ผลของการยืดกล้ามเนื้อคอในขณะพักการทำงานต่ออาการปวดคอ และการเปลี่ยนแปลงของ surface EMG median frequency ในกลุ่มพนักงานสำนักงาน

Effects of short break neck stretching on neck pain and surface EMG median frequency changes in office workers

Atipon Methatip[1*], Pongsak Yuktanandana[2]

[1*] นิสิตปริญญาโทหลักสูตรเวชศาสตร์การกีฬา
[2] ภาควิชากระดูกและข้อ คณะแพทยศาสตร์จุฬาลงกรณ์มหาวิทยาลัย กรุงเทพมหานคร

Abstract

Introduction: Chronic neck pain is a very common complaint among computer users and considered to be a serious work-related musculoskeletal disorder (WRMSD). Chronic neck pain causes sick leave, poor performance, poor quality of life and burdens the economics of the country. Treatment and prevention, therefore, of chronic neck pain among computer users are necessary.

Objective: To study and compare the effects of 4-week short break neck exercise between stretching exercise and relaxation breathing exercise on pain level (VAS), surface EMG median frequency (MF) and the neck disability index score (NDI) in chronic neck pain female office workers who are prolonged computer users.

Participants: The volunteers were 60 Thai female office workers with chronic neck pain from using computer more than 4 hours per day (8.18 ± 2.22) and aged between 25 - 35 years old (29.12 ± 2.99). These participants had not been treated by physiotherapy and/or medicine program.

Methods: Sixty volunteers were divided into 2 groups equally. They were 1) Stretching group stretched neck muscle 30 seconds for 3 times in both upper trapezius (UT) and cervical erector spinae (CES), 2) The breathing exercise group did diaphragmatic deep breathing for relaxation 5 minutes. VAS, MF, and NDI were used as parameters.

Results: VAS pain score in both groups reduced significantly after 4 weeks of exercise. The stretching group reduced VAS from 48.80±18.41 to 26.30±22.22 ($p<0.001$) and the breathing group reduced VAS from 42.83±22.20 to 19.33±20.37 ($p<0.001$). The initial surface EMG MF of all neck muscles in both groups was shifted toward lower frequency which indicated fatigue pattern. Only the left UT and the left CES in the stretching group showed no fatigue after training. There was significant ($p<0.001$) improvement of NDI score in both groups. The stretching group was 5.81 ± 6.29% (13.26 ± 8.81 to 7.44 ± 4.86) and the breathing group was 3.61 ± 0.79% (12.78 ± 10.59 to 9.16 ± 10.33).

Conclusion: The effects of stretching or breathing exercise as a short break exercise at work twice a day in 4 weeks program provided decreased pain level and increased quality of life. The stretching exercise potentially improved muscle fatigability of the neck muscles in the non-dominant side.

Keywords: chronic neck pain, neck exercise, muscle fatigue, median Frequency EMG, Neck Disability Index

บทคัดย่อ

บทนำ: อาการปวดคอเป็นปัญหาสุขภาพที่พบได้อย่างกว้างขวางในกลุ่มผู้ใช้คอมพิวเตอร์ทั่วโลก ส่งผลเสียอย่างมากต่อระบบเศรษฐกิจและสังคม ดังนั้นการรักษาและป้องกันจึงมีความจำเป็นอย่างยิ่ง

วัตถุประสงค์: เพื่อศึกษาการเปลี่ยนแปลงและเปรียบเทียบผลของการออกกำลังกายในขณะพักการทำงานในกลุ่มพนักงานสำนักงานเพศหญิงเป็นเวลา 4 สัปดาห์ ระหว่างการยืดกล้ามเนื้อคอและการหายใจลึกเพื่อการผ่อนคลายต่อระดับของอาการปวด (VAS), surface EMG median frequency (MF), และคะแนนของอาการปวดคอและการดำเนินชีวิต (NDI)

ตัวอย่างทดสอบ: อาสาสมัครหญิงที่มีอาการปวดคอเรื้อรังมานานกว่า 3 เดือน จากการทำงานด้วยคอมพิวเตอร์อย่างน้อยวันละ 4 ชั่วโมง (8.18±2.22) อายุ 25–35 ปี (29.12±2.99) โดยไม่อยู่ในการรักษาด้วยยาหรือกายภาพบำบัด

