

Analysis of muscle activation during sedentary positions in different upper extremities in office workers

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Abstract

Objectives: The goal of this research was to evaluate changes in trunk and upper extremity muscle activity throughout various sedentary postures (hands rest on the table (ST), Shoulder's lift (SU), shoulder forward (SF), shoulder backward (SB), head forward (HF) and head backward (HB)).

Method: Thirteen people were chosen to evaluate the activity of the pectoralis major (PM), upper trapezius (UT), middle trapezius (MT), and posterior deltoid (PD). One-way ANOVA was conducted to determine the difference in muscle activity in various postures. Tukey's test was used as a post-test to evaluate variance, with a significance of 0.05. (SPSS Version 22.0).

Findings: There were significant changes in pectoralis major, upper trapezius, middle trapezius, and posterior deltoid during the various sedentary positions. The pectoralis major showed higher muscle activity (65-70%, $p \leq 0.05$) in the SF and PD postures. The upper trapezius showed higher muscle activity (75-80%, $p \leq 0.05$) during SU posture, and the middle trapezius showed higher muscle activity (55-60%, $p \leq 0.05$) during SB posture.

Conclusions: According to the findings of this study, muscle activity varies depending on posture, and there is a significant effect on muscles during all postures.

Keywords: EMG, Upper Extremity, Sedentary Postures, Office Workers and SPSS.

I. Introduction

Sedentary behaviour is extremely common in current working circumstances. Adults are sedentary for approximately seven hours per day, according to researchers[1][2]. Adults' sedentary time is increased by desk jobs, television viewing, and commuting. Sedentary behaviour is notably widespread today; employees sit for approx. 70% of the time they are at work.[3]. There is now a plethora of evidence demonstrating a correlation amongst rising sedentary activity and a higher range of inflammatory health outcomes, which would include musculoskeletal disorders. [1][4].

The study's goal was to evaluate muscle activity in PM, UT, MT and PD during different postures. The activity was categorized into six postures (i.e., ST, SU, SF, SB, HF and HB) to analyse the changes. We observed higher activity in PM and PD for whole activity based on analysis.

II. Materials and Methods

a. Participants

The experiments included thirteen healthy male subjects. They were 24.2 years old on average (22-28 years), 176 cm long (157-178 cm), and 67 kg weight on average (54.1-81.0 kg). All subjects included in the study were office workers who underwent at least 6 hours of sedentary activity. Before enrolling in the study, subjects were informed (verbally and in writing) about risks involved, and consent was obtained. [5].

b. Testing procedures

The experiments were performed in the Biomechanics lab of Kaunas University of Technology (KTU). EMG of four upper body muscles was recorded with a wireless EMG system (Noraxon). Four electrodes, one on each muscle, were placed on the pectoralis major (PM), upper trapezius (UT), middle trapezius (MT), and posterior deltoid (PD). The task for all experiments was the same; the subject was asked to sit on the chair with both feet on the ground. He/she was asked to look at a fixed point in front of him/her, and elbows were straight during the experiment. Then, all subjects were asked to perform the following six positions. (1) Hands rest on the table

(stable). (2) Shoulder's lift. (3) Shoulder Forward. (4) Shoulder backward. (5) Head Forward and (6) Head Backward.

