한국전문물리치료학회지 제9권 제4호
KAUTPT Vol. 9 No. 4 2002.

The Effect of Head Posture on Muscle Activity of Upper Trapezius During Computer Work

Jung Do-young, B.H.Sc., P.T.
Dept. of Rehabilitation Therapy, The Graduate School, Yonsei University
Koh Eun-kyung, Kim Young, B.H.Sc., P.T.
Dept. of Rehabilitation Therapy, The Graduate School, Yonsei University
Kwon Oh-yun, Ph.D., P.T.
Dept. of Physical Therapy, College of Health Science, Yonsei University
Institute of Health Science, Yonsei University
Lee Jun, M.Sc., Lee Kyoung-joung, Ph.D.
Dept. of Biomedical Engineering, The Graduate School, Yonsei University

국문요약

컴퓨터 작업시 머리자세가 상부 승모근의 근 활성도에 미치는 영향

정도영
연세대학교 대학원 재활학과
고은경, 김영
연세대학교 대학원 재활학과
권오윤
연세대학교 보건과학대학 물리치료학과 및 보건과학연구소
이전, 이경중
연세대학교 대학원 의공학과

본 연구는 컴퓨터 작업시 머리자세가 상부 승모근의 근전도 활성도에 미치는 영향에 대해 알아보기 위해 실시하였다. 대상자는 상지에 근골계질환이 없는 대학생 5명을 대상으로 하였으며, 표면근전도(MP100WS)를 이용하여 근 활성도를 측정하였다. 실험은 10분 동안 머리를 중립자세로 모니터를 보고 컴퓨터 작업을 수행하는 것과 문서걸이(copy holder)를 보기 위해 머리를 45° 회전하고 컴퓨터 작업을 하는 두 가지 조건을 $\%RVC_{RMS}$를 이용하여 비교 분석하였다. 머리를 중립자세로 했을 때 평균 $\%RVC_{RMS}$ 값이 높았으나 머리를 45° 회전하여 작업시에는 시간이 지남에 따라 $\%RVC_{RMS}$가 지속적으로 증가함을 보여주었다. 따라서 컴퓨터 작업시 문서는 모니터로부터 가까이 하여 머리회전을 최소화시키는 것이 근육의 피로나 부작용을 줄일 수 있을 것이다.

핵심단어: 근골격계 질환; 근전도; 근 피로; 인간공학; 컴퓨터 작업.

---

*This work was supported by RRC program of MOST and KOSEF.

Introduction

Repetitive strain injury (RSI) is defined as cumulative trauma disorders(CTD) resulting from prolonged repetitive, forceful or awkward movements and postures. These movements and postures result in damage to the muscles, tendons, and nerves. RSIs are referred to as repetitive stress injuries, CTDs, repetitive motion disorders, occupational overuse injuries, and work-related musculoskeletal disorders such as carpal tunnel syndrome (CTS), tendinitis and myofascial pain syndrome (Nainzadeh et al, 1999). Repetitive arm movements, heavy work, insufficient rest and a static posture together with mental stress are shown to be the risk factors of the development of shoulder girdle musculoskeletal disorders (Sommerich et al, 1993; Waersted et al, 1996). Musculoskeletal complaints are common in workers who use visual display terminal (VDT), sitting in front of the screen over a long period of time. Ignatius et al (1993) reported that 50% of typist 170 had a local fatigue affecting the shoulders, neck, back and fingers, and back pain was the most common(53%), followed by neck pain (50%), arm pain (27.6%), and finger pain (27.6%).

Several studies of computer workplace have employed surface electromyography (EMG) parameters to verify a relation between musculoskeletal disorder and fatigue signs during work (Hagg and Suurkula, 1997), and to reduce disorder the incidence by changing the work environment (Moffet et al, 2002, Sundelin and Hagberg, 1989; Villannueva et al, 1998).

Hamilton (1996) compared the head position and neck muscle tension in two source document positions. He indicated that typing with document on a standing board on the table at each side of the key board is better than it is with document put flat on the table. Kline and Schumann (1999) reported that the increase in the left and right trapezius muscle activity was partly related to a lifting of the shoulders to compensate a slight slumping of the back over the course of the working time. Therefore, they recommended that strengthening training of the back muscles, which might have a preventive effect with respect to musculoskeletal complaints in VDT workers.

