Changes in Range of Motion and Muscle Strength in Occupational Neck Disorders A Study on Computer Workers

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ABSTRACT

Objectives: *Occupational health professionals reported a large numbers of musculoskeletal disorders, particularly affecting neck and upper limb related to computer and other occupational work. These disorders are associated with ergonomic factors, such as repetitions, force, static muscle loading, and extreme joint position that may lead to muscle, tendon, and nerve entrapment disorders. So far there are neither clinical nor biomechanical assessment tools to study such cases and the need to develop normal values for computer workers in Egypt is still present.* ***Methods:*** *Forty five subjects participated in the study. All were computer workers and were categorized into 3 groups: 15 normal as a control, 15 with neck pain and 15 without neck pain. They were tested using the cervical range of motion (CROM) device. Muscle strength of the neck extensors and the upper trapezius muscle were tested using load cell for all the groups. Data analysis was by two one-way MANOV A (one for each criterion) with a post hoc analysis to test the significant difference between the groups using these criteria.* ***Results:*** *Computer workers with neck pain developed limited neck ROM in side-bend and retraction, reduced neck extensors and upper trapezius muscle strength. If neck pain is absent results showed limited ROM of neck side-bend, reduced neck extensors muscle strength.* ***Discussion / Conclusion:*** *Posture induces disorders at the neck extensors and upper trapezius muscles in computer workers, even if symptoms are absent*
Key words: *Musculoskeletal Disorders, Occupational, Neck ROM, Neck Pain*

INTRODUCTION

Observing an inversed function of C7-T1 using the cervico-thoracic ratio (CTR) based on absolute values of skin distraction between C7 and T5, many workers reported disturbed joint mobility of the cervical spine with limitation of ROM, causing pain [1-2]. The measured C7-Tl function therefore may become an objective diagnostic criterion of neck and shoulder pain and can be used for follow-up and to assess treatment[3]. Other investigators studied AROM in the sagittal plane and isometric muscle strength of 90 patients complaining of neck pain before and after training. They used MedX Cervical Extension Machine. The study showed that a rehabilitation program using the same machine, improves neck AROM and the isometric muscle strength of the neck extensors with significant decrease in neck pain. Some of the studies also suggested that increased muscle strength, ROM and endurance may alleviate neck and shoulder pain and discomfort[4]. Other workers observed that in industrial countries there is an association between functional neck disorders with weakness and neck pain and muscular fatigue[5,6]. Another longitudinal study showed reduction of neck muscle strength in women who performed heavy manual work with a reduction in neck disorders after a controlled physical exercise[7,8,9]. Young women clerks showed improved neck muscle strength and reduced neck pain after nonspecific training of the shoulder and neck muscles. Also there was improved neck muscle strength, together with improvements of isometric strength of the cervical extension with rehabilitation programs, attributing pain as the cause muscular weakness and fatigue[10,11,12,13].

Neck, muscle strength has been documented to be an important factor in stability of the cervical spine[14]. Other studies showed the importance of strengthening the neck muscles to reduce neck pain and minimize the risk of neck injury[15]. These results lead to suggest the importance of defining safe and effective methods for strengthening of the cervical muscle. Some workers suggested that if trunk muscle weakness can cause low back pain, then it is assumed that strengthening exercises of the back muscles would reduce such pain[16-17]. Similar arguments could be made for the cervical flexor and extensor muscles as significant reduction in neck pain with improvement in neck ROM and muscle strength following specific training of the cervical spine was observed[18]. Quantitative evaluation of the strength of neck flexors by the strength gauge dynamometer proved a definite correlation between chronic neck pain and cervical muscle weakness or fatigue[19,20,21,23]. In some other studies such a correlation was not present[23] .

