

นิพนธ์ต้นฉบับ  
(Original article)

## การเปลี่ยนแปลงความตึงตัวของเส้นประสาทมีเดียนจากการใช้งาน คอมพิวเตอร์ 4 ชั่วโมง

### Alteration of Median Neural Tension from 4 Hours of Computer Use

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**บทคัดย่อ:** โรคทางระบบกระดูกและกล้ามเนื้อที่เกิดจากการทำงานมีสาเหตุมาจากการเคลื่อนไหวซ้ำๆ และการคงค้างของท่าทาง การเจ็บปวดกล้ามเนื้อที่ถูกเลี้ยงหรืออยู่ใกล้เคียงกับเส้นประสาทสามารถเพิ่มความตึงตัวของเส้นประสาทได้ เส้นประสาทมีเดียนเป็นเส้นประสาทส่วนปลายของระยางค์ส่วนบนซึ่งรวมรากประสาทบริเวณคอทั้งหมด เส้นประสาทนี้สามารถเป็นตัวแทนเส้นประสาทของระยางค์ส่วนบน การศึกษานี้มีจุดประสงค์เพื่อสำรวจความตึงตัวของเส้นประสาทมีเดียนระหว่างการใช้คอมพิวเตอร์เป็นเวลา 4 ชั่วโมง ผู้เข้าร่วมการศึกษามีจำนวน 20 คน เป็นผู้ที่ใช้งานคอมพิวเตอร์ 4 ชั่วโมงต่อวัน และมีประสบการณ์การใช้คอมพิวเตอร์อย่างน้อย 1 ปี ผู้เข้าร่วมการศึกษารวมถูกขอให้ใช้เมาส์ และพิมพ์คอมพิวเตอร์เป็นเวลา 4 ชั่วโมง และตรวจความตึงตัวของเส้นประสาท ความตึงตัวของเส้นประสาทมีเดียนถูกประเมินด้วยการตรวจการตอบสนองของเส้นประสาทมีเดียนทั้งแบบมาตรฐาน ก่อนการทำงาน ขณะพัก และหลังจากการทำงาน และการตรวจความตึงตัวของเส้นประสาทมีเดียนด้วยตนเอง โดยตรวจก่อนทำงาน และหลังการทำงานทุกชั่วโมง การตรวจการตอบสนองของเส้นประสาทมีเดียนแบบมาตรฐานใช้ข้อศอกเหยียดข้อศอกเมื่อพบแรงต้านครั้งที่หนึ่ง และครั้งที่สอง (R1 และ R2) เป็นตัวบ่งบอกความตึงตัวของเส้นประสาท สำหรับการตรวจความตึงตัวของเส้นประสาทมีเดียนด้วยตนเอง ประกอบไปด้วย 7 ลำดับการเคลื่อนไหวเลียนแบบท่ามาตรฐาน เพื่อให้ผู้ใช้งานสามารถตรวจได้ด้วยตนเองขณะทำงานและรบกวนการทำงานน้อยที่สุด ผลการศึกษาพบว่าเมื่อทำงานโดยใช้คอมพิวเตอร์เป็นระยะเวลา 4 ชั่วโมง ความตึงตัวของเส้นประสาทมีเดียนเพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติด้วยการประเมินทั้งสองแบบ แต่ในขณะที่พักพบความตึงตัวของเส้นประสาทมีเดียนลดลง การหยุดพักน่าจะช่วยให้การสะสมความตึงตัวของเส้นประสาทน้อยลง และอาจลดโอกาสการเป็นโรคทางระบบกระดูกและกล้ามเนื้อที่เกิดจากการทำงาน โดยสรุปผลการการศึกษา การใช้งานคอมพิวเตอร์อย่างต่อเนื่องทำให้ความตึงตัวของเส้นประสาทมีเดียนเพิ่มขึ้น โดยผู้ทำงานอาจใช้การตรวจประเมินความตึงตัวของเส้นประสาทมีเดียนด้วยตนเอง เพื่อเป็นตัวบ่งชี้อาการ และป้องกันการเกิดโรคระบบกระดูกและกล้ามเนื้อจากการทำงานได้ดียิ่งขึ้น

**ABSTRACT:** The work-related musculoskeletal disorders can be caused by repetitive movement and sustained posture. Muscle pain that innervated by or adjacent to the nerve can increase neural tension. Median nerve is a peripheral nerve of the upper limb that includes all cervical nerve roots. It can be a representative for the upper limb nerves. This study aimed to observe median tension during 4-hour computer use. Twenty participants work 4 hours a day and have at least one year of experience. They all were performed mouse using and typing computing tasks for 4 hours and applied nerve tension test. Median nerve tension was investigated by both standard test (introduced by Butler) at before, during break, and after computer work, and self-quick test at before and every hour. For the standard test, elbow extension was used as a surrogate outcome to indicate the tension at the first and the second resistance (R1 and R2) measured by the researcher. The self-quick test, composed of seven components, is modified from a standard neural tension test to minimize an obstruction of work. This study found that the median nerve tension increased significantly by both standard and self-quick tests over four hours of computer tasks. The tension of median nerve was reduced after having a short break. This behavior may indicate cumulative discharge of the nerve, which may further develop WMSDs. In conclusion, the continuous computer use increased median nerve tension. Workers may perform self-quick test to monitor their symptoms and can early detect and prevent the WMSDs.

