ULNAR NERVE CONDUCTION VELOCITY RESPONSES TO DIFFERENT ELBOW JOINT ANGLES AMONG COMPUTER USERS

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ABSTRACT

Background: long duration of computer work could result in pain and weakness **associated with decreased nerve conduction velocities (NCV) of peripheral nerves.Purpose: 1)To investigate the effect of different elbow joint angles(0º, 45 º, 90º, 120º) on ulnar NCV across elbow to identify the optimum elbow positions for computer users during work. 2)Tocompare ulnar NCV across elbow between the limited and extensive computer users.Design of the study: cross- sectional study design .Subjects: Fifty computer users from both sexes, Their age ranged from 20 to 40 years old were selected from the smart village and were assigned into two equal study groups. Group A consisted of limited computer operators who worked a maximum of 2 hours per day while Group B consisted of extensive computer operators who worked on the computer for a minimum of 6 hours per day as a part of regular work for at least 1 year. Subjects were using the computer devices with a postion of elbow flexion ranged from 90 to 120 degrees.Method:EMG was used for measuring ulnar NCV acrosselbow in bothgroups.Results:Mixed design ANOVA was used and revealed that there was asignificant increase (p <0.05) in nerve conduction velocity at zero elbow flexion compared with other positions(45, 90, and 120 degrees of elbow flexion) in both groups,As well there was a significant increase (p <0.05) in nerve conduction velocity at 45 degrees of elbow flexion than 90 and 120 degrees in both groups. Regarding between subject effects multiple pairwise comparisons revealed that there was significant increase (p< 0.05) in nerve conduction velocity of ulnar nerve at all angles in group A compared with group B (p> 0.05).Conclusion:1)Zeroelbow extension showed the most significant increase in ulnar nerve motor conduction velocity compared to 45, 90 and 120 degrees of elbow flexion.2)ExtensiveComputers users who workfor more than6 hours showed decrease in ulnar nerve conduction velocity than the limited computer users.**

Keywords: Ulnar nerveconduction velocity, elbow joint angles, computer users.

Introduction

Ulnar nerve is the largest unprotected nerve in the human body (meaning unprotected by muscle or bone), so injury is common. The ulnar collateral ligament of elbow joint is in relation with the ulnar nerve and it is directly connected to the little finger, and the adjacent half of the ring finger, supplying the palmar side of these fingers, including both front and back of the tips, perhaps as far back as the fingernail beds. (1)

In its course across the elbow, the ulnar nerve can be damaged at different sites and by several types of injurious forces. Ulnar nerve neuropathic injury is considered the second most common injury in the upper limb after Carpal tunnel syndrome. (2)

Cubital tunnel syndrome (CUTS) is entrapment of ulnar nerve in the cubital tunnel. It is the second most common entrapment neuropathy of the upper extremity, after carpal tunnel syndrome. (3,4,5,) Incidence of cubital tunnel syndrome in the general population has been reported at 24.7 per 100,000. Populations at risk for cubital tunnel syndrome include patients with diabetes, obesity, as well as occupations involving repetitive elbow flexion and extension, holding tools in constant positions and using vibrating tools.(6) Patients present with intermittent parasthesias, numbness and tingling in the small finger and ulnar half of the ring finger. As the disease progresses, the symptoms become constant and patients may complain of elbow pain around cubital tunnel, non-specific complaints of hand clumsiness or weakness and atrophy of the intrinsic hand muscles innervated by the ulnar nerve .(7)

Nerve conduction velocity shortly known as "NCV" tests are used determine the speed of the electrical signals moving along a specific peripheral nerve .There are numerous aspects that could influence nerve conduction study .(8)

