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Comparison of Muscle Activity for Sitting and Standing Positions on a Computer Workstation

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Abstract: Computerized systems and technology have promoted productivity and communication among workers and organizations. While we enjoy these advantages, the extensive use of computers has its shortcomings, such as increased cases of physical and occupational problems, particularly cumulative trauma disorders (CTDs). This is due to the prolonged usage of visual display units. The cases of CDTs are on the increase, with an exorbitant cost of compensation. This study aims to compare the muscle activities of the upper and lower extremities using an adjustable computer workstation in sitting and standing positions. Four males participated in this experiment. EMG sensors were placed on the 'participants' Trapezius, Erector Spinae, Rectus Femoris, and Gastrocnemius muscles. The experiment comprised of 30-minutes of typing on an adjustable computer workstation, and EMG data were collected in both sitting and standing positions. The participants provided a subjective rating of bodily discomfort and preferred position at the end of the experiment. The result shows a slight difference in all muscle activities. The Mean Absolute Value (MAV) of the Trapezius muscle in the standing position was 9.87% higher than in the sitting position. The Gastrocnemius, Rectus Femoris, and Erector Spinae had a difference of 7.70%, 8.04%, and 7.52%, respectively. While the muscle activity for the Trapezius, Gastrocnemius, and Rectus Femoris was higher in the standing position, the Erector Spinae had higher muscle activity in the sitting position. While the self-reported bodily discomfort levels were generally low, the preferred position among the participants varied, although the standing position was the least preferred one.

Keywords: EMG, Visual display unit, Muscle Activity.

1. Background and Objective

Computerized systems and technology have improved 'workers' productivity and organizational communication. Although we enjoy these benefits, its drawbacks, such as physical and occupational issues, are on the increase. Research has shown that prolonged use of visual display systems can result in cumulative trauma disorders (CTDs) (Park et al., 2000). Millions of workers have complained about CTDs, and the cost of compensation is astronomical (Bernard & Putz-Anderson, 1997). Bergqvist et al. (1995) researched musculoskeletal disorders among visual display terminal workers and identified static working posture as an important ergonomic variable. Gao et al. (2016) compared the work time muscle activity patterns and spinal shrinkage among office workers who used either a sit-stand workstation or a traditional sit workstation. They concluded that working with sit-stand workstations can promote more light muscle activity time and less inactivity without adverse effects on spinal shrinkage.

In a 60-minute task, Park et al. (2000) examined the effects of sitting on five upper extremity muscles: the Flexor Digitorum Superficialis, Extensor Digitorum, Medial Deltoid, Trapezius, and Erector Spinae. They noted that the participants exhibited more muscle activity using the regular workstation than the experimental chair. In the past, researchers have studied the muscle activities of the upper extremities while seated on a display unit (Barbieri et al., 2019; Gao et al., 2016; Seghers et al., 2003); however, there are no studies on the muscle activities of the lower extremities. This study aims to compare the muscle activities of the upper and lower extremities using an adjustable computer workstation in sitting and standing positions.

2. Materials and Methods

Four males between the ages of 24 and 27 voluntarily participated in the experiment. The mean height and weight values were 170.60 ± 6.87 cm and 78.54 ± 14.73 kg, respectively. All participants were healthy and had no musculoskeletal disorders. The apparatus used for this experiment was the Bagnoli-8 Channel EMG system, an adjustable workstation, and a visual display unit.

The experiment was carried out in a controlled lab environment. EMG sensors were placed on the 'participants' upper extremity muscles (Trapezius and Erector Spinae) and lower extremity muscles (Rectus Femoris and Gastrocnemius) for the sit-stand experiment (Figure 1). The experiment comprised of 30-minutes of typing on the adjustable computer workstation; EMG data were collected for both the sitting and standing positions. The workstation was adjusted to the comfort of the participants. The experiment was randomized, and there was a 24-hour rest period between each position to prevent the accumulation of stress on the muscles. After each trial, the participants provided a subjective evaluation of bodily discomfort and preferred position.