PATIENTS AND METHODS

Patients

After reading and signing a consent (format approved by the Human Subjects and Review Committee at Texas Woman's University), forty five subjects participated in the study. All were in the third and fourth decades. They were categorized as three groups each is formed of 15 subjects: G1 includes 15 normal subjects representing a control group, while G2 and G3 were computer users (5-6 hours per day 5 days per week for more than 3 years). G2 patients suffer from neck pain for more than 6 months, while G3 subjects had no such complaints.

Participants of the three groups were tested using the following

1-Testing Chair: Is a custom-designed force measurement apparatus. The chair has perforated modular tubing anchored to the front and back the apparatus and could be adjusted in height to accommodate different subjects. The posterior tubing houses load-cell force transducers and cuffs positioned to fit against the subject's head, and two other cuffs with adjustable arms were placed on the shoulders, to provide resistance for upper trapezius isometric contractions.

2-Cervical Range of Motion Unit: to measure cervical spine ROM It consists of a plastic frame that was placed on the subject's nose bridge and ears and secured to the head by a Velcro strap. Neck flexion and extension movements were recorded by a gravity goniometer attached to the side of the plastic frame. Another gravity goniometer was attached to the front of the plastic frame to measure the neck side-bend. Neck rotation was recorded by a compass goniometer attached horizontally to the plastic frame on the central top of the subject's head. A magnetic yoke was placed on the shoulders with the arrows pointing north to align the magnetic fields of the yoke's magnets and the earth, in order to minimize the chance of errors in rotation when using the compass measurement. A new attachment was added to measure head retraction and protraction. It consisted of an adjustable rod, and it reached the transverse measurement arm of the CROM with an arrow to determine protraction and retraction in centimeters while the subject maintained the gravity goniometer at zero to cancel flexion and extension.

3-Load Cell Force Transducers: to measure isometric forces using load cell force transducers with force sensitivity up to 100 lbs. The voltage difference of displacement of the force transducer was transmitted to an oscilloscope through a power amplifier, with gain controls. The oscilloscope was used to measure muscle forces after they were converted to differential voltage. The force transducer was calibrated linearly as 1.5 mv/5 lb.

Procedures

1-Clinical Assessment: History taking and physical examination for each subject was done. Each was evaluated by a series of neurological (dermatomal, myotomal and reflex) tests and safety tests (alar, transverse ligament and vertebral artery) to identify any significant problems in the neck and shoulder areas. Subjects with positive safety tests were excluded from study. Other tests included active and passive ROM of the shoulders and palpation of the skin, muscles and spine to rule out any postural defects or trauma.

2-Testing: Subject sat in a comfortable straight-back chair with no arm support. The lower back was supported against the back of the chair. The arms were hung relaxed at the sides and both feet were flat on the floor. The subject was stabilized in the chair using four wide straps fastened across the pelvis and the chest. The shoulders were exposed. By placing the CROM on the head of the subject over the ears and the nose-bridge, (similar to wearing eyeglasses), the rotation arm attachment was applied to measure rotation movement.

For training purposes each subject was asked to do proper neck movements in each direction (flexion, extension, left lateral flexion, right lateral flexion, left rotation, right rotation, retraction and protraction) as far as he/she could go pain free. For three times prior to the test, after this he was asked to perform each movement three more times for measurement and the average was calculated. Five minutes later, he/she was asked to do isometric pushing movements against the transducer cuff complex in head extension three times, with progressively increasing forces Having 5 minutes rest between, the subject was asked to perform three sustained isometric MVCs neck extensions for 10 sec each. The average MVC force (muscle strength) was calculated from the oscilloscope. The head cuffs were then replaced with shoulder cuffs that test shoulder shrugging. And he subject was asked to do isometric shoulder shrugging three times against the cuff with progressively increasing forces to get the feel for the task requirements. He then asked to do three sustained isometric (MVCs) shoulder shrugs of 10 sec each. With 5 minutes rest in-between the average MVC from the oscilloscope was calculated.

