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Effects of Slump Sitting Posture on the Masticatory, Neck, Shoulder, and Trunk Muscles Associated With Work-Related Musculoskeletal Disorders

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Abstract

The purpose of this study was to determine the effects of slump sitting postures on the masticatory, neck, shoulder, and trunk muscles associated with work-related musculoskeletal disorders (WRMD). Eleven healthy adults (age, 23.3±2.7 yrs; height, 174.0±4.1 ㎝; weight, 61.4±6.6 ㎏) participated in this study. The participants were free of injury history and neurologic deficits in the masticatory, neck muscles and upper extremities at the time of participation. The subjects were asked to perform erect and slump sitting postures under the guidance of physical therapists. The surface electromyography (EMG) was recorded from the anterior temporalis, masseter, upper trapezius, serratus anterior, middle trapezius, L3 paraspinal, external abdominal oblique, gluteus maximus muscles of 11 adults as they performed visual terminal display work, which are known as the weakened and tightened muscles owing to WRMD. The recorded signals were averaged and normalized to the mean amplitude of the EMG signal obtained during submaximal reference voluntary contractions. The results of study were as follows: The masseter, upper trapezius, serratus anterior, middle trapezius, L3 paraspinal, external abdominal oblique muscles significantly differed in the slump sitting posture ($p<.05$). The muscle activities of the serratus anterior, middle trapezius muscle, and external abdominal oblique were significantly lower and that of the masseter, upper trapezius, L3 paraspinal muscles were significantly higher. Further research is needed to assess the motor control problems and the function of the deep muscles in posture stability of patients with WRMD.

Key Words: Electromyography; Slump sitting; Work-related musculoskeletal disorders.

Introduction

Posture of the head, neck, and shoulders has been recognized as a factor contributing to the onset and perpetuation of cervical pain dysfunction syndromes (Braun and Amundson, 1989). Computer work involves prolonged viewing of a visual display unit and increases lower cervical flexion muscle tension to support the weight of the head (Straker and Mekhora, 2000). The effects of the static posture as-

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sumed when working at a visual display terminal (VDT) are most pronounced in the neck and shoulder regions, resulting in increased forward neck flexion and increased static muscle tension in the region (Ariens et al, 2001).

A previous study found that workers using VDTs had increased forward neck flexion compared to those with relaxed sitting postures (Szeto et al, 2002). Increased forward neck flexion may result in increased tension in posture-stabilizing muscles as well as increased compressive forces in the articulations of the cervical spine, resulting in a higher risk of work-related musculoskeletal disorders (WRMD) (Ariens et al, 2001).

Poor posture is a common finging in the physical therapy evaluation of the patient with a musculoskeletal complaint. In the upper spine has been of paticular interest to the physical therapist treating disorders of the cervical and thoracic spine, the shoulder and the temporomandibular region (Boyd et al, 1987). A relationship between cervical posture and dental occlusion has been observed (Boyd et al, 1987). The strongest evidence of the relationship between head posture and occlusion alteration was described by Rocabado et al (1982). Physical characteristics referred to as poor include a forward tilt of the head and the nature of these characteristics is self-explanatory (Blouin et al, 2003). The number of patients receiving combined occlusion and postural treatment is increasing (Ariens et al, 2001).

Slumped over documents and staring all day into a computer screen do no end of damage to muscles, exacerbating tension and tightness around neck and shoulders. Forward head posture and flexion of the trunk form the main components of slumped sitting, with the cervical alignment deemed to be poor when the head and trunk are held forward relative to the lumbopelvic region (Raine and Twomey, 1997). A flexed spine results in higher activity in the cervical erector spinae, trapezius, and thoracic erector spinae muscles (Gooch, 1993). There is evidence linking prolonged trunk flexed posture with increased muscle loading and a subsequently increased risk for symptoms in the upper body (Gore et al, 1986). Therefore, the aim of this study was to determine the effects of slump sitting posture on the masticatory, neck, shoulder, and trunk muscles, which are known to be weakened and tightened in WRMD during computer work.

Methods

Subjects

Eleven healthy young adults (age, 23.3±2.7 yrs; height, 174.0±4.1 ㎝; weight, 61.4±6.6 ㎏) participated in the study. All subjects were healthy and free of any neck and back pain for a minimum of 1 year prior to the study, and they did not have upper-limb or cervical spine pathologies, or rheumatological or neurological conditions. The age, height, and weight of the subjects are summarized in Table 1.