Bauer and Wittig (1998) investigated influence of the head posture with regards to the screen and the copy holder position on the activity of cervical muscle during 5-minute computer work. They recommended that the screen to be positioned in which the vision axis is horizontal or inclined slightly downwards, and the copy holder to be arranged at on only one side of the screen.

Although previous studies found upper trapezius muscle activity during comfortably computer work, no studies describe EMG activity during typing without resting. The purpose of this study, therefore, was to find the effect of head posture on EMG activity of both sides of upper trapezius during computer work. The results of this study will provide useful information for ergonomics to contribute to the prevention

Table 1. General characteristics of the subjects (N=5)

Sex (male/female)	Age (yrs)	Height (cm)	Body weight (kg)	Dominant hand (right/left)
2/3	23.4±2.5[a]	166±6.5	57.2±6.9	5/0

[a]Mean±SD

of health complaints when working at VDT.

Methods

Subjects

Five healthy subjects, 2 male and 3 female, were recruited from Yonsei University at Wonju. None of them had a pathological history of musculoskeletal or nervous system of the upper extremities. Their mean age was 23.4 years. The mean height and weight of the subjects were 166.2 cm and 57.2 kg, respectively. All the subjects were right hand dominant.

Procedures

Two experimental procedures, each of 10-minute durations, were carried out in sequence: 1) typing with head in neutral 2) typing with head 45° turned to left side.

The height of the seat and the front desk-top were adjusted according to the individual body dimensions at the beginning of the test. Before each test, the subjects were asked to adjust the components of the workstation at their own convenience. The subjects were instructed to sit in an upright posture and to keep in contact with the backrest, thus to exclude the effects of the spinal posture on the head.

The distance between the screen center and the copy holder on the side was 400 mm. The subjects performed a standardized typewriting test, Hanmetaja Teacher (Hanmesoft Co., Korea) in each condition. The subjects typed with both hands on the keyboard. They constantly looked at the monitor. The subjects took a rest in between trials to prevent muscle fatigue during 10-minutes

During the test, the muscle activity on the subjects' both side of the upper trapezius muscles was collected by surface EMG (MP100WSW)[1] using silver electrodes (model: DE-3.1)[2]. The electrode pairs were placed after preparation of the skin, along the direction of the muscle, 2 cm lateral to the midpoint of the line between the seventh cervical vertebra and acromion.

The sampling rate was 512 Hz. The EMG signals were digitally band-pass (100 ~2500 Hz) and notch (60 Hz) filtered. The root mean square (RMS) value was calculated. The Acqknowledge 3.53[3] program was employed for data reduction processing.

Reference voluntary contraction (RVC) was obtained to normalize RMS. During the four test contractions, the subject was

1) BIOPAC System Inc. USA.
2) Delsys Inc., MA. USA.
3) Biopac System Inc. CA. USA.

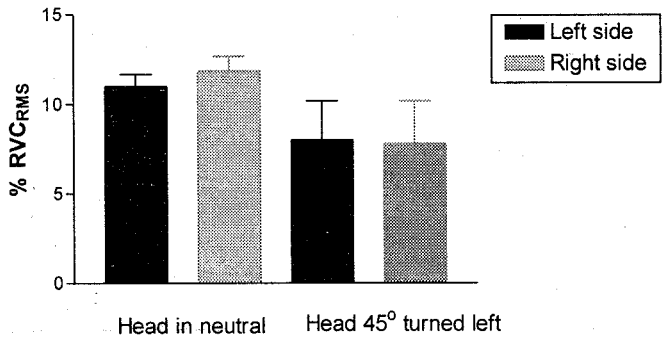

Fig 1. Mean values of %RVC_{RMS} of the right and left upper trapezius muscle under the two conditions