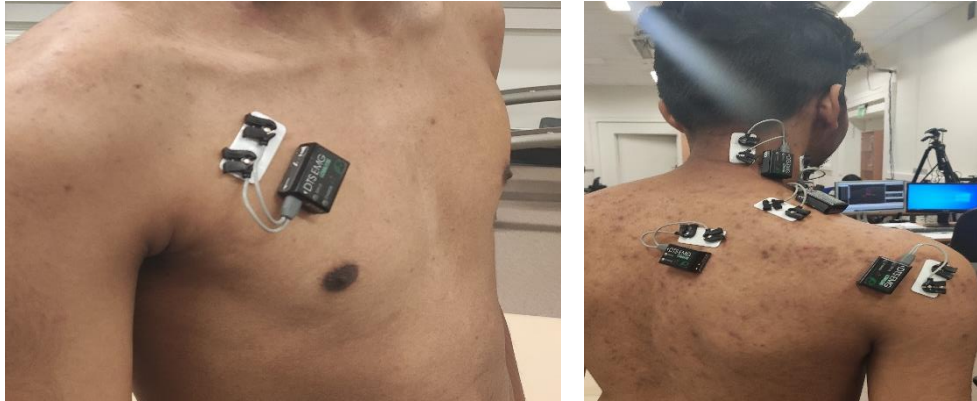


Figure 1 Marker Placement

c. Electromyography

The Noraxon TeleMyo 2400 system (Noraxon USA Inc.) was used for muscle sEMG recording and analysis. The sEMG activity of four muscles was recorded: the pectoralis major, upper trapezius, middle trapezius, and posterior deltoid. The skin was washed with alcohol before applying the gel coating. According to SENIAM guidelines, electrodes (1.1 cm contact diameter and 2 cm) were positioned at the assumed position [6]. The signals were processed at a frequency of 1000 hertz. The signals were bandpass filtered with cut-off frequencies of 8 Hz and 450 Hz, and the RMS was calculated[2]. To identify the start and end of the movement, a video recording (Logitech HD Pro C920 Pleasanton, United States) was used. The MVC of each muscle was then recorded and chosen to normalize the sEMG output. The normalization procedure was carried out separately for the dominant and nondominant sides of the [7]. To accomplish this, two maximum isometric contractions were performed for 3 s each, with a 10 sec rest between contractions and a 2 minute interval between MVC evaluations of each muscle using SENIAM procedures[2].

d. Maximum Voluntary Contraction (MVC)

MVCs of 3 each of 5 seconds were executed with 90 seconds rest time among each attempt to evaluate the maximal voluntary contraction (MVC). The MVC was determined by taking the average of the three readings. The experiment was repeated if there were any outliers[5]. Initial tests were conducted to identify the influence of muscles during sEMG muscles. If activity in these muscles exceeded 5% of MVC (as determined by RMS of sEMG), subjects were asked to rest these muscles. After the muscles rested, experiments were continued in which 3 sets of MVCs were recorded[8][6].

e. Statistical Analysis

SPSS was used to conduct statistical analyses (v22, Chicago, IL, USA). One-way analysis of variance with independent samples (ANOVA). Post hoc comparisons were conducted with the Tukey test in the event of a significant main effect. $p < 0.05$ was determined for statistical importance. Additionally, calculated 95% CI and effect size.

III. Results

a. Pectoralis major (PM)

One-way ANOVA was conducted to investigate the impact of different sedentary postures, i.e., shoulder lift (SU), shoulder forward (SF), shoulder backward (SB), head forward (HF) and head backward (HB), compared to the stable position (ST) on pectoralis major (PM) activation.

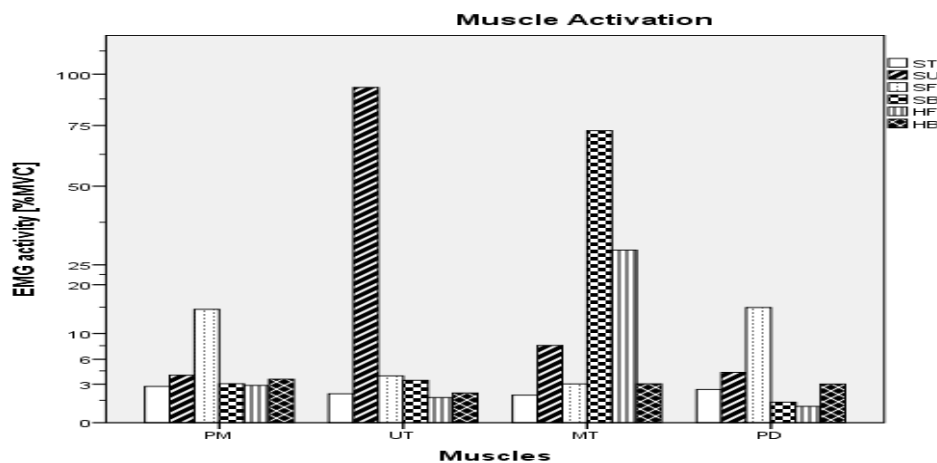


Figure 2 Activation of various muscles during different postures

The mean RMS EMG activity in the PM was 70% higher in SF than in SU and HB during the whole movement. There was a significant effect of SF posture on PM at the $p < 0.05$ level for the five postures. [$F(5,30) = 75.13$, $p = < 0.001$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the SF posture ($M = 20.7$, $SD = 4.20$) was significantly different than the other postures SU ($M = 5.54$, $SD = 1.30$), SB ($M = 4.20$, $SD = 0.52$), HF ($M = 3.97$, $SD = 0.54$) and HB ($M = 4.81$, $SD = 0.84$).