Instruments

The electromyography (EMG) signals were preamplified by a preamplifier placed close to the electrodes and then sent to the data acquisition unit of an MP100 system[1)] that amplified and sampled the EMG inputs at 1000 ㎐. The root mean square values were calculated, and the amplitude was normalized to submaximal reference voluntary contractions (RVC) rather than to the maximal voluntary contractions so as to reduce the risk of injury or residual muscle soreness, especially in the neck, and because there was no assurance that a maximum contraction could be obtained. The reference mastica-

Table 1. General characteristics of subjects (N=11)

Characteristics	Mean±SD
Age (yrs)	23.3±2.7
Height (㎝)	174.0±4.1
Weight (㎏)	61.4±6.6

1) Biopack System, Santa Barbara, CA, U.S.A.

tory and neck contractions were obtained by attaching a .5-㎏ weight to the face mask of a helmet, and having the participant look straight ahead and keep the neck in line with the spine (thereby resisting neck flexion). Shoulder reference contractions were obtained by holding a .5-㎏ weight in each hand with arms abducted 90° in the frontal plane and parallel to the floor. Trunk reference contractions were obtained by attaching a 1-㎏ weight in the right ankle, and having the participants keep the right leg in the line with trunk in the quadruped position. Participants completed three 5-second submaximal exertions with a 1-min rest period between contractions. EMG data were analyzed using a program created with Acqknowledge software (version 3.7.3) and expressed as the mean %RVC.

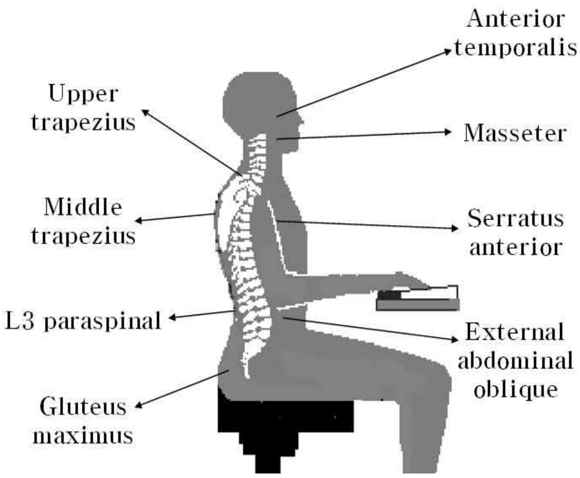

Figure 1. The selected masticatory, neck, shoulder, and trunk muscles.

Procedures

Surface EMG measurements were obtained from eight muscles associated with WRMD when subjects worked on a VDT: The anterior temporalis, masseter, upper trapezius, serratus anterior, middle trapezius, L3 paraspinal, external abdominal oblique, gluteus maximus muscles. Muscle activity from muscles in the subjects' right side was detected by surface electrodes[2] that were attached after the skin was shaved and cleaned with alcohol.

The muscles tested and the electrode locations were as follows: (1) anterior temporalis, palpated the temporal region while the patients clenches subject teeth and placed over the belly of the muscle, (2) masseter, palpated the temporal region while the patients clenches subject teeth and placed over the belly of the muscle, (3) upper trapezius, slightly lateral to and one half of the distance between the cervical spine at C7 and the acromion, (4) serratus anterior, just below the axillary area, at the level of the inferior tip of the scapular, and just medial to the latissimus dorsi, (5) middle trapezius, at the medial border of the spine of the scapula, (6) L3 paraspinal, palpated iliac crest and placed parallel to the spine over the muscle, (7) external abdominal oblique, lateral to the rectus abdominis directly above the anterior superior iliac spine, one half between the crest and the rib at a slightly oblique angle so that they run parallel to the muscle fibers, and (8) gluteus maximus, one half of the distance between the trochanter and the sacral vertebrae in the middle of the muscle on an oblique angle at the level of the trochanter or slightly above (Figure 1) (Cram et al, 1985).

The standard erect sitting postures was defined as a position in which the angle between the acromion, L1 spinous process, and greater trochanter was 132° or more, with a neutral pelvic tilt, lumbar lordosis, and thoracic kyphosis. The slump sitting postures were defined as a position in which the angle between the acromion, L1 spinous process, and greater trochanter was 93° or less, with a neutral pelvic tilt, lumbar lordosis, and thoracic kyphosis (Figure 2) (O'Sullivan et al, 2002). The angles were recorded by a 3-D motion analysis system CMS-HS[3].

