

Electromyography (EMG) of the Trapezius Muscles during Clerical Work

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ABSTRACT

Electromyography (EMG) was recorded with surface electrodes on both upper trapezius muscles during continuous keyboarding. Subjects included five clerical workers residing in Main Hall on the University of Wisconsin-La Crosse campus. Each subject participated in four ten-minute trials throughout their eight-hour workday. These four trials (morning, midmorning, afternoon, late afternoon) consisted of ten minutes of continuous typing of the same manuscript. Following each completed trial, the subject's maximal voluntary isometric contraction (MVIC) was collected to normalize EMG readings. Data collection from the four trials using a repeated measure analysis of variance compared the peak and average normalized trapezius muscle activity over time and between sides ($p < 0.05$). Results indicated that EMG measurements over time (morning, midmorning, afternoon, late afternoon) or between sides (right and left) did not change throughout the eight-hour workday.

INTRODUCTION

Within our society, there are a growing number of individuals who suffer from muscle pain due to strenuous work-related exercises. According the American Occupational Therapy Association, ergonomics is the number one growing area in the field of occupational therapy. Occupational therapy studies ergonomics through task analysis by breaking down each activity into its performance components for further analysis. The population that tends to be affected are those who are employed as clerical/office personal. According to National Institute of Occupational Safety and Health (NIOSH), 92,576 injuries or illnesses occurred as a result of repetitive motion, including typing or key entry, repetitive use of tools, and repetitive placing, grasping, or moving of objects other than tools (Bernard, 1997). The information revolution is producing a change in the nature of work today. In the course of a few decades, vast numbers of occupations have become, in one way or another, linked to computer keyboard jobs.

Upper extremity disorders or injuries are the fastest growing occupational musculoskeletal problems in Canada, the United States, Europe, Japan, and Australia (Richardson & Larson, 1997). Musculoskeletal disorders refers to conditions that involve the nerves, tendons, muscles, and supporting structures of the body (Bernard, 1997). In many cases, pain is localized to small-circumscribed areas that are very tender to palpation and extremely sensitive to pressure. Muscle tenderness is, considered to be a sign proceeding musculoskeletal disorders

(Nakata, Hagner, & Jonsson, 1993). Of these upper extremity disorders and syndromes, tendinitis, epicondylitis, carpal tunnel syndrome, and various shoulder and neck conditions are fast reaching epidemic proportion in companies manned by keyboard operators. Basic symptoms that are seen in these disorders are pain, inflammation, and a decrease in strength and flexibility. In our research, we will be examining one of the key muscles that can demonstrate the symptoms listed above, the trapezius muscle.

The trapezius muscle is located in the shoulder-neck region. It is very vital for clinical use because it exhibits high prevalence of pain symptoms due to repetitive work-related tasks. Trapezius is characterized as a stabilizer of the scapula and is then activated during any arm motion. The trapezius is therefore often selected as a muscle choice to measure electrical activity during repetitive work-related tasks.

Surface EMG can be used to measure muscular activity during repetitive work-related tasks. To quantitatively measure the muscle activity through EMG, a surface electrode is placed over the belly of a muscle. The electrode is interfaced with an amplifier and a Dell 133 laptop computer that measures increasing and decreasing amounts of muscle activation during a given task. Results can be compared quantitatively with different tasks or treatment interventions.

Previous studies indicate that more research needs to be performed in the area of ergonomics. One study done by Ericson and Fernstrom published in 1996 examined at how the muscle activity in the upper trapezius changed when the workstation and the tasks of their subject were altered. This study took place over an 18-month period of time in which data collection was taken over two days. The first data collection consisted of the subjects typing continuously for one day in their natural work environment. The second data collection session also consisted of the subjects typing continuously for one day in an altered workstation. No significant difference was found in the muscle activity of the upper trapezius between session one and session two. In another study which also examined muscle activity of the upper trapezius had subjects key continuously for 20 minutes, with a 10-minute rest following another 20-minute session in a new workstation according to Occupational Safety and Health Administration. Results over this time period indicated no significant difference in muscle activity (Colson, Johnson, & Reynolds, 1994). Our study is unique when compared to our literature review. To maintain consistency, a specific workstation criterion and typing literature was used for all five subjects. In addition to consistency data collection was broken down into four time intervals showing an accurate span of an average workday. The hypothesis to be tested is if EMG recordings over the trapezius will increase in muscle activity throughout an eight-hour workday.