The repetitive computer use such as typing the keyboard and dragging the mouse overloads neck, shoulder, arm and hand muscles and joints. As they continue to be overworked, cumulative trauma happens. The muscles inthe forearm that control the movement of fingers may become irritated and soft tissues become inflamed and swollen. The irritated muscles, swollen tendons and soft tissues can press on the nearby nerves and cause ischemic neurophysiological changes: A progressive reduction in nerve conduction appears, resulting in a transient increase in the sensation, numbness, tingling and then weakness and loss of strengthof the muscles of the hand. **(9,10)**

In previous studies there were alot of controversies about the ideal position of the elbow during nerve conduction study and even some studies have denied the effect of elbow position on nerve conduction velocity of the ulnar nerve at the elbow area. This study was designed to investigate effect of different elbow joint angles(0º, 45 º, 90º, 120º) on ulnar NCV across elbow between limited computer users and extensive computer users and to identify an

optimum elbow angle for computer users during work.[11,12,13,14,15]

The aim of this study was to determine the effect of elbow posture on ulnar nerve conduction studies in computer operators and to determine the ideal position of the elbow for computer users during their work . For this reason motor NCVs of the ulnar nerve at the elbow area of the mouse-operating limb was measured in 4 different positions of the elbow (0º, 45 º, 90º, 120º) of elbow flexion.

Subjects, Instrumentations and Methods

Subjects:

The study was conducted on two equal groups in number of healthy participants , fifty computer operators from both sexes participated in this study, study group (A) Consisted of 25 participants (limited computer users who work 2 hours maximum at computer per day) and the other group (B) consisted of 25 (extensive computer users who work 6 to 8 hours minimum at computer per day) ; their age was ranged from 20-40 years old, All participants had Body mass index between 18.5 and 29.9 kg/m2 .subjectswere evaluated using EMG for measuring the motor conduction velocity of the ulnar nerve across elbow.

Inclusion criteria:

Limited computer users	Extensive Computer users
1. Healthy participants 2. Age ranging from 20-40. 3. All participants were conscious. 4. All participants were non-smokers. 5. All participants had Body mass index between 18.5 and 29.9 kg/m2. 6. Work at computer for two hours maximum per day.	1. Healthy participants 2. Age ranging from 20-40. 3. All participants were conscious. 4. All participants were non-smokers. 5. All participants had Body mass index between 18.5 and 29.9 kg/m2. 6. Having practiced on conventional computer keyboard and mouse for a minimum 6-8 hours per day as a part of regular work for at least 1 year.

Exclusion criteria

Diabetic patients.
Hypertension patients.
Patients with cervical spondylosis
Patients with cervical disc prolapsed
Patients with Thoracic outlet syndrome
Pregnant women
Upper limb injuries or fractures.

Instrumentation:

1-Universal goniometer for elbow position measurement (0 , 45 ,90 ,120 degrees).
2-EMG For measuring the motor conduction velocities of the ulnar nerve, the Neuropack S1 MEB-9004 NIHON KODEN, JAPAN were utilized as an objective evaluation of the motor conduction velocity.

3- Tape measurement for measuring the distance between proximal and distal stimulation sites of EMG.

Subjects' preparation

A brief explanation was done regarding the EMG machine and the protocol of the ulnar nerve motor conduction velocities measurement. Subjects participated in the current study after theapproval of ethical committee of faculty of physical therapy, Cairo University with numberP.T.REC/012/001380 while each subject signed a consent form before the beginning of the MCV measurement.

Subjects were asked to remove any metallic objects to avoid any interference. The examined upper limb was uncovered when conduction velocity was measured.

Assessment Procedures

The subject was in a relaxed sitting position on a chair and the subject's forearm supported on the plinth. The Earth electrode was around the wrist level in motor conduction. Recording motor electrodes, negative electrode was on the center of the abductor digitiminimi muscle and the positive electrode was on the tip of the little finger.

The ulnar nerve was stimulated at four sites:

I)At the wrist just above the wrist joint on the ulnar border (once)

II)Below the elbow joint below the medial epicondyle . (once).

III) Above elbow: behind and above the medial epicondyle.

