

The effect of long-term use of computer mouse devices on median nerve entrapment

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ABSTRACT

الهدف: تقييم تأثير استخدام الموجهات الخاصة بالحاسوب (الفارة) على العصب الناصف.

الطريقة: تم إجراء دراسة تأملية مقطعية خلال العام 2004 وشملت 41 سكرتيراً ذكراً ممن يعملون في الكليات الصحية بجامعة الملك خالد في أبها. عمل على إتمام استبيان يصف التوزيع الاجتماعي واستخدام الحاسوب. تضمنت الدراسة الغرائزية الكهربائية قياس التأخر الحركي والسرعات النقلية والسعات التركيبية للفعل الكهربائي العضلي وذلك على العصب الناصف الأيمن ومقارنتها بنظائرها للعصب الناصف الأيسر (المأخوذ كشاهد) (كل المشتركين في الدراسة يستخدمون الطرف الأيمن). تم حساب معامل التأخر النهائي لكل عصب مفحوص بينما تم تحديد اعتلال العصب الناصف في الرسغ بمعامل التأخر النهائي لأقل من $TLI < 0.30$.

النتائج: بينت الدراسة الغرائزية الكهربائية أن متوسط معامل التأخر النهائي للعصب الناصف الأيمن كان أقل من نظيرة الأيسر. وقد شوهدت تأكيدات غرائزية كهربية تقترح حدوث اعتلال العصب المحجوز في الرسغ وذلك عند ثمانية مشتركين من أصل 23 في الدراسة ممن لا يشكون شيئاً (34.8%) وستة من أصل 12 ممن ذكروا شعور بعدم الارتياح (50%) وكل الذين انطبقت عليهم أعراض الإصابة بمتلازمة النفق الرسغي وهم ستة أشخاص. كما بينت الدراسة الترابطية وجود علاقة ارتباطية سلبية مهمة بين معامل التأخر النهائي للعصب الناصف في اليد اليمنى وعدد الساعات الأسبوعية لاستخدام الموجهة بينما لم تظهر تلك العلاقة الترابطية بين معامل التأخر النهائي للعصب الناصف وعدد الساعات الأسبوعية لاستخدام لوحة الإدخال.

خاتمة: الاستخدام الطويل الأمد لموجهات الحاسوب تعرض للإصابة باعتلال العصب الناصف المحجوز في الرسغ.

Objective: To assess the effect of long-term use of computer mouse devices on the median nerves.

Methods: A cross-section prospective study conducted during the year 2004 involved 41 male secretaries employed in the Health Colleges of King Khalid University in Abha, Kingdom of Saudi Arabia. A questionnaire describing sociodemographic and

computer use was completed. The electrophysiological study included measurements of motor latencies, motor conduction velocities, and amplitudes of compound muscle action potential of the right median nerve and compared these with those of the left median nerve (control). All of our subjects were right handed. Terminal latency index (TLI) was calculated for each nerve tested. Entrapment neuropathy of the median nerve at the wrist was defined as $TLI < 0.30$.

Results: The mean TLI of the median nerve in the right hand was significantly lower than that in the left hand. Eight of the 23 asymptomatic participants (34.8%), 6 of the 12 who reported hand discomfort (50%), and all the 6 participants who met clinical criteria for carpal tunnel syndrome showed electrophysiological evidence suggestive of right median nerve entrapment neuropathy at the wrist. Test of association showed a negative and significant correlation between TLI of the right median nerve and weekly hours mouse device use while no significant correlation was found between TLI in the same hand and weekly hours keyboard use.

Conclusion: Frequent computer mouse device users are at high risk of developing median nerve entrapment neuropathy at the wrist.

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Computer use is increasingly common among working populations these days. Several studies suggested that long term computer users are at increased risk for carpal tunnel syndrome (CTS) and other musculoskeletal disorders of the upper extremities.¹⁻³This

was thought to be due to deviated wrist postures, which result from extensive use of the computer keyboard,^{4,6} and computer mouse devices.^{7,8} The conclusions of most of these studies were based on self reported symptoms of CTS without involving the objective measurements such as electrophysiological studies. However, Stevens et al⁹ demonstrated that the prevalence of CTS among frequent computer users, as confirmed by nerve conduction study, was comparable to the estimated rates of CTS in the general population, suggesting that using a computer does not seem to increase the risk of developing CTS. The present study was therefore undertaken to assess the effect of long-term use of computer mouse devices on median nerve entrapment using a questionnaire and electrophysiological study.