METHODS

Five program assistants in good health volunteered as subjects for this study in Main Hall. Healthy subjects were chosen after answering a health questionnaire indicating any past shoulder injury or other cumulative trauma within the past five years. The experiment followed guidelines set by the Institutional Review Board and each subject was given an informed consent form to sign in accordance with university policy.

The study comprised of one eight hour session consisting of four different EMG measurements, all occurring in the participant's natural working environment. Before data collection all subjects' workstations had to be in compliance with a designated workstation checklist.

The work station checklist comprised of five key components: chair table height, foot/leg positioning, keyboarding/arm and wrists positions, monitor/display screen and lighting/glare reductions. The EMG measurements were performed at different time intervals, (morning, midmorning, afternoon, and late afternoon) that consisting of ten minutes in length.

The equipment that was used consisted of a Pathway MR-20 Dual Channel Surface EMG System, DeLuca Preamplifier Electrodes (Ag/AgCl). The EMG was interfaced with a Dell 133 laptop computer for data collection and storage. The sampling rate was set at 10Hz for ten minutes. The EMG signal was processed to root mean square and normalized to maximum voluntary isometric contraction (MVIC). Each participant after each ten-minute session generated a single MVIC. This required the participant to “shrug their shoulders” against manual resistance performed by one of the investigators.

The surface electrodes were placed bilaterally on the belly of the trapezius muscles after alcohol sterilization of the site. The EMG recorded measurements of the trapezius during the task of typing specifically assigned literature.

A repeated measure analysis of variance was used to compare peak normalized trapezius muscle activity as measured by EMG at the four different time intervals throughout the day. Alpha level was set at 0.05.

RESULTS

A repeated measures analysis of variance (ANOVA) was performed on all four trials among the five subjects. The ANOVA contained two within factors, time and side. Time was divided into pre and post intervals, while side was divided into right and left sides.

Normalized peak readings for EMG activity during session one (morning) indicated an EMG amplitude reading of 35% MVIC. Session two (midmorning) EMG amplitude reading consisted of a 28% increase in MVIC to 63%. Afterwards, there was a 33% decrease from midmorning to late afternoon which resulted in a 30% MVIC for session four. According to the data, our peak EMG reading occurred during session two (refer to figure one).

Data analysis showed no differences between the means of time and side. The mean p-value for time was 0.452 while the mean p-value for side was 0.204. The comparison between time and side indicates a p-value of 0.533, again showing no difference. Refer to

table one for the ANOVA Normalized Peak Readings, which display df, mean square, f-value, and p-value.