All subjects typed randomly selected computer work on a computer. The EMG data were obtained from the last 30 seconds of a 1-minute da-

2) Delsys Inc., Boston, MA, U.S.A.
3) Zebris Medizintechnik, GmbH, Isny, Germany.

ta-collection period whilst the subject sat either in an erect sitting posture or in a slump sitting posture. The test order was selected randomly. All of the procedures were performed by the same investigator in order to reduce the variability. During data collection, the study participants were barefoot with arms relaxed, and feet positioned 20 ㎝ apart. An adjustable-height table and chair were used for the initial sitting posture so as to ensure that the hips and knees were flexed by 90°.

Figure 2. Slump sitting posture.

Statistical Analysis

The SPSS statistical package (version 12.0, SPSS, Chicago, IL, U.S.A.) was used to analyze the significance of differences in the EMG muscle data between the erect sitting posture and the slump sitting posture using the paired t-test, with significance defined as being present when $p<.05$.

Results

The normalized EMG data of the masseter, upper trapezius, serratus anterior, middle trapezius, L3 paraspinal, external abdominal oblique muscles significantly differed between sitting in the erect sitting posture and in the slump sitting posture ($p<.05$) (Table 2). When sitting in the slump sitting posture, the muscle activities of the serratus anterior, middle trapezius muscle, and external abdominal oblique were significantly lower and that of the masseter, upper trapezius, L3 paraspinal muscles were significantly higher. However, the normalized EMG data of the anterior temporalis, gluteus maximus muscles weren't significant difference between sitting in the erect sitting posture and in the slump sitting posture ($p>.05$) (Figure 3)

Table 2. Comparison of the normalized EMG data of the muscles in the erect and slump sitting postures (Unit: %)

Muscles	Erect sitting posture	Slump sitting posture	t	p
	Mean±SD	Mean±SD		
Anterior temporalis	13.42±1.38	14.97±2.62	-2.22	.05
Masseter	12.10±1.81	14.68±2.04	-2.45	.03
Upper trapezius	20.31±1.06	23.34±3.62	-2.42	.04
Serratus anterior	25.75±3.59	22.79±3.94	2.45	.04
Middle trapezius	25.54±5.55	20.77±2.23	3.24	.01
L3 paraspinal	25.56±4.97	38.52±5.52	-10.88	.00
External abdominal oblique	24.89±3.83	13.03±1.63	8.80	.00
Gluteus maximus	12.59±1.75	11.74±1.71	1.64	.13

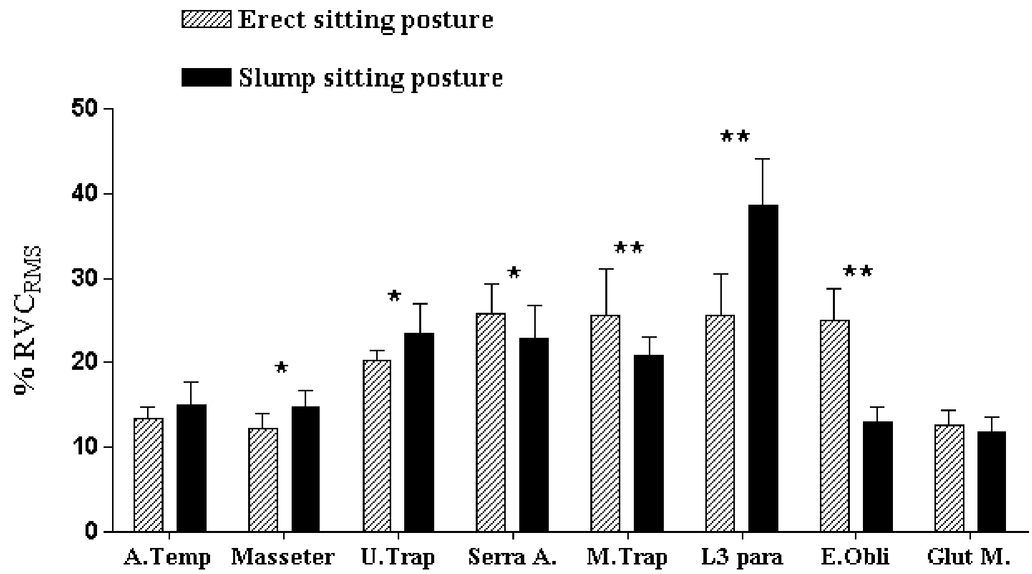

Figure 3. The %RVC data of the muscles between sitting in the erect sitting posture and in the slump sitting posture. A.Temp, anterior temporalis; U.Trap, upper trapezius; Serra A, serratus anterior; M.Trap, middle trapezius; L3para, L3 paraspinal; E.Obli, external oblique; Clut M, gluteus maximus. *p<.05, **p<.01.