วิธีดำเนินการ: อาสาสมัคร 60 คน แบ่งเป็น 2 กลุ่ม กลุ่มละ 30 คน คือกลุ่มยืดกล้ามเนื้อคอและกลุ่มการหายใจลึกเพื่อการผ่อนคลาย โดยออกกำลังกายทุกวันที่ทำงานวันละ 2 เวลา วัดผลทั้งก่อนและหลัง 4 สัปดาห์ด้วยการวัดระดับ VAS ระดับ MF และ NDI

ผลการทดลอง: VAS และ NDI ลดลงอย่างมีนัยสำคัญทางสถิติ ($p < 0.001$) จากการออกกำลังกายในกลุ่มยืดกล้ามเนื้อและกลุ่มหายใจลึกเพื่อการผ่อนคลาย การฝึกหายใจลึกเพื่อการผ่อนคลายไม่สามารถแก้ปัญหาอาการล้าของกล้ามเนื้อได้ส่วนการยืดกล้ามเนื้อสามารถแก้ปัญหาอาการล้าของกล้ามเนื้อได้เฉพาะทางด้านซ้ายเท่านั้น

สรุปผลการทดลอง: การยืดกล้ามเนื้อคอทำให้ระดับอาการปวด ระดับอาการล้าของกล้ามเนื้อคอ และระดับคะแนนคุณภาพชีวิตดีขึ้น ส่วนการหายใจลึกเพื่อการผ่อนคลายทำให้ระดับอาการปวดและระดับคะแนนคุณภาพชีวิตดีขึ้นแต่ไม่ได้ทำให้อาการล้าของกล้ามเนื้อคอดีขึ้น

คำหัส: ปวดคอเรื้อรัง บริหารคอ กล้ามเนื้อล้า Median frequency EMG/ Neck Disability Index

Introduction

There are many office workers who use computer longer than 6 hours a day continuously. The intensive computer useage could cause the neck - shoulder musculoskeletal disorder. The workers may need medical service with the chief complaint of chronic neck and shoulder pain occasionally. Computer plays major and universal role in most careers, anyone could hardly avoid computer task. Each career worker spends various time of computer usage. Some career workers such as secretary, accountant, programmer, architect, typist, etc. may use computer for a long period daily. Prolong computer users need prolong neck muscle contraction and position to accommodation their vision in order to type the computer correctly. Working with computer and stress are associated and the users always develop neck pain in the workplace.

Neck pain or cervical myalgia from computer usage is one of the work-related musculoskeletal disorders (WRMSD). This syndrome is the most common health problem among both developed and developing countries. Usually, neck pain is greater among women than men. Due to women is smaller anthropometric and lower shoulder muscles strength, additional, work characteristic is more monotonous task, such as secretary, etc.[1, 2] In Canada, 54% of the Canadian female office workers suffered from neck pain.[3] Around 67% of Dutch female office workers also had experienced neck pain.[4] In United State, more than 600,000 office workers suffered musculoskeletal pain each year.[5] Prevalence of WRMSD in Norway working population rates 30% or even higher.[6] The Denmark national research center referred the problem of neck symptoms in female office workers at 80%.[7] In Thailand, there were 62.7% of office workers with WRMSD, comprised of neck and shoulder 43%, lower back and wrist 36.9%, upper back 29.7%. This symptom occurred in both female and male age groups between 20–60 years old.[1]

In term of economic impact, it was estimated that in 1995, the cost of WRMSD in the USA was approximately $215 billion.[5] The cost of treating neck pain in the Netherlands in 1996 was around $868 million.[4] In 1996, the total cost was added up to approximately 668 million

Euros in 1996.[8] In 2000, 594,000 Dutch males and 1,013,700 Dutch females were registered with chronic neck pain. The average treatment cost of chronic neck pain in Finland in 1988 was estimated to be 240 Euros and the cost due to sick leave per patient case was 653 Euros.[9] For more than a million of computer office workers, complaint of the arm, neck, and shoulder pain were the cause of treatment costs and absentees in the USA rate $45 to $54 billion annually. Additionally in Netherlands annual cost for occupational pain are estimated to be 2.1 billion Euros for 7 million working population.[10] In Thailand, number of workers' WRMSD compensation claim from the data of the Social Security Office in 2003 was 11,737 of 55,596 claimed cases (21%).[1] The cost of insurance and compensation for patients, employers could affect finance, economic and social.