Methods. This is a cross-sectional prospective study, carried out during 2004. The subjects were male secretaries employed in the Health Colleges of King Khalid University in Abha, Kingdom of Saudi Arabia. Ethical approval was taken from King Khalid University and consent was obtained from the participants after explaining to them the purpose, methods, benefits, and risks of the study. For each participant, a detailed questionnaire dealing with sociodemographic profile and computer use was completed. Body weight for each participant was measured and recorded using an Avery Beam weighing scale to the nearest 0.1 kg. Standing height was measured and recorded to the nearest 0.5 cm with stadiometer. Body mass index (BMI) was computed from the weight and the height (weight in kg/height in m²). The inclusion criteria for this study were healthy employees who had used the computer as a part of their job for at least 2 years. The exclusion criteria were: i) Previous or current illness or trauma that affected one or both upper limbs. ii) BMI \geq 30. iii) Repetitive motions of the wrist other than that due to computer use. iv) Metabolic diseases that may be associated with entrapment neuropathy such as diabetes mellitus, thyroid diseases, and autoimmune diseases. A total of 47 employees were recruited (90% of the total number of secretaries working in Health Colleges), 6 of whom were excluded for not fulfilling the criteria for inclusion. The electrophysiological study consisted of motor conduction studies of the right and left median and ulnar nerves. All our subjects were right handed. The median nerve in the left hand was used as control, and the ulnar nerves were studied to secure that we are dealing with a mono-neuropathy of the median nerve and not a median neuropathy, which is part of a more diffuse subclinical peripheral nerve disease. Recording was made on Medelec MS 92 Machine. The hands temperature varied between 32-34°C during the tests. The median and ulnar nerves were stimulated at the

wrist and at the elbow with supramaximal stimulus of square-wave pulse of 0.2 milliseconds (msec) duration. Distal stimulation of the median nerve was applied between flexor carpi radialis and palmaris longus tendons 8 cm proximal to the active electrode while proximal stimulation was applied in the medial aspect of the antecubital fossa, just lateral to the brachial artery. For the ulnar nerve, distal stimulation was applied medial to the flexor carpi ulnaris tendon also 8 cm proximal to the active electrode and proximal stimulation was applied at the ulnar groove. Compound muscle action potentials (CMAPs) were recorded from the abductor pollicis brevis muscle and abductor digiti minimi muscle for the median and ulnar nerves respectively using active surface electrodes. A reference electrode was placed at 2 cm distal to the active electrode. The ground electrode was placed between the points of stimulation and recording. For both nerves, proximal and terminal motor latencies in milliseconds (ms) were measured from the shock artifact to the initial negative deflection of the responses from the isoelectric baseline. Differential motor latency was computed by subtracting the motor terminal latency (MTL) from the motor proximal latency. The amplitude in millivolts (mV) was measured from the isoelectric baseline to the peak of the negative phase of CMAP. Motor conduction velocity (MCV) in meter/second (m/s) was calculated by dividing the distance in millimeters (mm) between the 2 stimulation sites over the differential latency (ms). The terminal latency index (TLI) of the median nerve was calculated using the following formula:¹⁰ $TLI = \text{Terminal distance (mm)} / \text{MCV (m/sec)} \times \text{MTL (msec)}$. Entrapment neuropathy of the median nerve at the wrist was defined as TLI less than 0.30.^{11,12}

At different stages of the study, the collected data were compiled and fed into an IBM computer. The SPSS package version 10 was used for standard statistical analysis including Student's t-test and Pearson's correlation coefficient. A value of $p < 0.05$ was considered statistically significant.