Discussion

The repetitive use of the computers, TVs, video games, and even backpacks has forced the body to adapt to the forward head posture and kyphosis. Because the neck and shoulders have to carry this weight all day in an isometric contraction, these postures cause loss of blood, damage, fatigue, strain, pain, burning and fibromyalgia in the neck muscles and the interaction between dental occlusion alterations and head posture, examination of the function of the stomatognathic system in patients with head posture alterations should be included in physical therapy evaluation (Boyd et al, 1987).

In our results, the masseter, upper trapezius, serratus anterior, middle trapezius, L3 paraspinal, external abdominal oblique muscles associated with forward head posture, round shoulder, kyphosis, and trunk stability were showed significant differences. When sitting in the slump sitting posture, the muscle activities of the serratus anterior, middle trapezius muscle, and external abdominal oblique were significantly lower and that of the masseter, upper trapezius, and L3 paraspinal muscles were significantly higher.

Kebaetse et al (1999) assessed 34 healthy subjects' active range, strength, and scapulohumeral rhythm in both erect and slump sitting. They found that, in a slump posture, the subjects demonstrated less active shoulder adduction, 16% less strength in horizontal abduction, and a more elevated scapula in active motion of the arm abduction than when sitting erect. Some studies have investigated the relationship between the masticatory muscles and head posture using electromyography (EMG) analysis (Solow and Sandham, 2002). It was observed that EMG activity of the masticatory muscles changes according to the head position; forward head posture produces a greater muscular activity in the temporal and masseter muscles (Boyd et al, 1987). When spinal tissues are subject to a significant load for a sustained period of time, they deform and undergo remodeling changes that could become permanent (Gore et al, 1986). The present study did not examine the mechanisms leading to pain in subjects with postural malalignment in any detail since the ultimate goal was not spine straightening, which might lead to other musculoskeletal disorders.

Solomonow et al (2003) investigated the influence of static and repetitive forward bending on the-flexion-relaxation phenomenon, which is the occurrence of muscle-activity silence during a small range of motion around peak forward bending. It is believed that at peak flexion the flexor moment created by forward posture of the trunk is resisted by the passive tissues rather than by active muscular contraction. Previous studies have documented that inappropriate motor patterns can result from a history of low-back dysfunction (McGill, 2004). The superficial thoracic erector spinae muscle and the anteroinferior portion of the internal oblique muscle are less activated in passive trunk postures than in erect standing and sitting postures (McGill, 2004; Szeto et al, 2005).

Forward head and trunk flexion may have gradually developed into a fixed postural habit whenever the subjects worked at VDTs, and different muscle control strategies may have also developed (Szeto et al, 2005). Many clinicians use exercise to train motor patterns for the purpose of improving spine stability (Szeto et al, 2002; Szeto et al, 2005). Increased flexion at the atlanto-occipital joint increases the horizontal distance from the center of mass of the head to its axis of rotation (Burgess-Limerick et al, 1999). Similarly, with the trunk in a vertical position, an increase in flexion of the cervical spine increases the horizontal distance from the center of the head and neck combined to the axes of rotation in the vertebral column (Gore et al, 1986). Hence, with the trunk in an upright position, both atlanto-occipital and cervical flexion increase the torque required of the extensor musculature to maintain static equilibrium (Burgess-Limerick et al, 1999).

The adoption of standard erect postures may result in more effective load sharing with the active system, reducing focal end-range stress on the sensitized passive structures. The significant differences of the selected muscles in slump sitting posture may result in increased tension in posture-stabilizing muscles as well as increased compressive forces in the articulations of the spine. Posture stability is usually required in more proximal structures, such as the trunk and hip, for effective positioning and motion of a distal part (Ariens et al, 2001). Exercises designed to develop stability in proximal parts are referred to as rhythmic stabilization, and treatment approaches for WRMD must focus on the trunk muscles prior to strengthening and stretching of the neck muscles.

Conclusion

In the slump sitting posture, the muscle activities of the serratus anterior, middle trapezius muscle, and external abdominal oblique were significantly lower and that of the masseter, upper trapezius, L3 paraspinal muscles were significantly higher than the in erect sitting. Further research is needed to understand the nature of motor control problems in deep muscles in patients with WRMD, and to assess synchronous obtained motion analysis and EMG data of the neck, shoulder, and trunk.

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