Chronic neck pain among office workers is a very important health problem. If the strategy of prevention or treatment is not appropriate, the problem may be more severe and affect more workers. The reimbursement for treatment and sick-leave would increase and cause economic and social impact. Therefore, any studies for better understanding of the cause, prevention and treatment of WRMSD could benefit for the workers, society and economy of the country.

The aims of this study were to investigate and compare the effect of 4 weeks short break neck stretching exercise and relaxation breathing exercise in female office workers with prolong use of computer in term of neck pain, neck muscle fatigability by surface EMG median frequency (MF), and the neck disability index (NDI). The hypothesis was computer user office workers in neck stretching group would have pain level, Surface EMG median frequency level changes, and the neck disability index level less than the ones in breathing exercise for relaxation group. The study was approved by the Institutional Review Board of Faculty of Medicine, Chulalongkorn University.

Method

Participants

Volunteers were recruited from various companies in Bangkok. Everyone used computer desktop or Video Display Terminal (VDT). The population of this study was 25–35 year–old female office workers including secretary, human resource. The sampling subjects were volunteers with chronic neck pain. The inclusion criteria were female office workers aged 25–35 years old, performed a minimum daily 4 hours computer usage with mainly typing task, experienced neck pain or discomfort during working or after computer task for at least 3 months, not in medical treatment program or physical therapy program and willing to participate in clinical trial and sign the consent form. The exclusion criteria were past history of neck surgery, and neck trauma, showed sign and symptom of cervical radiculopathy or myelopathy, sign and symptom of systemic illness or connective tissue disorder, present illness such as rheumatoid arthritis or spondyloarthropathy, constant severe pain (VAS > 7),[26, 27] contraindicate for stretching exercise such as acute inflammation affecting the joint or surrounding tissues (soreness, warm, swelling, redness), sharp pain associated with stretch, and local hematoma as a result of an overstretch injury.

All participants were computer–generated random sampling into 2 groups; experimental group and control group.

Sample size calculation

To compute the target population was calculated from David M. Kietrys which studied effects of at work exercise in computer user 72 office workers. To be divided into various exercise types. The result showed stretching group is better 63% (15/24) and control group 21% (5/24)13 that calculate in the proportion difference equation with two - sample population.

$$n/group = \frac{\{Z_{\alpha}\sqrt{(r+1)P(1-P)} + Z_{\beta}\sqrt{rP_1(1-P1) + P_2(1-P2)}\}^2}{r(P_1 - P_2)^2}$$

n/group = 26.85 ≈ 27

To prevent participants loss, additional, should add more participants 10% approximately. Finally, this is 27 + 3 = 30 participants for each group.

Methodology protocol

After the explanation of the study objective and protocol, all volunteers who were willing to participate, were screened by the inclusion and exclusion criteria. Volunteers who met all criteria reviewed the information sheets and signed consent form. All participants filled the personal data form and were randomized into two groups; stretching exercise (experimental) group or breathing exercise (control) group; by a computer generated randomize technique, with 30 participants in each group.

Researchers interviewed the participants and filled the case record form. Visual analog scale (VAS) for neck pain and the neck disability index (NDI) score was collected.[13]. Surface Electromyography (SEMG) of upper trapezius and cervical erector spinae were collected using standard technique.

The median frequency of SEMG was collected during 120 minutes computer using trial. The laboratory was set as similar as the real work characteristic that prolonged static posture and continue typing. The SEMG collecting was captured 5 times every 30 minutes.

All participants were instructed and trained the stretching exercise program or breathing exercise program according to the exercise group. Exercise information sheet were also given to each participant. All participants performed short break exercise during computer work task two times a day, every working day for four weeks. Investigator sent SMS to all participants to remind exercise performance at 10:00 and 15:00 0'clock Monday to Friday. Investigator also made telephone calls to monitor the exercise of all participants. VAS pain score sheet were filled at the end of every week.

After the completion of exercise program, all participants were appointed to be interviewed and for collection of VAS score, NDI score and SEMG median frequency data.