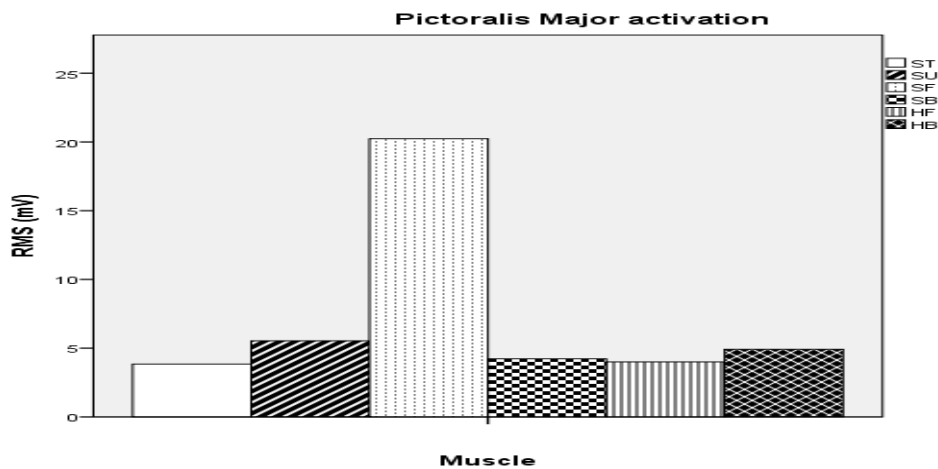


Figure 3 Pectoralis Major Activation

b. Upper Trap (UT)

Mean RMS EMG activity in the UT was 80% higher in the SU than in the SF during the whole movement. There was a significant effect of SU posture on UT at the $p < 0.05$ level for the five postures. [$F(5,72) = 2343, p < 0.001$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the SU posture ($M = 190.9, SD = 13.6$) was significantly different than the other postures SF ($M = 6.63, SD = 1.70$), SB ($M = 5.81, SD = 1.47$), HF ($M = 2.95, SD = 0.70$) and HB ($M = 3.63, SD = 1.03$).

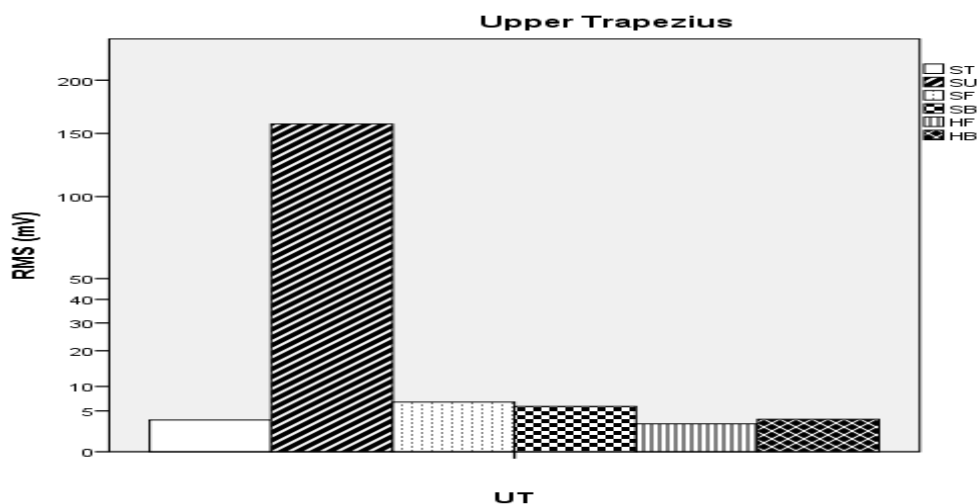


Figure 4 Upper Trapezius muscle activation

c. Middle Trap (MT)

The average RMS EMG activity in MT was 55% higher in SB than in HF during the entire motion. SB posture had a significant effect on MT at the $p < 0.05$ level for all five postures. [$F(5,72) = 245.92, p < 0.001$] Post-hoc compared with the Tukey HSD test showed a significant difference in the mean SB postures score ($M = 143.83, SD = 9.82$) over those of SU ($M = 15.91, SD = 2.47$), SS ($M = 5.98, SD = 1.57$), HF ($M = 57.5, SD = 29.35$), and HB ($M = 6.0, SD = 1.48$).

