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DEVELOPMENT OF THE ERGONOMIC NECK POSTURE LEVEL BY USING ELECTROMYOGRAPHY METHOD

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Abstract

Comfortable level of the neck posture on flexion and extension in working with visual display terminal (VDT) is an important position to alleviate neck discomfort. This paper presents a study to determine an appropriate range of flexion and extension to neck when working with VDT for Indonesian. Empirical study was conducted in ergonomic laboratory to identify those range levels. 70 subjects (35 males and 35 females) participated in this study. They were instructed to typewrite a document for 30 minutes on each position. Signal contraction on cervical erector spinae (CES) was recorded by using Electromyography and normalized into Maximum Voluntary Contraction (MVC) data. Statistical analysis was conducted to test the MVC difference between males and females. The study reveals that the maximum comfortable posture level is in the range of 30° below Ear-eyes Line (20%MVC) for flexion and 30° above Ear-eyes Line (17.42%MVC) for extension. This is proven to be valid for both males and females at 5% of significance level.

Keywords: CES; Electromyography; Flexion and Extension; MVC; Neck

1.0 INTRODUCTION

In Indonesia, the growth of computer use in company accounted for 92% of the overall computer use of the country [1]. This proportion still escalated up to 2012 which comprised of 7.45% in 2010, 6.89% in 2011 and 6.46% in 2012 for personal computer and 6.44% in 2010, 8.80% in 2011 and 12.19% in 2012 for laptop respectively [2].

However, computer use at works can increase the risk of musculoskeletal disorders especially on cervical region (WMSDs) [3]. Furthermore, some studies unveiled that such disorder was caused by poor posture of neck, longer work, and position of computer monitor and keyboard [4,5,6].

The position of head when seeing VDT is extremely considerable to investigate when it is in an unnatural position [7]. Several studies in some countries indicate the use of computer has higher prevalence in neck and upper extremity disorder. There are about 23% of musculoskeletal disorders among 27.25% of workers experiencing neck ache and backache leading to the highest rate of absence from work in Europe [8]. A study in India also discovers that there

are prevalence between musculoskeletal disorders (MSDs) and computer use in neck up to 38.6% beside low-back pain, upper back, hand/wrist, and shoulder [9].

Some researches that studied about comfort angle in seeing VDT such as, [10] suggested that visual target should be located between 10-35° when sitting. [11] Studies on "comfortable" head/neck posture discovers that visual target is best placed at 7.7° above horizontal line. Furthermore, [12] suggests that VDT position should be located between 0-60° below horizontal eye-height; if height of VDT cannot be adjusted it must be accommodated by 95th percentile.

In the present study, Electromyography investigation is applied to evaluate Cervical Erector Spinae (CES) contraction in various neck angle flexion and extension to find comfortable angle of neck posture.

2.0 METHOD

Subject

Seventy university students (35 males and 35 females) participated in this study. All participants have experienced using computer for work for at least 3 years. They used computer for twice a week and two hours for every use with no chronic medical history of musculoskeletal disorder in neck [7,13,14].

Apparatus

The main tools used in these study was Electromyography (Lab Quest 2: Vernier Tech & Soft, Texas, USA) to investigate muscle contraction on neck. Raw signal was recorded and normalized into a percentage data of Maximum Voluntary Contraction (MVC). Two set of personal computer was used in this study, first computer to record muscle contraction and second computer to display the task. The signal was identified by electrodes as sensor adhered on skin.

Experimental Design

Experiment was conducted in Ergonomic Laboratory requiringeach respondent to sit in front of VDT within 80 to 100 cm distance for comfortable position in seeing a monitor. It required ten minutes for exercise and five minutes for setting the equipment while thirty minutes for real experiment [14]. 7 angles used in this study were -45°, -30°. -15°, 0°, +15°, 30°, and +45° based on Ear-eye line. Ear-eye Line (EEL) is defined as a line that connects thecenter of the outer canal of the ipsilateral ear to outer

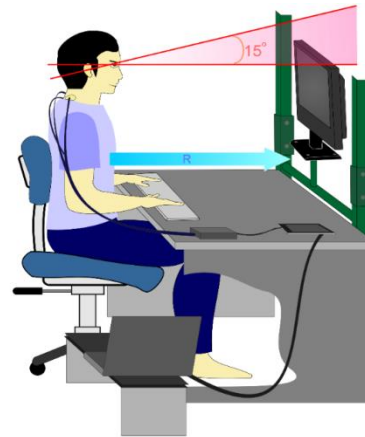canthus of the eyes [7]. Fig 1 shows the experiments design.