RESULTS

1- *Neck Range of Motion Measurements:* Measurement of neck ROM showed reduced value of side-bend, rotation, flexion, extension, protraction and retraction in both computer workers groups (G2 and G3) compared with normal subjects (G1)(Table1). The values of the movements were smaller in G2 (computer workers with neck pain) than G3 (computer workers without neck pain) in most movement directions. The variability among subjects, seen in the SD values, was higher in G2 and G3 than in normal subjects. Such variability was more pronounced in G2 than G3 in most movement directions reflecting painful movements in G2 subjects (Table2). Data were analyzed using a one-way MANOV A, between-groups design (Table3, Fig.1). The results of this analysis revealed a significant difference [Wilks' Lambda = .412, E (12, 74) = 3.440, 2<.001] in ROM between groups. Subsequently, follow-up testing (alpha = .0027) of the univariate group effects, one-way ANOV As, showed that at least two of the three groups were significantly different with respect to side-bending LE (2,42) = 9.308, 2<.001] and retraction LE (2,42) = 9.097, 2<.001]. Using Turkey's test for multiple comparisons, results demonstrated significant differences between G 1 and G2 and between G 1 and G3 with respect to side-bending (Fig. 2) and significant difference between G1 and G2 with respect to retraction .The results showed that the differences among the three groups were not significant with respect to neck ROM in flexion, extension, rotation, and protraction. Also the difference between G2 and G3 in retraction was not significant.

2- *Muscle Strength Measurements:* Strength measurement showed substantial reduction in its value during head extension (CPM) and shoulder shrug (UTM) in and G3 compared with G 1. The reduction were more pronounced in G2 than G3, reflecting the painful symptom of the neck in G2. Concerning ROM measurements, the variability in the value of the strength measurements for CPM and UTM in G2 and G3 were not higher than those in G1. Data were analyzed using a one-way MANOV A, between groups design. The results of this analysis revealed a significant difference [Wilks' Lambda = .440, E (4, 82) =10.416, 2<.001] between groups. Subsequently, follow-up testing (alpha = .008) of the univariate group effects, one-way ANOV As, showed that at least two of the groups were significantly different with respect to neck muscle (CPM) strength [E (2,42) = 18.259, 12<.001], and upper trapezius muscle (UTM) strength [E (2,42) = 14.743, 12<.001]. Using Tukey's test for multiple comparisons, results demonstrated significant differences between G 1 and G2 and between G 1 and G3 with respect to CPM (Fig.3), and significant differences between G 1 and G2 with respect to UTM. The results demonstrated that the difference between G2 and G3 was not significant with respect to CPM. There were no significant differences between G 1 and G3 or between G2 and G3 with respect to UTM.

Table(1): MANOVA of the neck ROM in the three groups

Dependent Variable	Type III sum of squares	df	Mean square	F	Sig
Flexion	683.2	2	341.6	6.3	.004*
Extension	28.3	2	14.1	.13	.878
Retraction	10.1	2	5.0	9.1	.001*
Protraction	7.7	2	3.8	3.0	.062
Side-bend	781.9	2	390.9	9.3	.000*
Rotation	459.4	2	229.7	3.4	.041*