IV) At axilla (once)

Measurement at the above elbow level was done in 4 different elbow positions (joint was held in the assumed position using universal goniometer):

a- 0° elbow extension

b - 45° degree elbow flexion

c- 90° degree elbow flexion position

d- 120° elbow flexion

Distance between distal and proximal stimulation was measured by the tape to calculate conduction velocity of the ulnar nerve using the following formula [16]:

Conduction velocity (Meter/Second) =

$$\frac{\textbf{Distance (cm) X 10}}{\textbf{Proximal latency – Distal latency}}$$

Statistical Analysis

All statistical measures were performed using the Statistical Package for Social science (SPSS) program version 22 for windows. The current test involved two independent variables. The first one was the (tested group); between subject factors (group A limited computer users and group B intensive computer users). The second one was the (positions of elbow flexion); within subject factor which had four levels (Zero elbow flexion, 45 degrees of elbow flexion, 90 degrees of elbow flexion, and 120 degrees of elbow flexion) which was measured by universal goniometer. In addition, this test involved one tested dependent variable (nerve conduction for ulnar nerve). Prior to final analysis, data were screened for normality assumption, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculation of the analysis of difference and analysis of relationship measures. Descriptive analysis using histograms with the normal distribution curve showed that the data were normally distributed and not violates the parametric assumption for the nerve conduction for ulnar nerve. As well as, normality test of data using Shapiro-

Wilk test was used, that reflect the data was normally distributed for nerve conduction for ulnar nerve. So, 2×4 mixed design ANOVA was used to compare the tested variables of interest at different tested groups and different positions of elbow joints. With the initial alpha level set at 0.05. The alpha level was set at 0.05.

RESULTS

P-value	0 Vs. 45 degrees	0 Vs. 90 degrees	0 Vs. 120 degrees	45 Vs. 90 degrees	45 Vs. 120 degrees
Group A	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*
Group B	0.001*	0.0001*	0.0001*	0.001*	0.004*

Multiple pairwise comparison tests (Post hoc tests) Between groups

	0 degrees elbow flexion	45 degrees elbow flexion	90 degrees elbow flexion	120 degrees elbow flexion
Group A Vs. group B	0.0001*	0.0001*	0.0001*	0.0001*