Results. Table 1 illustrates the results of the questionnaire and the calculated BMI. The average age of the employees was 36.6 ± 8.0 years. Twenty-three (56.1%) of the employees were asymptomatic, 12 (29.3%) reported right hand discomfort after computer use, and 6 (14.6%) met the clinical criteria for right CTS and showed positive Phalen's and Tinel's signs.^{12,13} Table 2 shows that in all participants, the mean MCV in the forearms, the mean amplitude of the CMAP, and the mean MTL of the right and left ulnar nerves were within normal ranges. No significant differences in the above mention parameters were found between the right and left ulnar nerves (Table 2). Table 3

shows motor nerve conduction results of the 3 above-mentioned subgroups of employees and the total. In the asymptomatic subjects, the mean MCV in the forearms and the mean amplitude of the CMAP of the right and left median nerves were within normal ranges. No significant differences in the MCV and mean amplitude of the CMAP were observed between the 2 tested nerves, although the mean MCV and the mean amplitude of

the CMAP of the right median nerve were lower than that of the left median nerve. The mean MTL of the right median nerve was significantly longer than that of the left median nerve ($p<0.0001$). Conversely, the mean TLI of the median nerve was significantly lower in the right hand compared with the one in the left hand ($p<0.0001$). The same findings were observed in the 2 other subgroups, however, the differences were greater in employees who reported hand symptoms after computer use and still greater in those that reported symptoms suggestive of CTS (Table 2). Using TLI as an indicator for entrapment neuropathy, 8 of the asymptomatic employees (34.8%), 6 of the employees who reported hand discomfort after computer use (50%), and all the employees who met clinical criteria for CTS showed electrophysiological evidence suggestive of right median nerve entrapment neuropathy at the wrist, namely, TLI <0.30 . Test of association showed a negative and significant correlation between the TLI of the right median nerve and the weekly hours mouse use ($r = -0.48, p<0.002$) indicating an increase risk of right median nerve entrapment neuropathy at the wrist with increase in weekly hours mouse use. No significant correlation was found between right median nerve TLI and weekly hours keyboard use ($r = -0.05, p<0.76$), nor between TLI of the left median nerve and the weekly hours keyboard use ($r = -0.12, p<0.45$).

Table 1 - The results of the questionnaire and the calculated body mass index (BMI) of the secretaries working in the Health Colleges of King Khalid University.

Variable	Mean±SD	Range	
		Minimum	Maximum
Age (years)	36.6 ± 8.0	24.0	47.0
BMI (kg/m ²)	24.7 ± 3.4	19.4	29.8
Computer job duration (years)	8.7 ± 5.4	2.0	21.0
Computer work duration (hours/week)	26.9 ± 12.0	7.0	42.0
Keyboard work duration (hours/week)	11.3 ± 9.2	2.0	34.0
Mouse work duration (hours/week)	15.6 ± 10.2	3.0	33.5

BMI - body mass index

Table 2 - Motor terminal latency (MTL), motor conduction velocity (MCV), and amplitude of compound muscle action potentials (CMAPs) of the right and left ulnar nerves. All values are expressed as mean ± standard deviation.

Variable	Right ulnar nerve	Left ulnar nerve	Significance
MTL (ms)	3.03 ± 0.56	3.02 ± 0.41	NS
MCV (m/s)	59.85 ± 6.06	60.54 ± 5.41	NS
CMAP (mV)	6.22 ± 1.3	5.98 ± 2.02	NS

ms - millisecond, m/s - meter/second, mV - millivolt, NS - not significant

Discussion. Our results demonstrated that the mean TLI of the right median nerve in the right-handed frequent computer users was significantly lower than that of the left median nerve. This was true for the total and the 3 subgroups. Among various indices, the TLI was selected as it is a useful and sensitive adjunctive electrophysiological measure for entrapment neuropathy of the median nerve at the wrist.^{12,14,15} As such, these findings suggest that frequent computer users have a tendency to median nerve entrapment neuropathy at the wrist. This is in line with a previous study, which showed an increased risk of CTS in computer users.¹⁶

Table 3 - Motor terminal latency (MTL), motor conduction velocity (MCV), terminal latency index (TLI), and amplitude of compound muscle action potentials (CMAPs) of the right and left median nerves. All values are expressed as mean ± standard deviation.