*Significant alpha=0.0028

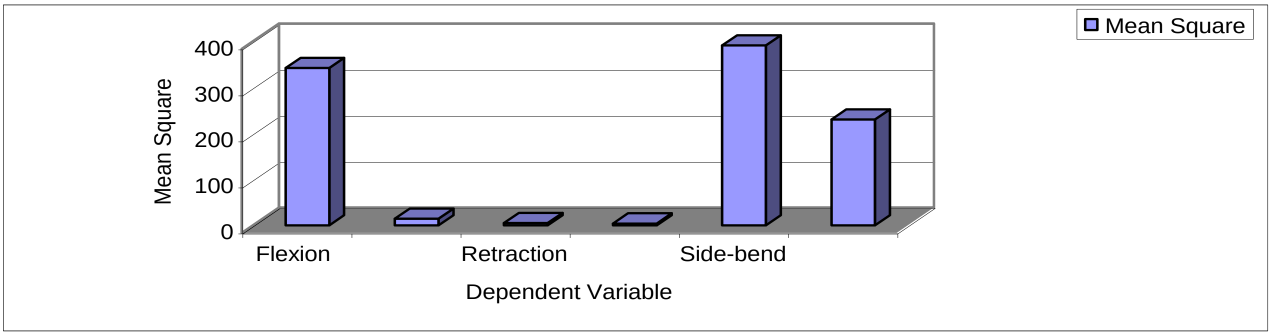

Fig. (1): MANOVA of the neck across the three groups

Table(2): Descriptive statistics of the three groups for Neck Extensors (CPM) and the upper Trapezius muscles(UTM)

Group	Muscle	Minimum	Maximum	Mean	SD
1	UTM CPM	3.00 2.00	8.00 5.00	4.72 3.28	1.29 .966
2	UTM CPM	1.50 1.00	4.50 3.00	2.68 1.79	.76 .63
3	UTM CPM	2.00 1.00	5.00 3.00	3.61 1.88	.97 .63

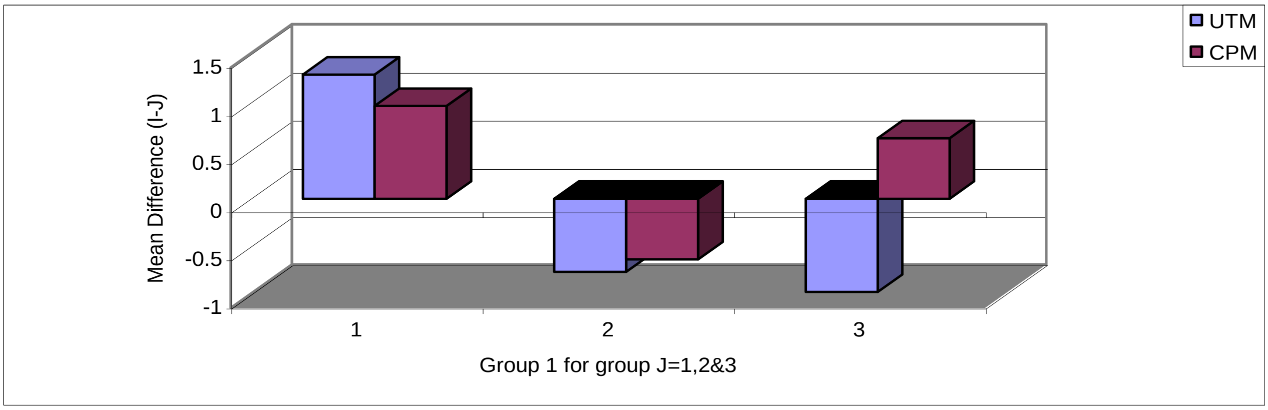

Fig (2): Post-hoc tests (Turkey): Retraction variable

Table (3): MANOVA of muscle strength in the three groups

Dependent Variable	Type IIIsum of squares	df	Mean sq.	F	Sig
Neck Extensors	21.0	2	10.5	18.3	.000*
UpperTrapezuis	31.2	2	15.6	14.7	.000*