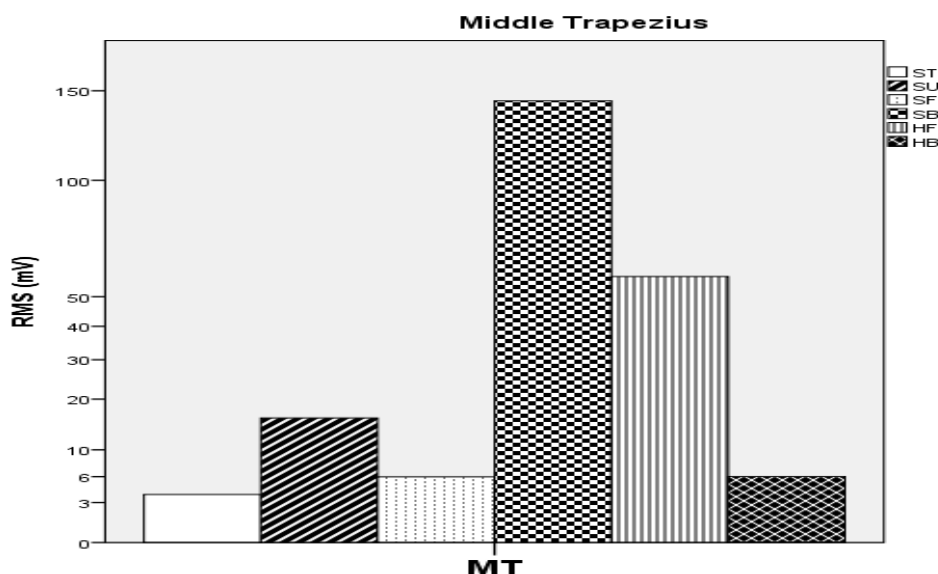


Figure 5 Middle Trapezius activation

d. Posterior Deltoid (PD)

During the entire movement, the mean RMS EMG activity in the PD was 33% higher in SF than in SU. For the five postures, there was a significant effect of SF posture on PD at the p0.05 level. [$F(5,72) = 74.8, p 0.001$] Using the Tukey HSD test, post hoc comparisons revealed that the mean score for the SF posture ($M = 23.27, SD = 8.13$) differed significantly from the other postures SU ($M = 6.74, SD = 1.30$), SB ($M = 2.11, SD = 0.42$), HF ($M = 1.6, SD = 0.30$), and HB ($M = 4.71, SD = 0.8$).

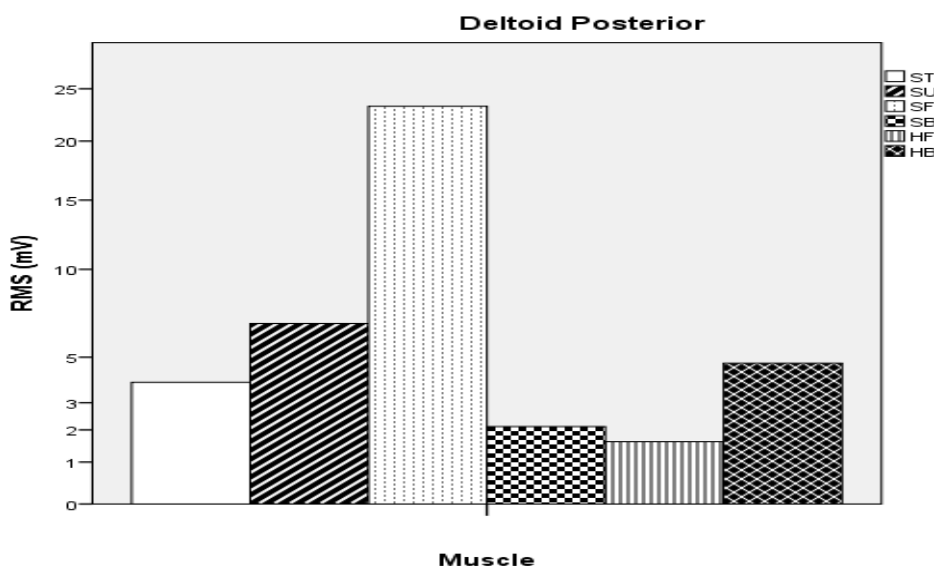


Figure 6 Deltoid Posterior activation

IV. Discussion

The findings revealed that activation of SF is large in PM and PD for the entire movement compared to other postures. In contrast, UT was more activated during SU than the other postures, and MT was more activated during SB than the other postures.

During the SF, greater activation in PM and PD was observed throughout the activity, as predicted. The major difference in movement between the postures is due to the change in the external moment arm during SF, which alters the total resistance during the SU to a much greater extent than the SB. Previous research comparing muscle activation differences between standing and sitting positions revealed differences in muscle activation [3]. When compared to other postures, the instruction to maintain the SF posture surges the unsteadiness in the forearm. As a result, the primary task in the SF posture is likely to be to stabilize and uphold a persistent angle in the forearm rather than to generate force in the PM.

There are some constraints that must be addressed. Due to comparative modification of the electrodes, unbalanced signals, and variations in skin properties, the interpretation of signals throughout dynamic measurements will be complex. Furthermore, there is always the problem with sEMG measurements, which may comprise the activity of neighbouring muscles. However, data were collected in a single session, and no electrodes were replaced.

V. Conclusion

In conclusion, when compared to the other postures, the SF demonstrated higher muscle activation in PM and PD. UT, on the other hand, established larger muscle activation in SU than in SF. The authors recommend using shoulder forward and shoulder lift positions if the goal of analysis is maximum muscle activity.

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