice for neck pain population.

Conclusions

Placing the document holder in stand right position accounts lesser muscle activity compared to other position of the document. An in-depth knowledge and information on the benefits of document holder would be able to impose a good ergonomic and positive workplace station for the computer users.

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