Fig. 1. Experimental layout in this study

Task

Each participant was instructed to type a full text using KeyBlaze Typing Tutor v2.14 (NHC Soft). All materials which were presented by the software and an automatic typing cannot be procceded if there are mistakes. No wonder, typing should be exactly the same with the software displayed.
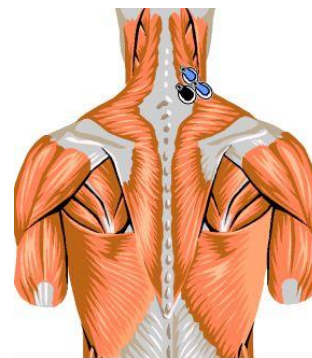
Procedure

Fig. 2. Electrodes placement at CES

Identifying location of Cervical Erector Spinae (CES). Location of CES shown at Fig. 2 [15]. Each participant was given information about aim of the study and everything that participant needs during the experiment. Before the experiment started participants were asked to sit and grip keyboard comfortably. After the experiment was done participant were instructed to shrug their shoulder to record MVC data for three times. Average data of MVC was used in the analysis.
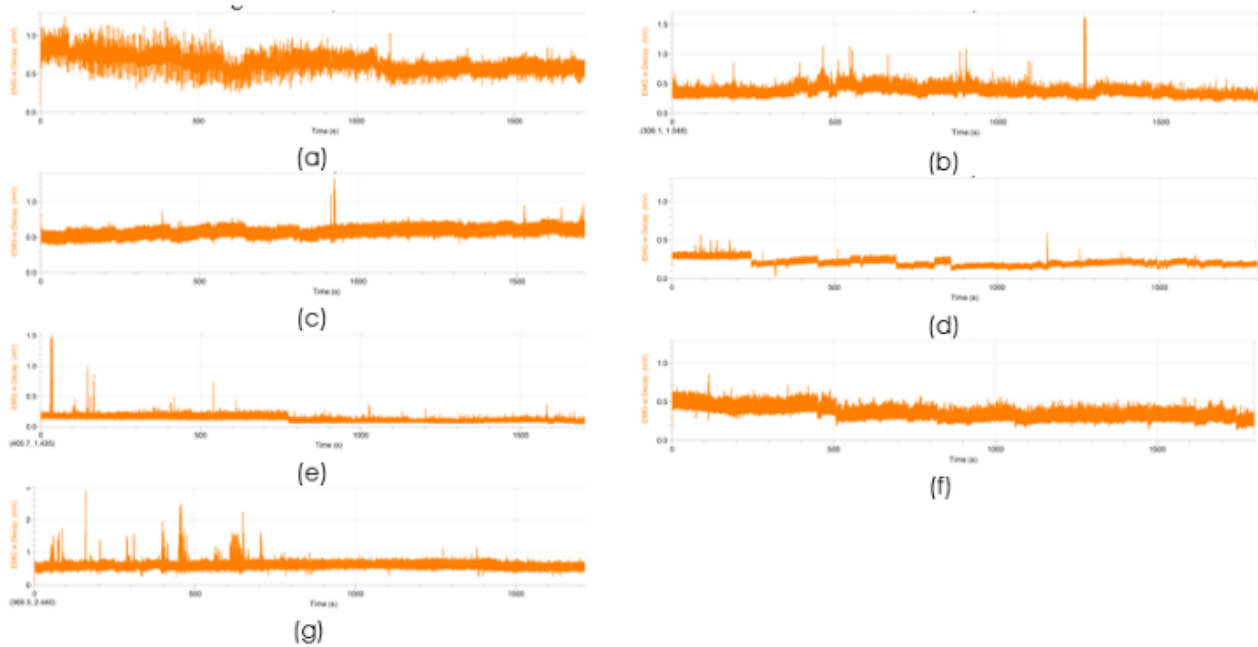
3.0 RESULTS AND DISCUSSION

Fig. 3. RMSE Signals at (a) 45° above EEL (b) 30° above EEL (c) 15° above EEL (d) accordance with EEL EEL (e) 15° below EEL (f) 30° below EEL (g) 45° below EEL

Analysis of EMG Signals

Fig. 3 illustrates that RMSE signals muscle contraction graph and score are (a) at 45° above EEL or 60° above horizontal with 0.07503 mV, (b) at 30° above EEL or 45° above horizontal with 0.06773 mV, (c) at 15° above EEL or 30° above horizontal with 0.04208 mV, (d) at accordance with EEL or 15° above horizontal with 0.03683 mV, (e) at 15° below EEL or in line with horizontal line with 0.03592 mV, (f) 30° below EEL or 15° below horizontal with 0.04619mV, (g) and 45° below EEL or 30° below horizontal with 0.07912 mV. This indicates that there are increment of RMSE score alongside with more flexes and extents of neck angles. It is because seeing VDT in higher angle requires higher muscle contraction that is conducted for long period. It is also presented by the graph that shows higher fluctuation when neck angles become more flexes and extents.