*Significant level was set at alpha level <0.05, P value: Probability value

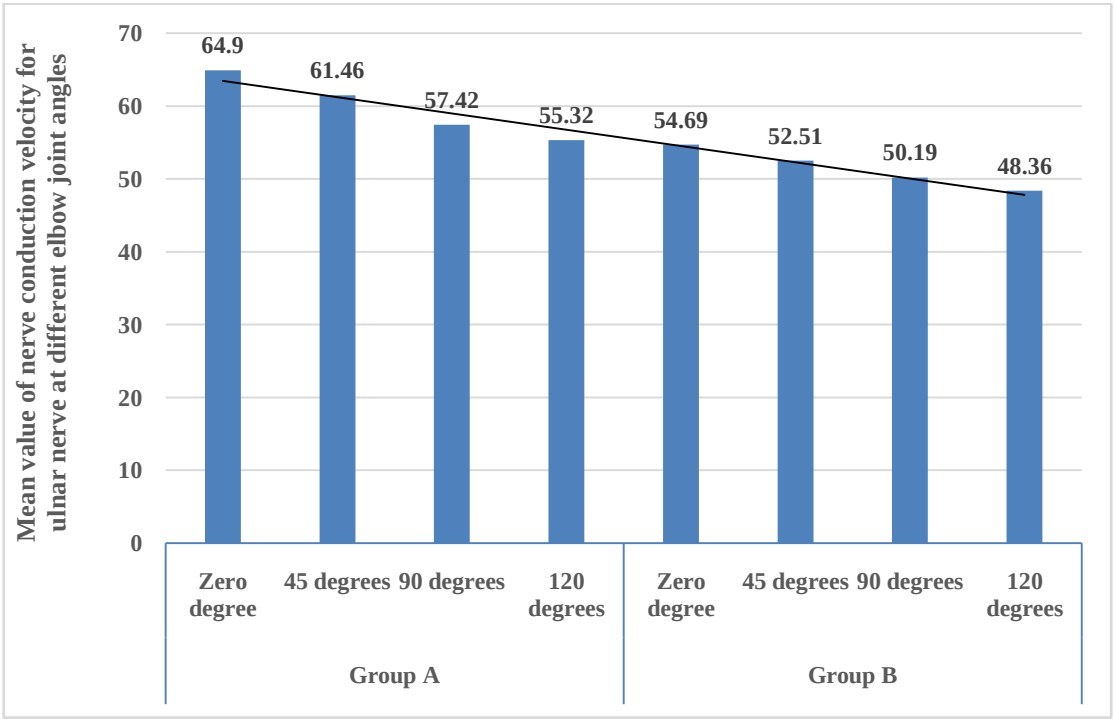

Fig.(1): Mean values of nerve conduction velocity of ulnar nerve for both groups at different elbow joint angles.

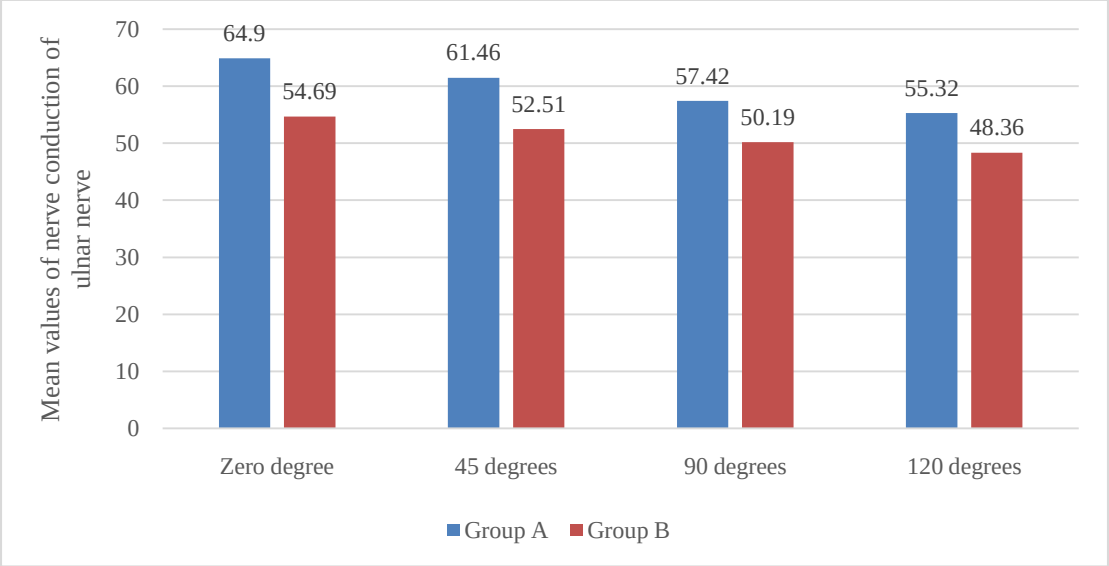

Fig.(2): Mean values of nerve conduction velocity of ulnar nerve for different elbow joint angles between both groups.

DISCUSION

Ulnar neuropathy at the elbow is the most common form of nerve entrapmentafter carpal tunnel syndrome (CTS) [17]Computer use is often associated with the increased prevalence of upper limb disorders, complications associated with computer upper limb disorders namely pain (wrist, elbow, shoulder and neck),manifestations are tingling, numbness, fatigue and paraesthesias. These symptoms are typically found in computer operators who work long work hours at their computers. At the onset of such symptoms, computer operators should undergo detailed clinical and neurological evaluation including nerve conduction tests.[18,19,20].