Data collecting

The Visual Analog Scale

Intensity of neck muscle pain was rated by individual participants on a 100–mm visual analog scale, where at 0 mm was "not pain at all" and 100 " was the worst imaginable pain". The score was to be recorded at rest, as pain at rest after 120–minute computer typing task. All participants also received VAS record form to rate the pain intensity every Friday evening for 4 weeks. VAS sheets were separated to 4 papers for 4 weeks. Each paper was then marked | on the 100–mm line and placed in an envelope to prevention the comparison during measurement. There were total of 5–VAS score including pretest and 4 - week tests. The score was measured by ruler in the length of millimeter unit.

The SEMG median frequency

Skin area over neck extensor and upper trapezius on both sides was exposed. Skin on both cervical erector spinae muscles (CES) and upper trapezius muscles (UT) were cleaned and abraded using 75% alcohol and gauze to minimize skin impedance. Bipolar self - adhesive Ag/AgCl surface electrodes 18 mm. diameter were placed on four muscles, including both upper trapezius located along the ridge of the shoulder, a halfway between the cervical spine at C7 and the acromion process and both cervical erector spinae about 1 cm. lateral to the C4 spinous process bilaterally, with 36 mm inter–electrode distance (center to center).

The instrument used for EMG capture in this study was BIOPAC MP 100 (BIOPAC Systems Inc., USA) The captured EMG signals were set as sampling frequency of 1,000 Hz and a band–width 10 - 500 Hz. EMG data were captured from the four muscles, included left CES (Lt. CES), left UT (Lt. UT), right CES (Rt. CES), and right UT (Rt. UT). A high pass filter at 20 Hz, a low pass filter at 500 Hz, and notch filters at 50 and 60 Hz to reduce the noise levels. The participants had to adjust posture, work-station, chair, and computer set into proper ergonomics, and performed typing trial for 120 minutes. The EMG signal data was capture 5 times over the 120 - minute, at 0, 30^{th}, 60^{th}, 90^{th}, and 120^{th} minute for a 60 - second period capture. Each capture was then transformed to the median frequency value by AcqKnowlegde Software® (BIOPAC Systems Inc., USA).

The Neck Disability Index

The neck disability index (NDI) score was used. NDI score consisted of 10 sections including; pain intensity, personal care, lifting, work, headaches, concentration, sleeping, driving, reading and recreation. To score the NDI, participants chose the most closely answer in each section, and scores were calculated according to the NDI formula. This questionnaire needed to be answered in pretest and posttest after computer typing trial only. Units were percentage.

Participant instruction protocol

Neck stretching instruction for experimental group

Participants sat upright in working chair with stretched upper trapezius muscle and cervical erector spinae. To stretch upper trapezius muscle was side by side. Start right neck lateral stretching by using left hand pull gentry at the temporal region of head to the left side until felt tightness or a tolerable point and sustain the position for a certain period of time.[14] Stretching of cervical erector spinae muscle was putting both hands behind the head at the occipital area and pushed gentry to bend head forward until felt tightness. Each stretching needed holding 30 seconds with repeated 3 times.[5,15] To perform stretching exercise was at 10:00 am and 3:00 pm. All participants would receive reminding SMS before both practice sessions.

Deep breathing exercise instruction for control group

Participant sat upright comfortably and relaxed in the working chair. Both hands were placed over diaphragm or inferior to xyphoid process. Participants inhaled through nose until abdomen inflate with no shoulder elevation before exhaled with purse lip technique.[16] This breathing exercise was performed daily with 5- minute period in workplace at 10:00 am and 3:00 pm. All participants would receive reminding SMS before both practice sessions.

Research Laboratory

This experiment gathered data at Sports Medicine Research Center, 4th floor Padthayapatana building, Faculty of Medicine, Chulalongkorn University.

Data Analysis

All data was verified after collection. All demographic data was analyzed by descriptive statistic that demonstrate as Mean±SD. VAS pain score, NDI score and surface EMG median frequency value between before and after 4-week-sexercise in both group were compared using pair t-test. Between-group comparison was analyzed by ANOVA with significance level at 0.05 ($p < 0.05$).