*Significant alpha=0.0085

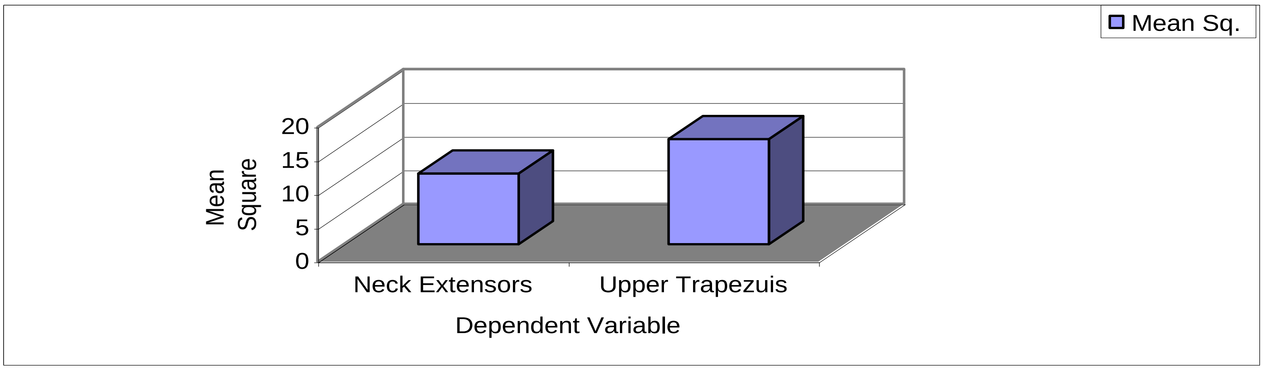

Fig (3): MANOVA of the muscle strength across the three groups

DISCUSSION

Present work signifies reduction in neck side-bend ROM in computer workers (with or without neck pain) compared with normal subjects. The limitation increased in computer workers with neck pain over those without neck pain. This was possibly due to postural limitation adopted by those groups for extended periods during their daily routine; which might result in stiffness of the involved structure. This limitation could also be due to the neck and /or shoulder pain, muscle spasm, weakness or fatigue of the neck muscle. Identical results were similarly reported with patients working with forest machines and having neck pain. They proved to have limited cervical ROM with significant limitation in the horizontal plane movements when compared with the workers having no pain, suggesting decreased neck ROM by aging[1,2].

A non significant difference was found concerning the decrease in the three dimensions (sagittal, coronal, and horizontal) in individuals whose age 50-54 years compared to those having their age between 35-39 years. Patients who complained of neck pain during the preceding 12 months had significantly lower ROM in the cervical flexion-extension movements than those without pain [3]. This may be associated with limitation of ROM of the cervical spine with neck shoulder pain [4]. When radiography was used for testing the neck ROM in frontal and sagittal planes there were lower values than those reported in the current study[5]. This might be due to the isolation of the upper thoracic spine from the cervical one during testing. The cervical ROM (flexion, extension, right and left rotation, right and left side-bending) in the G1 of the present work was compatible with those published before. In previous studies, the mean and standard deviation of the male ages 40-49 years were (49.5±11.4) in flexion, (62.2±12.2) in extension, (62±7.6) in left rotation, (64.6±9.6) in right rotation, (35.6±8) in left lateral flexion, and (38±1 0.9) in right lateral flexion, with higher values in young females[6,7]. These were compatible with the values obtained in this study with the mean and standard deviation of (502:6.6) flexion, (64.8±6.5) in extension, (68.5±7.5) in left rotation, (68.2±7.1) in right rotation, (42.9±2.2) in left lateral flexion, (43.4±2.7) in right lateral flexion. Age and gender were matched in the three groups in this current study. Our results of reduced ROM were more pronounced in side-bending and retraction movements. Previously reported studies showed similar limitation in side-bending movement direction and reduced neck ROM in flexion, extension and axial rotation in the neck pain group[8,9]. Our study did not record this limitation in flexion, extension or axial rotation in the neck pain group.

Neck retraction movements were significantly decreased in G2 and G3. This limited ROM in retraction could be due to neck and /or shoulder pain or spasm of the neck muscle due to holding the neck in an almost fixed position for long periods of time. No previous studies have evaluated the retraction movement with a reliable measure.

Although, many studies used CROM for measuring cervical spine ROM in normal and neck pain patients, no studies were carried out to evaluate the protraction and retraction movements. In the present a new attachment was added to the CROM, to measure these movements, with very good reliability.