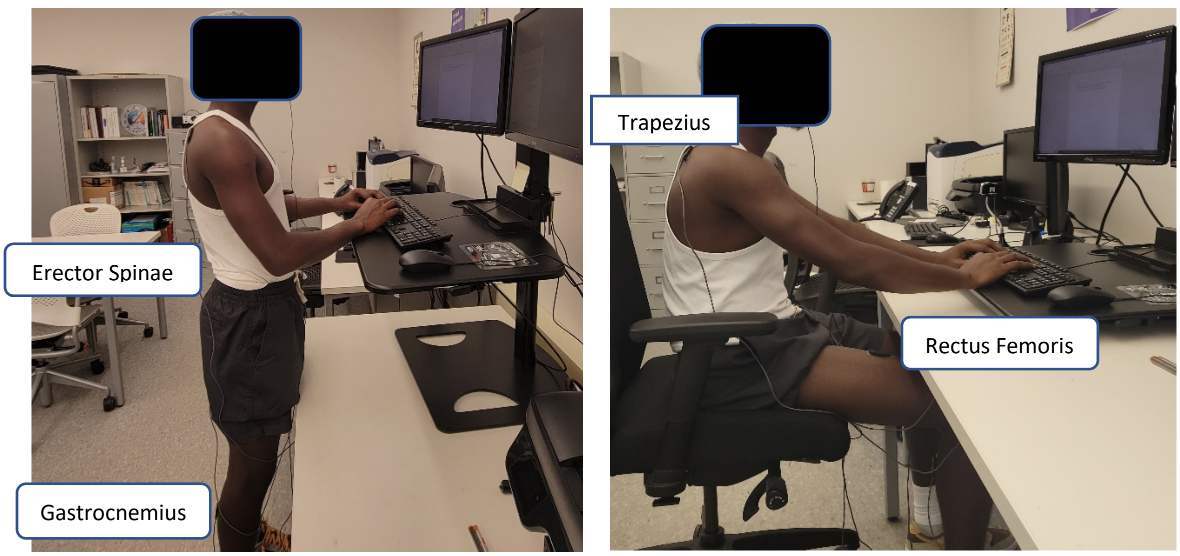

Figure 1(a): Standing position; (b): Sitting position

3. Results and Conclusions

A paired t-test was conducted to compare the muscle activities in the sit and stand experiments. The level of significance was centered on a predetermined alpha level of 0.05. The analysis was done independently for each muscle for the participants, in the sit-stand positions while using the adjustable workstation. The paired t-test analysis shows a difference for all muscle activities. Next, the percentage difference of the Mean Absolute Value (MAV) of the muscle activity between each position was computed. The result shows a slight difference in all muscle activities, with the Trapezius having the highest percentage difference. The MAV of the Trapezius muscle in the standing position was 9.87% higher than in the sitting position. The Gastrocnemius, Rectus Femoris, and Erector Spinae had a MAV difference of 7.70%, 8.04%, and 7.52%, respectively. The MAV for the muscle activities is shown in Figure 2. While the MAV of the muscle activity for the Trapezius, Gastrocnemius, and Rectus Femoris, was higher in the standing position, the Erector Spinae had higher muscle activity in the sitting position. The higher muscle activity for the Trapezius for the standing position could be attributed to the use of an armrest in the sitting position. The resulting analysis shows that the standing position requires more muscle activities except for the Erector Spinae.

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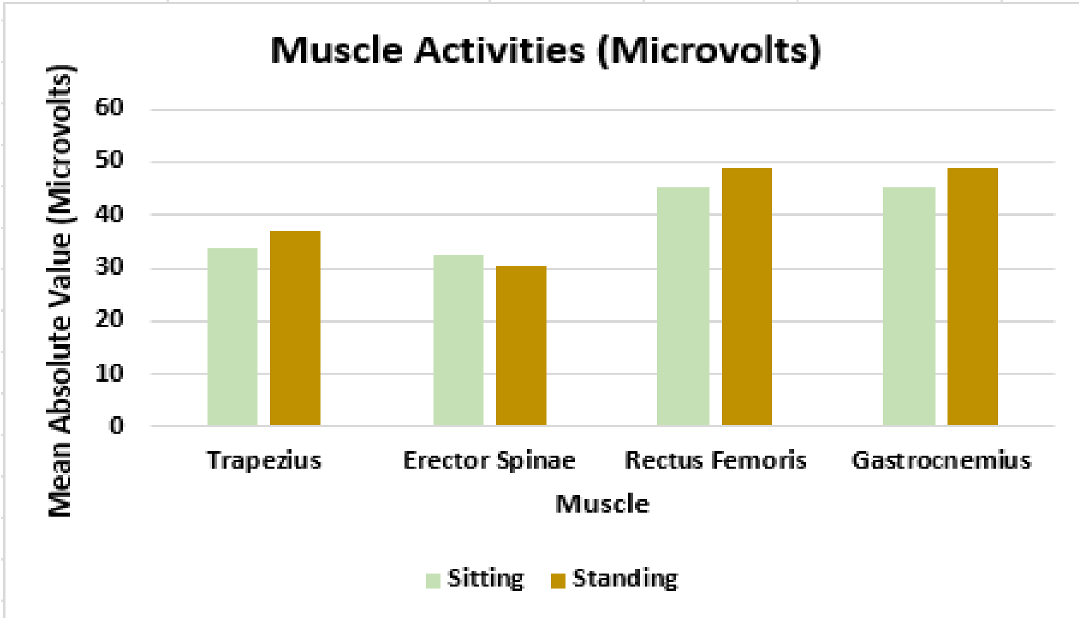

Figure 2: MAV of Muscle Activity

Bao and Lin (2018) studied the effect of sit/stand schedules of office workers via objective and subjective measures and reported that workers prefer the sit/stand duration in the range between 1:1 and 3:1. The result showed that the office workers preferred sitting for longer duration than standing when using the sit/stand workstation. This result agrees with our study as there were higher muscle activities in the standing position. Andersson et al. (1975) studied the lumbar Intradiscal Pressure (IDP) in standing and upright sitting positions and reported higher pressures in the sitting position. This finding agrees with the present study, which shows higher muscle activity of the Erector Spinae in the sitting position.

While the self-reported bodily discomfort levels were generally low, the preferred position among the participants varied, although the standing position was the least preferred one. We may conclude that the effects of using a sit-stand workstation to improve musculoskeletal health may be limited but promoting more active break-time activities can help. The limitation of this study includes the configuration of the sitting where the workstation adjustment was based on the participants' comfort due to their postural variability. In addition, the experiment lasted 30 minutes; a prolonged usage of the workstation will give a more realistic simulation since workstations are used for long hours. Further study can be expanded to analyze the muscle fatigue in both sitting and standing positions while also comparing the performances. In addition, normalized muscle activities for a fair comparison across participants can also be considered for future study.

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