The forces applied to the computer mouse and keyboard may constitute a risk factor for musculoskeletal symptoms.[21].The symptoms may be associated with specific clinical entities such as peripheral nerve entrapment. The present study observed reduced mean motor NCV in ulnar nerves in the extensive computer users compared with the limited computer users. These slower MNCV findings in the neurologically asymptomatic computer users who spend much of their time using keyboard and mouse may correspond to preclinical lesions. We proposed that abnormal elbow mechanics such as prolonged flexion of the elbow makes computer users vulnerable to ulnar nerve disorders. Certain postures or positions can place increased pressure either directly or by increasing tension on the nerves at different entrapment points.[22].

Determining whether there is a link between entrapment neuropathy and computer use is important due to the morbidity associated with entrapment neuropathies and the ever increasing use of computers in the workplace and at home.[23].

This study was aimed to investigate the influence of different elbow positions on ulnar nerve

conduction velocity responses in both extensive computer and limited computer users. The study was conducted on 50 participants (25 limited computer users and 25 extensive computer users) the elbow positions studied were extension (0), flexion, (45) flexion, (90) flexion and (120) flexion.

In 2002, **Jensen et al.** have found an elevated vibration threshold in hand areas innervated by the median and ulnar nerves among computer users with pain in the upper limbs compared with a control group of computer users without such symptoms and a control group of subjects who do not use a computer. They concluded that the findings indicated entrapment of the median and ulnar nerves. **(24).**

In 2005, **Conlon and Rempel**found a threshold effect for entrapment neuropathies ulnar and median nerves at the wrist, confirmed by nerve conduction, with an increased risk when the computer was used for more than 28 h per week.**(23).**

In 2013**, Ganeriwal et al.** studied the effects of working hours on nerve conduction velocity in computer operatorsand They concluded that there were a decreased conduction velocities of peripheral nerves in computer operators who work long hours as well as symptoms of pain, paraesthesia and subjective weaknesses. **(25)**

Our results are in agreement with these studies on computer users showing a significant decrease in NCV in ulnar nerves. Continual elbow flexion may have resulted in the increased pressure on the ulnar nerve at the elbow and eventually caused subclinical focal neuropathy of the ulnar nerve.

In 1985 ,**Werner** stated that during elbow flexion, the ulnar nerve is stretched 4.5 to 8 mm (since it lies posterior to the axis of motion of the elbow) and the cubital tunnel cross-sectional area narrows by up to 55% as intraneural pressures increase up to 20-fold.As a result, repeated and sustained elbow flexion can irritate the ulnar nerve and eventually lead to cubital tunnel syndrome.**(26)**

In 2007, **Sattari** studied the effect of elbow position on the measurement of ulnar motor and sensory NCV and concluded that the most erroneous increment was found at 135º of the elbow flexion and they suggested that elbow flexion at 45º was the position of the least variation in motor and sensory NCVs between the across and below elbow segments.**(27)**

In addition to this explanation, in **2012**, **Andersen et al** carried out double case-referent study compared patients with ulnar neuropathy and patients with ulnar neuropathy-like symptoms as distinguished by ENG with two separate referent groups, with emphasis on associations with computer work characteristics. A negative exposure-response relationship was found between hours of daily computer use and ulnar neuropathy and the same tendency was seen for ulnar neuropathy-like symptoms.**(28)**

The results of this study suggested that the elbow extension (zero elbow flexion) created the least deformation on the ulnar nerve conduction velocity and that the 120 degrees elbow flexion created the most deformation in ulnar nerve conduction velocity compared to other elbow positions.

Conclusion:

- It was concluded that the recommend position for elbow joint during computer use is 0º – 45º elbow

flexion, as this position was shown to decrease possibility of CuTS.