Data of the present study shows reduced muscle strength of the CPM and UTM in G2 and G3 when compared with G1. The difference in the isometric muscle strength between G2 and G3 was not statistically significant. This reduction in the muscle strength reflects localized muscle weakness and could be due to forward head postures at work for long periods. This may result in neck muscles fatigue and subsequent muscle weakness[1], added to pain reflex inhibition and disuse muscle weakness resulting from neck pain, preventing the worker from normally using these muscles. Another explanation of these findings is that recorded weakness of the neck muscle may directly reduce the stability of the neck, thus inducing a load on the soft tissue structures of the neck and causing neck pain.

Trunk weakness is associated with the presence of chronic and recurrent low back pain[2,3]. Postulated that a similar argument could be made for the cervical flexor and extensor musculature regarding chronic neck pain, but no other studies have confirmed this hypothesis. It has been suggested that there is an association between neck muscle weakness and neck pain[4]. Improvement in neck muscle strength shows reduced neck pain[5].

Reduced neck ROM is compatible with recorded reduction in neck strength. Both symptoms are risk factors that are associated with increased neck pain[6]. It is difficult to identify which is the leading symptom (ROM or strength). Both may be interchangeable, resulting in neck pain. This is supported by previous studies[7] that encourage neck rehabilitation, (improvement of neck muscle strength and reduction of neck pain with restoration of neck function). On the other hand, chronic neck pain could possibly be the cause of neck muscle weakness as a result of disuse. Some investigators found unclear whether neck or back muscle weakness is a residual finding based on disuse weakness resulting from pain or an acute or chronic pain causing the muscle weakness[8]. These results predict the possible future development of symptomatic clinical neck disorders in computer workers without current neck pain. It also suggests that earlier neck exercise programs may prevent advancement of sub clinical neck disorder into a full-fledged pathology.

Conclusion

Based on the result of statistical analysis of the present work (which is subjected to type II error due to failure to reject the null hypothesis) and within the limitation of this study the following conclusion could be made:

1- Computer workers with neck pain have limited neck ROM in retraction and side-bend directions.

2- Computer workers with neck pain have reduced neck muscle strength of the CPM and UTM during neck extension and shoulder shrugging.

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الملخص العربى

التغيرات فى المدى الحركي وقوة العضلات فى إصابات العنق المهنية دراسة على مشغلى الكمبيوتر

سجل المتخصصين فى الصحة المهنية عدد من التغييرات فى العضلات الهيكلية التى تصيب الرقبة واليدين فى مشغلى الكمبيوتر والمهنيين وهذه التغييرات مرتبطة بعوامل مثل التكرار والقوة والحمل العضلى ووضع المفصل .

وهذه التغييرات تؤدى إلى الضغط على العضلة أو الوتر أو العصب وحتى الآن لا توجد وسائل تقييم إكلينيكية أو ميكانيكية لدراسة هذه التغيرات فى مصر .

شملت الدراسة 45 مريضًا عن مشغلى الكمبيوتر وتم تقسيمهم إلى 3 مجموعات : مجموعة إنضباطية (15 مريض) ومجموعة 2 يعانون من الألم فى العنق (15 مريض) ومجموعة 3 بدون الألم فى العنق (15 مريض) .

وتم اختيارهم باستخدام جهاز قياس حركة العنق وقياس قوة العضلات الانبساطية وعضلة الترابيزيس وتحليل النتائج عن طريق مقياس مانوفا الاحصائى ذو الاتجاه الواحد وتحليل هوك وكانت النتائج كما يلى :

أ) مشغلى الكمبيوتر الذين يعانون بألم فى العنق كان لديهم فصور فى حركة الرقبة فى اتجاه الجانبين وإلى الخلف مع ضعف العضلات الباسطة وعضلة الترابيزيس.

ب) أما إذا كان ألم العنق غير موجود فكأن هناك قصور فى العضلات السابقة أيضًا .

وبالتالى تخلص الدراسة أنه يوجد قصور فى العضلات السابقة لمشغلى الكمبيوتر حتى لو لم تكن هناك أعراض .