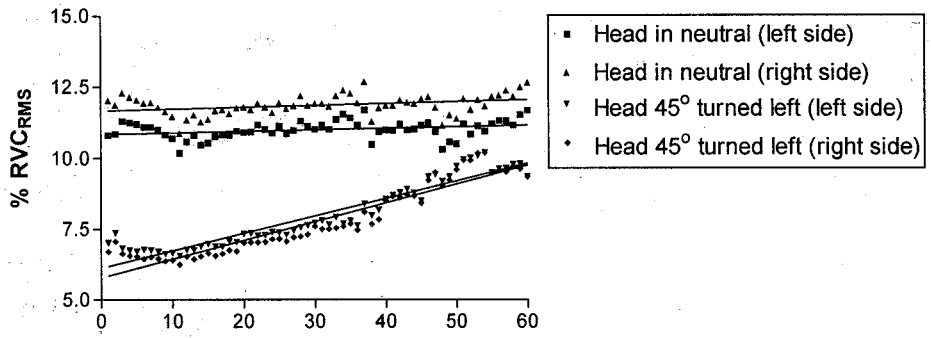

Fig 2. Ensemble-averaged RMS (%RVC) profile of the upper trapezius during typing under each conditions (N=5)

standing, with both arms, at a time, abducted to 90° in the scapular plane and the elbow held straight, with the dorsum of the hand facing upward. For recording of RVC, a weight of 1 kg was held in the hand for 15 seconds. Averaging the middle 5 seconds over four repetitions provides a reference value.

Results

The highest EMG activity of upper trapezius was found in the right side during typing with head in neutral(11.29±1.61%). EMG activity of left side of upper trapezius during typing with head in neutral was 10.95±2.06%. Muscle activity of each of left and right side during typing with head 45° turned left were 8.49±2.21% and 7.94±1.87%, respectively (Figure 1).

The slope of linear regression of the %RVC_{RMS} (t) of the trapezius during typing with head turned 45° to left side showed steeper than that of during typing with head in neutral. The highest slope of linear regression %RVC_{RMS} (t) demonstrated the right side of the upper trapezius muscle when typing with head 45° turned left (Figure 2)(Table 2).

Table 2. Slope of linear regression of the $\%RVC_{RMS}$ (t) for left and right trapezius under each condition

	Linear regression $\%RVC_{RMS}$ (t)			
	Head in neutral		Head 45° turned left	
	Left side	Right side	Left side	Right side
Slope	.0049±.0068[a]	.0063±.0088	.061±.0078	.066±.0074

Discussion

Recent EMG studies related to VDT use work have aimed at quantifying the load pattern of the upper extremity muscles to find the mechanisms of musculoskeletal disorders. The experiments of Westgaard and De Luca (1999) have shown that the motor units with initially higher recruitment thresholds may substitute the motor units with lower thresholds during 10-minute duration of trapezius muscle contraction, indicating that continuous firing may temporarily increase the firing threshold of a motor unit. In our study, because higher threshold motor units are recruited to replace lower-threshold fatigued motor units that have stopped firing, a consistent increase of %RVC was found in the left and right upper trapezius under each condition over the course of working time (Figure 2). Since overexertion of low-threshold motor units is thought to play a role in the pathogenesis of trapezius myalgia (Waersted et al, 1996), static load and the frequency of short EMG pauses (gaps) were especially studied. Hagg and Astrom (1997) found that gap frequency could predict the development of neck/shoulder disorders. Moreover, subjects with neck/shoulder disorders displayed lower relative duration of muscular rest during work, as compared to subjects without disorders. Both these findings are consistent with the "Cinderella hypothesis".

In our study, as shown in Figure 1, %RVC when typing with head in neutral was higher than it was when typing with head 45° turned left. This could be due to the adaptation to position or confidence in computer work task. If our study controlled the typing speed, each condition would have %RVC when typing with head in neutral almost equal to it when typing with head 45° turned left.

Many previous studies recommended that the copy holder should be positioned on one side of the screen(Bauer and Witting, 1998; Grandjean et al, 1983). Lie and Watten (1987) found that the activities of the facial and shoulder muscles were sensitive to visual stress experienced by seated subjects reading at eye level under the different visual stress conditions. The authors suggested that increased activity in postural muscles during the VDT work is due to the connection between the extraoccular and smooth eye muscles and the postural muscle through synapses in the midbrain and brain stem.