Result

No one dropped out during the experimental period. Both groups were similar in age, physical characteristics, and computer usage duration with keyboard, excepted mouse duration (Table 1). Table 2 showed percentage of exercise session, they were no significant difference ($p > 0.05$).

Neck pain score (VAS) was a self-report pain intensity score. In this study, VAS pain score referred to pain of all involved muscles around the neck. Both stretching exercise group and breathing exercise group had moderate pain initially and demonstrated reduction of pain score significantly ($p < 0.001$) at the end of the study compared with at beginning (Table 3). The changes between pretest and posttest of pain level in both groups were no significant difference (Table6).

The neck disability Index (NDI) was also self-reported levels of pain that associated between pain and disability. Score of disability in both groups reduced significantly 4 weeks after exercise (Table 4). There was also no difference between group difference at pre-test and post-test period (Table 7).

Table 5 shows median frequency of 4 muscles including right cervical erector spinae, left cervical erector spinae, right upper trapezius and left upper trapezius in both stretching exercise and breathing exercise. After 120 minutes of computer typing trial at the beginning of the study, median frequency of all muscles compressed toward lower frequency with significant different between at 0 minute to 120 minute. After 4 weeks of exercise, all muscles except left upper trapezius and left cervical erector spinae in stretching exercise group showed fatigue pattern with the median frequency compressed toward

lower frequency significantly.

Figure 1 - 4 showed the mean of the MF at five captures in the 2 - hour typing trial in both groups. They demonstrated the apparent trend to be lower MF at 30th min, after that they were little upward trend until the end of typing trial. However, the most of them were downward shift significantly, except the post – test of Lt. UT and CES in neck stretching exercise (Figure 1 and 2).

Table 1 Baseline characteristics of subjects (n=60)

Features	Stretching group n=30	Breathing group n=30	p values
	Mean(SD)	Mean(SD)	
Age (years old)	29.83(2.98)	28.40(2.86)	0.709
Weight (kg.)	52.37(7.03)	54.18(10.52)	0.198
Height (cm.)	159.67(5.94)	158.37(7.22)	0.360
BMI (kg/m^2)	20.52(2.32)	21.74(3.92)	0.182
Work hour (hr)	8.70(2.26)	7.67(2.09)	0.071
Keyboard (hr)	5.20(1.06)	5.27(1.33)	0.832
Mouse hour (hr)	3.47(1.57)	2.40(1.10)	0.003*
VAS 0th	48.80(18.41)	42.83(22.20)	0.001*
Pre – test of NDI (%)	13.26(8.81)	12.78(10.59)	0.000*

**p <0.05 represents statistic significant*

Table 2 Percentage of exercise session (n=60)

	Stretching group (n=30) Mean (SD)	Breathing group (n=30) Mean(SD)	p values
Exercise session (%)	86.83 (11.82)	88.42 (12.70)	0.619

Table 3 Visual Analog Scale (VAS) (n=60)

Group	VAS 0 (mm.)	VAS 4th (mm.)	p values
	Mean (SD)	Mean (SD)	
Stretching group	48.80 (18.41)	26.30 (22.22)	0.000*
Breathing group	42.83 (22.20)	19.33 (20.37)	0.000*

**p< 0.001 represents statistic significant*

Table 4 The neck disability index (NDI)

Group	Pre - test	Post - test	p values
	Mean (SD)	Mean (SD)	
Stretching (%)	13.26 (8.81)	7.44 (4.86)	0.000*
Breathing (%)	12.78 (10.59)	9.16 (10.33)	0.000*

**p< 0.001 represents statistic significant*

Table 4 The neck disability index (NDI)

Group	Muscle	Pre – test Mean (SD)		p values	Post – test Mean (SD)		p values
		Min0th	Min120th		Min0th	Min120th	
Stretching	Lt. CES	181.25 (24.33)	165.73 (19.53)	0.000*	173.86 (23.07)	171.04 (23.07)	0.648
	Lt. UT	183.10 (33.92)	157.03 (27.44)	0.001*	171.41 (28.40)	161.07 (30.82)	0.120
	Rt. CES	186.68 (21.04)	171.49 (24.05)	0.002*	185.39 (21.50)	175.62 (27.27)	0.014*
	Rt. UT	193.10 (30.34)	141.00 (27.02)	0.000*	194.99 (41.02)	150.70 (31.23)	0.000*
Breathing	Lt. CES	174.42 (21.32)	165.37 (20.66)	0.017*	180.39 (26.91)	167.99 (18.39)	0.018*
	Lt. UT	180.19 (42.37)	158.33 (31.42)	0.002*	169.11 (29.17)	151.97 (25.06)	0.003*
	Rt. CES	181.34 (27.24)	168.32 (21.55)	0.009*	183.83 (25.66)	173.04 (28.95)	0.009*
	Rt. UT	186.43 (39.60)	147.64 (30.84)	0.000*	179.61 (41.29)	135.41 (23.87)	0.000*