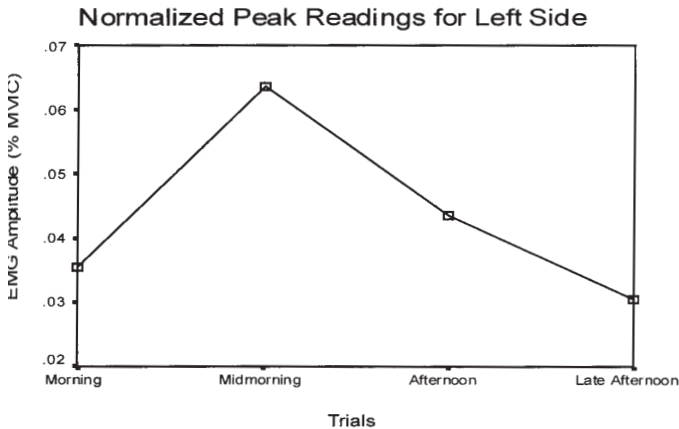


Figure 1

Table 1: Normalized Highest Peak Readings

| <i>Source</i> | <i>Df</i> | <i>Mean Square</i> | <i>F</i> | <i>P-Value</i> |
|--------------------------------------|-----------|--------------------|----------|----------------|
| TIME | 3 | 1.142 x E-03 | .941 | .452 |
| Error (TIME) | 12 | 1.215 x E-03 | | |
| SIDE | 1 | 1.092 x E-03 | 2.306 | .204 |
| Error (SIDE) | 4 | 4.737 x E-04 | | |
| TIME * SIDE | 3 | 1.580 x E-04 | .770 | .533 |
| Error (TIME * SIDE) | 12 | 2.052 x E-04 | | |

DISCUSSION AND CONCLUSIONS

What supports our findings of differences? Through our literature review we find it may have been a number of the following. According to a back injury study by McGill in 1997 EMG recordings do not predict the forces of the backs passive tissues such as ligaments and intervertebral discs. Given the poor prediction of these forces through EMG this could be problematic and one could argue its suitability to access individual injury. Given the origin and insertion of the upper trapezius, as posture breaks down and gradually relies less on muscle EMG activity will decrease. Another supporting study by Ericson and Fernstrom in 1996 analyzed the duration of muscle contraction. Ericson and Fernstrom discovered that during low load contraction it took approximately twenty minutes to produce an overload or measurable increase in muscle activity. This made it difficult to determine if the four, ten-minute intervals of data collection we performed were long enough. A final study conducted in 1997 by Westgaard and Jensen supports the idea of a functional subdivision of the upper trapezius muscle. Westgaard and Jensen confirmed that normalized EMG activity of sixteen health subjects showed significantly different EMG amplitudes at three different electrode positions. In addition they also found that while the EMG level was similar at one electrode position, significant differences were found among other electrode positions indicating a functional subdivision of the upper trapezius muscle. Our study utilized a single electrode site that may have affected our results.

Additional support for not finding a gradual increase in upper trapezius muscle activity could have been the use of ergonomically correct workstations and prior subject education. Approximately four months prior to our study each subject had been involved in proper body mechanic training and back anatomy through a project done by the student of the Occupational Therapy program on the University of Wisconsin La Crosse campus. Their work satiation was then individually modified to meet their individual occupational needs. To establish consistency to our study prior to data collection each subject had to meet eight of twelve specific OSHA workstation criterions. A final finding of support in that rest breaks were of increased length thus eliminating muscle fatigue between typing activities. As was previously mentioned data collected on each subject four times during the day, morning, mid-morning, afternoon, and late afternoon. There was approximately a one-hour time period between each of these sessions. How the subjects spent these hours was not monitored.

LIMITATIONS

There were several important limitations within our study. One was the lack of randomized subjects. In our literature review the studies generally consisted of fifteen or more subjects. All subjects had previous workstation modifications and body mechanics training.

A more random selection of subjects may have produced different results. Secondly, data collection was limited through computer ability. Our equipment only allowed us to collect data for ten-minutes at a time. A longer time period may have shown different results. Lastly, data collection was taken on a Friday. Through observation Friday may not have been an optimal replication of an average workday or average workload.

SUGGESTIONS FOR A FURTHER STUDY

After analyzing our current study, there are a number of recommendations that would be suggested for a further study. The first is that data collection span over a twenty-minute period. The four, ten-minute intervals of data that was collected did not give optimal insight on the developments of low-load contraction within the upper trapezius muscle. The second suggestion would be to increase the length of the study, thereby collecting data over a longer period of time (such as 3-6 month period). This would enhance the statistical analysis and provide for more statistical power. It would have also been more beneficial to have a larger subject population. A larger subject population may have provided a greater representation of data collection. A final suggestion would be to compare two groups. One group consisting of a natural working environment compared to a pre-determined uniform workstation. Data collected within these two groups could then be compared and analyzed for specific differences and benefits. With these suggestions in mind there is hope to enhance future studies of this nature.

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