In typing with head 45° turned left, the right side of muscle activity was higher

than the left side. This means that when working on a computer with head turned to one side, the opposite side of the upper trapezius muscle predicted as to be more vulnerable to damage.

As shown in Figure 2, %RVC of the trapezius during typing with head 45° turned left increased with working than did during typing with head in neutral. It is suggested that typing with head in neutral is recommended to prevent musuloskelectal disorder than typing with head turned position. Further studies are needed to use various methods of surface EMG data reduction, such as amplitude analysis, fatigue analysis, and EEG gaps, to assess the workload during computer work

Conclusion

Purpose of this study was to find the effect of head posture on EMG activity of both sides of upper trapezius during computer work task. The slope of linear regression of the $\%RVC_{RMS}$ (t) of the trapezius during typing with head turned 45° to left side showed steeper than that of during typing with head in neutral. The highest slope of linear regression $\%RVC_{RMS}$ (t) demonstrated the right side of the upper trapezius muscle when typing with head 45° turned left. This result suggested that maintaining neutral head position during computer work could be useful to minimize the overuse syndrome and CTDs upper trapezius.

References

Bauer W, Wittig T. Influence of screen and copy holder positions on head posture, muscle activity and user judgement. Appl Ergon. 1998;29(3): 185-192.

Grandjean E, Hunting W, Pidermann M. VDT workstation design: Preferred settings and their effects. Hum Factors. 1983;25(2):161-175.

Hagg GM, Astrom A. Load pattern and pressure pain threshold in the upper trapezius muscle and psychosocial factors in medical secretaries with and without shoulder/neck disorders. Int Arch Occup Environ Health. 1997; 69(6):423-432.

Hagg GM, Suurkula J. Zero crossing rate of electromyograms during occupational work and endurance tests as predictors for work related myalgia in the shoulder/neck region. Eur J Appl Physiol Occup Physiol. 1991;62(6):436-444.

Hamilton N. Source document position as it affects head position and neck muscle tension. Ergonomics. 1996;39(4):593-610.

Ignatius YT, Yee TY, Yan LT. Self reported musculoskeletal problems amongst typist and possible risk factors. J Hum Ergol (Tokyo). 1993 ;22(2):83-93.

Kleine BU, Schumann NP, Bradl I, et al. Surface EMG of shoulder and back muscles and posture analysis in secretaries typing at visual display units. Int Arch Occup Environ Health. 1999;72(6):387-394.

Lie I, Watten RG. Oculomotor factors in the aetiology of occupational cervicobrachial

diseases (OCD). Eur J Appl Physiol Occup Physiol. 1987;56(2):151-156.

Moffet H, Hagberg M, Hansson-Risberg E, et al. Influence of laptop computer design and working position on physical exposure variables. Clin Biomech (Bristol, Avon). 2002;17(5):368-375.

Nainzadeh N, Malantic-Lin A, Alvarez M, et al. Repetitive strain injury (cumulative trauma disorder): Causes and treatment. Mt Sinai J Med. 1999;66(3):192-196.

Sommerich CM, McGlothlin JD, Marras WS. Occupational risk factors associated with soft tissue disorders of the shoulder: A review of recent investigations in the literature. Ergonomics. 1993;36(6):697-717.

Sundelin G, Hagberg M. The effects of different pause types on neck and shoulder EMG activity during VDU work. Ergonomics. 1989;32(5):527-537.

Taptagaporn S, Sotoyama M, Saito S, et al. Visual comfort in VDT workstation design. J Hum Ergol (Tokyo). 1995 ;24(1):84-88.

Villanueva MB, Jonai H, Saito S. Ergonomic aspects of portable personal computers with flat panel displays (PC-FPDs): Evaluation of posture, muscle activities, discomfort and performance. Ind Health. 1998;36(3): 282-289.

Waersted M, Eken T, Westgaard RH. Activity of single motor units in attention-demanding tasks: Firing pattern in the human trapezius muscle. Eur J Appl Physiol Occup Physiol. 1996;72(4):323-329.

Westgaard RH, de Luca CJ. Motor unit substitution in long-duration contractions of the human trapezius muscle. Neurophysiol. 1999;82(1):501-504.