p <0.05 represents statistic significant

Table 6 Comparison of difference between VAS0 and VAS4 from both groups by ANCOVA.

Mean(SD)	Stretching group	Breathing group	p values
VAS 0th – VAS 4th	22.50 (22.10)	23.50 (23.41)	0.866

Table 7 Comparison of difference NDI between pre - test and post - test from both groups by ANCOVA.

Mean(SD)%	Stretching group	Breathing group	p values
Pre – Post test	5.81 ± 6.29	3.61 ± 0.79	0.122

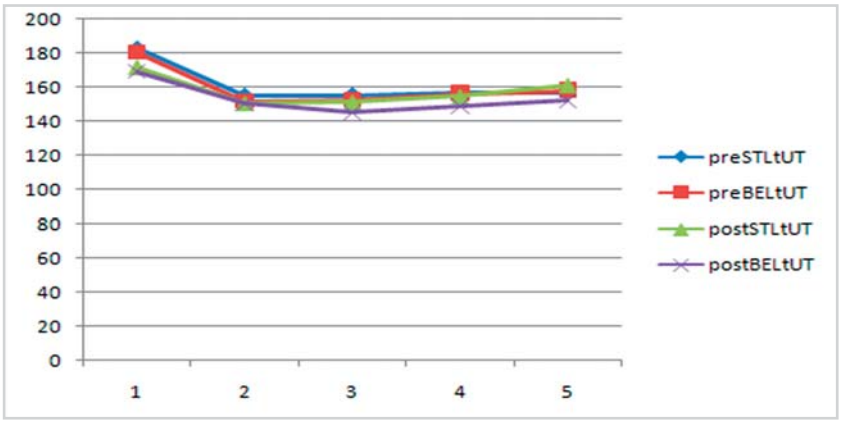

Figure 1 SEMG median frequency of Lt. UT

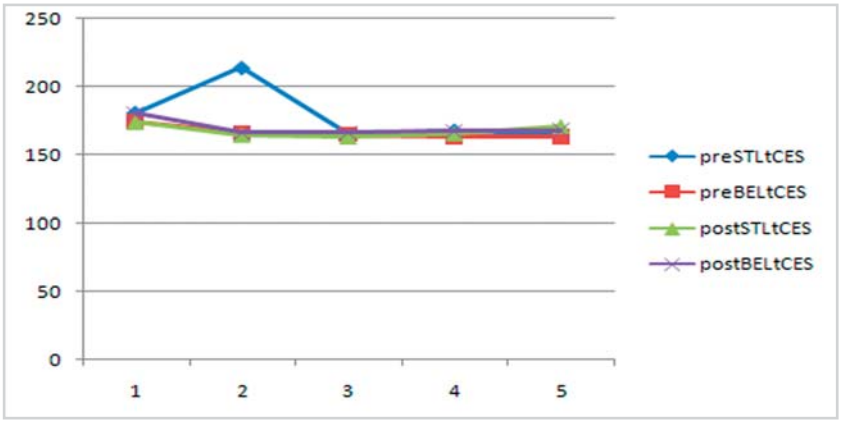

Figure 2 SEMG median frequency of Lt. CES

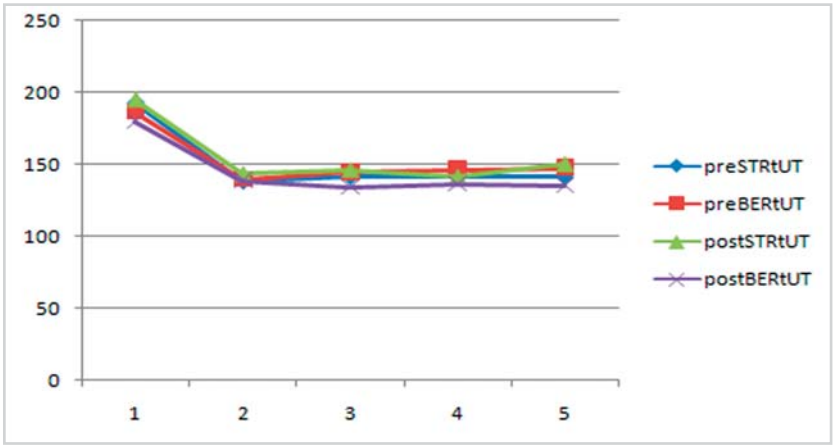

Figure 3 SEMG median frequency of Rt. UT

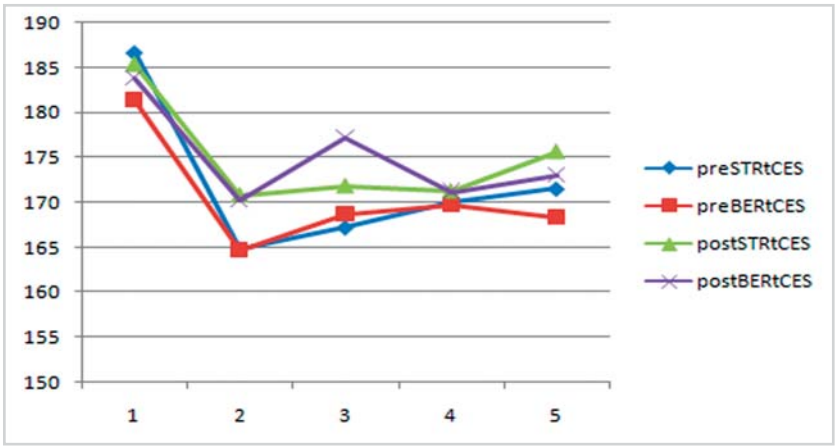

Figure 4 SEMG median frequency of Rt. CES

Discussion

Computer users used both hands for keyboard task and right hand for mouse task, which may reflect that right hand, may work greater than left hand. As shown in Table 1, average computer usage duration and keyboard hours were very similar in both groups but stretching exercise group used mouse longer than breathing group significantly. It might be potentially painful on the right side more than left side if right hand was used more than the left one. Mean age of all samples in this study was below 30 years old which should eliminate degenerative cervical spondylosis that might cause neck pain rather than work related chronic neck pain from computer task fatigue.

Both stretching exercise and relax breathing exercise could reduce VAS pain score at neck significantly ($p<0.001$) after 4 weeks of exercise (Table 3). Stretching exercise is a popular and widely prescribed treatment for neck pain. The effects of stretching contribute to reduce discomfort and pain around the neck effectively. Sustained contraction for prolonged period of time is related to decreased blood flow in the muscles. Stretching provides more efficient muscle contraction requiring less oxygen. Additional, stretching is able to increase the pain threshold that decreased sensitivity of muscle spindles and inhibit α motorneuron due to analgesic effect of stretching.[5] Thus, there is a growing utilization of stretching exercise for reducing the risk of work - related musculoskeletal disorder in the workplace, especially, in computer users. A systemic review 5 showed a positive outcome on the productivity and release fewer neck symptoms using programs of "stop and stretch" or "stretch break" program among computer users during working hour. There are various protocols of stretching intervention in office