Fig. 4 showed the result of average percentage MVC (%MVC) for males (blue), females (red) and both males and males (green). Percentage of MVC scores for muscle contraction at 45° above EEL is 30.29% for males, 58.14% for females, and 44.22% for both. Muscle contraction at 30° above EEL is 14.25% for males, 20.58% for females, and 17.42% for both. At 15° above EEL is 13.81% for males, 20.68% and 17.25% for both. For accordance with EEL is 14.55% for males, 16.73% for females and 15.64% for both. At 15° below EEL muscle contraction is 15.75% for males, 15.14% for females, and 15.45 for both. In addition, muscle contraction at 30° below EEL is 22.96% for males, 17.05% for females and 20% for both. While muscle contraction at 45° below EEL is 23.11% for males, and 36.59% for females and 29.85% for both.
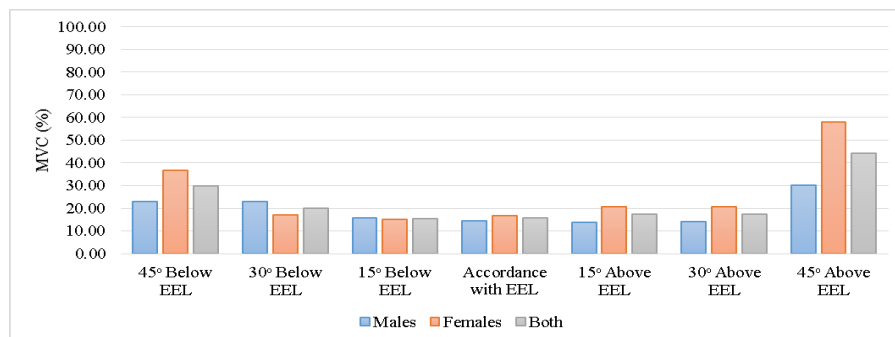

Fig.4. MVC Score of muscle contraction

The highest score for both males and females from each muscle is shown at 45° above EEL with 44.22 %MVC and then followed by 45° bellow EEL with 29.85%. It is also means that on those angles may produce high muscle contraction and exceeded the threshold for long period use at 25% MVC [16]. While the other angles are still safe to use.

Statistical Analysist

Kruskall-Wallis test was performed to describe the difference of muscle contraction (%MVC). There was significant difference between muscle contractions in each angle at 5% significance level. Mann Whitney test is used to describe significant difference for each angle.

Table 2. Table 2 Result of Mann Whitney test for posture level between males and females

Angles	Sig.	Decision
45° Below EEL	0.175	No Difference
30° Below EEL	0.175	No Difference
15° Below EEL	0.754	No Difference
Accordance EEL	0.917	No Difference
15° Above EEL	0.175	No Difference
30° Above EEL	0.047	Difference
45° Above EEL	0.117	No Difference

Table 1. Result of man whitney test for each angle

	45° Below EEL	30° Below EEL	15° Below EEL	Accordance to EEL	15° Above EEL	30° Above EEL	45° Above EEL
45° Below EEL	-	0.11*	0.00	0.03	0.02	0.02	0.13*
30° Below EEL	0.11*	-	0.22*	0.29*	0.49*	0.49*	0.00
15° Below EEL	0.00	0.22*	-	0.82*	0.45*	0.29*	0.00
Accordance to EEL	0.03	0.29*	0.82*	-	0.54*	0.40*	0.00
15° Above EEL	0.02	0.49*	0.45*	0.54*	-	0.88*	0.00
30° Above EEL	0.01	0.49*	0.29*	0.40*	0.88*	-	0.00
45° Above EEL	0.13*	0.00	0.00	0.00	0.00	0.00	-

*p>0.05 not significant

Table 1 shows the result of Mann Whitney test. It presents differences among MVC score in each angle. There were significant difference in MVC score between 45° below EEL and 15° below EEL, 45° below EEL and accordance with EEL, 45° below EEL and 15°above EEL, 45° below EEL and 30° above EEL. At 30° above EEL there is significant difference at only 45° above EEL as well as at 15° below EEL, in accordance with EEL, 15°above EEL, and 30° above EEL which were different significantly only with 45° above EEL. And there were no significant difference among the other angles. Thus, it indicates and supports the result of %MVC score above.

Table 2 shows result of Mann Whitney test for each angle between males and females. It presents that there are no difference between males and females at 45° below EEL, 30° below EEL, 15° below EEL, in accordance to EEL, 15° above EEL, and 45° above EEL. But there is only difference between males and females at 30° above EEL. However, because the average value of muscle contraction scores at 30° above EEL is 20.58% for females and 14.25% for males, this angle does not exceed the threshold and is still safe to use.

4.0 CONCLUSION

Based on the analysis, it can conclude that :

a. Comfortable range of neck posture level for extensions of Indonesia is at 30° above Ear-eye Line or 45° above horizontal line.
b. Comfortable range of neck posture level for flexion of Indonesian is at 30° below Ear-eye Line or 15° below horizontal line.
c. It is valid for both males and females at 5% of significance level.

Acknowledgement

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