- 90^{o} to 120^{o}elbow flexion position should be avoided during using computer.
- Prolonged usage of computer more than 6 hours is not recommended as it is a predisposing factor for cubital tunnel syndrome.

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استجابات سرعة التوصيل العصبي للعصب الزندي لمختلف زوايا مفصل الكوع فى مستخدم ي الكمبيوتر/ دعاء ياسر عبد الفتاح ، المشرفون **:أ.د./محمد حسين الجندى** ، أستاذ بقسم العلوم الأساسية ، كليه العلاج الطبيعى ، جامعة القاهرة ،**أ.د/ابراهيم محمد ابراهيم** ، أستاذ مساعد بكلية العلاج الطبيعي ،جامعة 6 أكتوبر .

المستخلص

خلفية : ساعات العمل الطويله على جهاز الحاسوب يمكنأنيؤديإلىالألموضعفالعضلاتالمرتبطبانخفاضسرعاتالتوصيلالعصبيفىالأعصابالطرفية .**الهدفمنالبحث** : 1) للتحقيقفيتأثيرزواياانثناءالكوع (0º،45º،90º،120º) علىسرعةتوصيلالعصبالزنديعبرالكوعلتحديدمواقفالكوعالأمثللمستخدميالكمبيوترأثناءالعمل . 2) مقارنةسرعةتوصيلالعصبالزنديعبرالكوعبينمستخدميالكمبيوتراستخداممحدودومستخدمىالكمبيوتراستخداممكثف .**تص ميمالدراسة** :تصميمدراسةمستعرضة .**الأفراد المشتركين فى الدراس ة**:خمسونمستخدميالكمبيوترمنكلاالجنسين،تراوحتأعمارهممن 20 إلى 40 سنة تماختيارهممنالقريةالذكيةوتمتعيينهمفيمجموعتيندراسةمتساويتين . تتألفالمجموعةأمنمشغليحاسوباستخداممحدودعملواساعتينكحدأقصىفياليومبينماكانتالمجموعةبتتألفمنمشغليكمبيوتراست خداممكثفعملواعلىالكمبيوترلمدةلاتقلعن 6 ساعاتفياليومكجزءمنالعملالمنتظملمدةسن ة علىالأقل، وكان الأفراد يستخدمون أجهز ة الحاسوب فى وضع ثنى للكوع يتراوح بين 90 الى 120 درج ة. **الطريقة:**تماستخداماالتخطيطالكهربىللعضلاتلقياسسرعةتوصيلالعصبالزنديعبرالكوعفيكلاالمجموعتين.**النتائج:** كانت هناك زيادة معنوية (P <0.05) في سرعة التوصيل العصبي عند زاوية انثناء الكوع صفر من المواضع الأخرى (45، 90، و120 درجة انثناء الكوع) في المجموعتين. كذلك كانت هناك زيادة معنوية (p <0.05) في سرعة التوصيل العصبي عند 45 درجة من انثناء الكوع من 90 و120 درجة في المجموعتين. فيما يتعلق بآثار الموضوع أظهرت المقارنات الزوجية المتعددة أن هناك زيادة معنوية (p<0.05)في سرعة التوصيل العصبي للعصب الزندي في جميع الزوايا في المجموعة أ مقارنة مع المجموعة ب (p> 0.05) .**الخلاصة:** 1) أظهر تمديد الكوع (زاويه انثناء صفر) الزيادة الأكثرفى سرعة توصيل العصب الزندى مقارنة مع درجات انثناء المرفق 45 و90 و 120. 2) مجموعه مستخدمي الحاسوباستخدام مكثف الذين يعملون لأكثر من 6 ساعات أظهرت انخفاض في سرعة التوصيل العصبي الزندي بصوره أكثر من مستخدمي الكمبيوتر استخدام محدود.

كلمات البحث: سرعة توصيلالعصب الزندى، زوايا انثناء الكوع، مستخدمي الكمبيوتر.