workers that provide positive effects. In this study, stretching exercise in the office twice a day while at work for a period of 4 week was able to help reduce discomfort from neck and neck pain significantly. Other studies[13, 17] showed not only neck pain but also upper extremities pain and discomfort could be improved by sustained stretching. The program set a sustained stretch 20–30 seconds at least 3 times daily during working hours and after working over a 6 - month period.[17] A home program stretching twice a day for one week followed by sustained stretch for 30 seconds for 10 times also showed the effectiveness of pain reducing in individuals with neck and upper back pain from myofascial pain syndrome.[15] Sustained stretching was always prescribed to chronic neck pain patients. Any sustained stretching, as well as, conventional static stretching and muscle chain stretching, in accompany with manual therapy provided significant pain relief, ROM improvement, and quality of life improvement.[18] Working break stretching, whether rest break 5 minutes in every 35 minutes or 7 seconds micro break in every 5 minutes at computer work station showed the efficacy of neck pain reduction during computer work.[19] Yoga is an exercise that combines stretching with diaphragmatic breathing exercise. Yoga during working and rest could reduce pain score, increase pain threshold and improve quality of life in housewife with chronic neck and upper back pain.[20] There were increased used of mixed intervention model included massage, stretching, mobilization, correct posture, and relaxation techniques which provided reduction of pain intensity and muscle tone that induced by stress.[21] Deep breathing exercise also showed positive outcome in patient with medical condition associated with anxiety/depression and musculoskeletal pain syndrome.[22] The total workout in this study was 10 minutes per day for 4 weeks, this amount of exercise showed efficacy in the reduction of neck pain and improved neck disability index scores (Table 4).

Deep breathing exercises released stress and reduced discomfort of upper trapezius and cervical extensor spinae muscles.[13] This study compared the effect of stretching exercise, strengthening exercise and breathing exercise in the office twice a day for 4 week and found that all exercises could reduce neck disability index score. All of studies mentioned showed that breathing exercise provided improvement of function outcome as same as stretching exercise. The breathing exercise protocol in this study could reduce the pain score and improve the quality of life significantly.

The frequency domain of surface EMG in this study used median frequency as the indicator to measure pain and neck muscle fatigue phenomenon. The lowering of median frequency in the linear regression slope and increase EMG activities after prolonged muscle contraction indicated muscle fatigue around neck muscles.[23] All participants in this study showed neck pain and muscle fatigue after 120 minutes computer typing trial when compared the median frequency of neck muscle before and after the computer tasks. After 4 weeks of breathing exercise, surface EMG of neck muscles still showed the lowering of median frequency after 120 minutes computer typing trial while there was improvement of the fatigue pattern by surface EMG median frequency in left upper trapezius and left cervical erector spinae. The right upper trapezius and right cervical erector spinae still showed lowering of the median frequency after prolonged working. These findings were similar to Grace study [24] who found that EMG muscle activity of symptomatic office workers on the Rt. CES and Rt. UT was more than Lt. side. This finding may imply that right side worked more than left side and 4–week stretching exercise still could not prevent muscle fatigue on the right side.

There was another study 25 using surface EMG analysis to evaluate physiologic of muscle changes in female computer users during 120 – minute typing task. The results of this study showed downward shifting of the median frequency of Rt. CES, Lt. CES, and Lt. UT, but not Rt. UT. Mitsutochi et al 23 assessed the development and recovery of muscle fatigue by analysis of surface electromyographic median frequency. This study showed that after 120 minutes typing with the perception of fatigue, there was downward shift of median frequency surface EMG and the frequency increased after rest period. There were some studies exploring the relationship between EMG amplitude and functional tests and showed greater

surface EMG activity of neck muscles during the test session.[26] Another study tried to explain the relationship between surface EMG analysis and psychosocial stress test in chronic myalgia females but there was still no conclusion.[27] Most of the studies did not explore the effect of exercise intervention in the benefit of changing muscular fatigue pattern by surface EMG frequency domain test. This study tried to study the effect of stretching exercise and relaxation breathing exercise to improve neck muscle fatigue pattern, it could be observe that the stretching exercise could only improve fatigue on the left upper trapezius and the left cervical erector spinae which might be used less than the right side neck muscle during computer work.

This study has limitations, such as the participants would be bored due to hour typing trial, therefore the participants might be motivated for control speed of typing over the trial. This study is unable to compare the effects of stretching across different occupational groups with distinct demand. Finally, deep breathing exercise for relaxation was possible to reduce the pain intensity; farther study could be set as normal life style.

Conclusion

The effects of stretching exercise from short break exercise at work twice a day for 4 - week reduced neck pain level, improved quality of life, and reduced muscle fatigue especially on the left side. The effects of 4-week breathing exercise for relaxation also improved pain level and quality of life but not improved neck muscle fatigability. Thus, short break stretching exercise should be recommended to computer users in order to reduce neck pain and neck muscle fatigue.

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