Variable	Right median nerve				Left median nerve			
	MTL (ms)	MCV (m/s)	TLI	Amp (mV)	MTL (ms)	MCV (ms)	TLI	Amp (mV)
Asymptomatic group (n= 23)	3.85±0.25*	61.85±10.53†	0.34±0.08*	5.55±2.17†	3.42±0.28	64.42±6.96	0.38±0.09	5.53±2.47
Hand discomfort group (n=12)	4.49±0.36*	61.92±7.10†	0.29±0.07**	5.57±1.88†	3.71±0.25	62.13±5.23	0.34±0.08	6.57±1.88
CTS group (n=6)	6.99±0.88**	58.25±8.12†	0.18±0.01*	4.78±1.6†	4.53±0.17	61.08±7.50	0.32±0.06	5.34±1.6
Total (n=41)	4.50±1.15*	61.10±6.7†	0.30±0.09*	5.37±1.15†	3.66±0.50	62.88±8.22	0.36±0.08	5.55±2.17

ms - millisecond, m/s - meter/second, mV - millivolt, CTS - carpal tunnel syndrome, * $p<0.0001$, ** $p<0.01$, NS - not significant

It is most unlikely that the median neuropathy shown in this study is a part of a more diffuse peripheral nerve disease as electrophysiological study of the ulnar nerves were normal.

Over one third (35%) of asymptomatic participants and half of the participants who reported right hand discomfort after computer use, but did not meet clinical criteria for CTS, showed electrophysiological evidence suggestive of right median nerve entrapment neuropathy at the wrist. This may be taken to indicate that neurological injuries in frequent computer users remain asymptomatic or subclinical and are not recognized before neurological damage is permanent.

The frequency of clinically determined and electrophysiologically confirmed CTS was 14.6%. This estimate is comparable to a frequency of 13.3% among computer workers in Taiwan.¹ However, Stevens et al⁹ reported that the frequency of self reported CTS in computer users at a medical facility in the USA was 10.5% and only 3.5% was confirmed by nerve conduction studies. They concluded that the frequency of CTS in computer users is similar to that in the general population. Their study is subjected to criticism on several grounds, the most important of which is that the authors did not provide any indication of the cause of general population CTS. The reported frequency by other studies varies. Jones and Orr² reported a frequency of 4% among high school computer use classes in the USA, however, no attempt was made to confirm this by electrophysiological studies. In another study, Andersen et al¹⁷ found that only 1.5% of computer users in Denmark reported classic symptoms of CTS. This variation in the frequency of CTS among computer users could be due to selection of target study groups in relation to age, gender, and the criteria used for diagnosis of CTS, or could be due to genetic factors.¹³

Our results also showed a negative and significant linear relationship between TLI of the right median nerve and the weekly hours mouse use indicating an increase in the risk of developing median nerve entrapment neuropathy at the wrist with an increase in mouse use. This is consistent with previous studies in the field.^{7,8} Sustained elevated carpal tunnel pressure has been reported as a causative factor in this case.¹⁸ The sustained pressure is due to the combined effects of wrist extension and the finger grip force applied to depress the button and to grip the sides of the mouse.^{19,20}

There are 2 main limitations to this study. First, the median palmer latencies and amplitudes were not measured in this study due to logistic reasons. However, this is unlikely to affect our conclusions, as the TLI appeared to be a distinctive diagnostic criterion for median nerve entrapment neuropathy at the wrist. In this respect Kabiraj et al,¹⁴ using TLI identified

approximately 47% of patients with strong clinical evidence of CTS who were reported normal using other tests, and comparative studies using other techniques including palmer latency and amplitude failed to single out the best one in detecting CTS at an early stage.^{21,22} Secondly, no control group was provided in this study. However, this was not an easy task because it was very difficult to find volunteers who are non-secretary, asymptomatic, age, gender, and BMI matched group who are not using a computer these days, and the few volunteers recruited were found to use their dominant hands for other tasks. In addition, the main theme of the paper was to look at the effect of mouse use on the median nerve, and in this case the non-mouse use hand certainly served as a good control.

In conclusion, the employees who are frequent computer mouse users are at high risk of developing median nerve entrapment neuropathy at the wrist. We suggest that efforts are made to educate frequent computer users to minimize the wrist extension associated with mouse device use, minimize prolonged dragging tasks and if possible, frequently perform other tasks with the mousing hand.

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Related topics

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