**คำสำคัญ:** ความตึงตัวของเส้นประสาท ความตึงตัวของเส้นประสาทมีเดียน การใช้คอมพิวเตอร์ โรคทางระบบกระดูกและกล้ามเนื้อที่เกิดจากการทำงาน

**Keywords:** Neural tension, Median nerve tension, Computer use, WMSDs

## 1. INTRODUCTION

The characteristic of computer work is composed of static task [1], awkward posture [2, 3] and repetitive movement [4]. Ninety percent of college students use computer every day [5]. Computer use was found to be associated with increasing incidence and prevalence of work-

related musculoskeletal disorders (WMSDs) at the neck and upper extremities [6, 7]. The median nerve was reported to be the problems of long experienced computer users, carpal tunnel syndrome and median neuropathy [8]. The muscles adjacent to the median nerve were high muscle contraction [9-13]. They bring to increase tension to the median neurodynamic response as a mechanical effect [9, 14]. As a consequence, computer use contributes mechanical [15] and physiological changes of neural tissue [9, 14] including inflammatory response and disturbed nerve function [15].

Upper limb neurodynamic test (ULNT) can be used for diagnosis and treatment of peripheral neural tension [9]. It previously called upper limb tension test (ULTT). Byng 1997 reported the significant difference of ULTT1 between keyboard users and non-keyboard users. The increase of ULTT1 was possible risk of overused syndrome of the upper limbs [16].

Therefore, the current study evaluated behaviour of alteration of upper limb neural tension during computer work by the standard ULNT1 and self-quick test.

## 2. MATERIALS AND METHODS

This study was an observational study set in a laboratory to determine alteration of the median neurodynamic response over four hours of computer work. Twenty participants were recruited from students in the universities. The number of sample size was calculated by using nquery advisor 6.0 program. Participants must have accustomed to involve with computer use for more than four hours at least a year. They might be having pain or discomfort on neck and upper extremities only the time of computer use. The participants were performed computer tasks on their adjusted workstation based on EQ-dex [10] with a minimal adjustment for more individual comfort. The task included typing and mouse using for four hours with twenty minutes break. The task processes were interrupted with the standard ULNT1, for 3 times at baseline (0), 2<sup>nd</sup> and 4<sup>th</sup> hour and 6 times for self-quick test at baseline (0), 1<sup>st</sup>, 2<sup>nd</sup>, 2-af (after break), 3<sup>rd</sup>, and 4<sup>th</sup> hour. The standard ULNT1 was performed after the self-quick test.

The standard ULNT1 based on the test from Butler [17]. The sequence is shoulder depression, shoulder abduction, shoulder external rotation with forearm supination, full wrist and finger extension, and elbow extension. The outcomes of the test were elbow extension range of motion at R1 and R2 which indicate tension of median nerve. Full elbow extension is 180 degree indicating no tension. In this study the standard ULNT1 was performed by using an invented table. It is composed of shoulder depression sensor spring, head-shoulder wooden block, wrist-hand wooden splint, and switch light detectors.

The shoulder depression sensor spring was attached with an electronic load detector set at four kilograms. This load from the spring was maintained throughout the median neurodynamic test. Head part of head-shoulder wooden block kept a head in neutral position and shoulder part kept a shoulder in 110 degree of abduction. The wrist-hand wooden splint was composed of three pieces of wooden plate with two fulcrums. Three pieces were attached their dorsal side of

forearm, metacarpal bone and phalanges, with the fulcrums being placed at wrist joint and metacarpophalangeal joint. The table can sustain component of shoulder depression, shoulder abduction, wrist and fingers extension. Additionally, the light detectors were showed at the times of R1 (first resistance), R2 (second resistance) by researcher (Figure 1). The table is aimed to prevent compensation from the participants during testing. The researcher was trained to detect the R1 and R2 (ICC value of R1 was 0.749 and ICC value of R2 was 0.890).



Figure 1: Participant was performed standard ULNT1, on an invented table.

The self-quick test was modified to provide simple and easy to test while working with the computer. It is composed of eight components.

Component 1: both shoulder abduction 90 degree (Figure 2A)

Component 2: component 1 with both shoulder depression and minimal horizontal abduction

Component 3: component 2 with full both shoulder external rotation and forearm supination

Component 4: component 3 with full both wrist and finger extension (Figure 2B)

Component 5: component 4 with both elbow extension from 90 degree to about 135 degree

Component 6: component 5 with both elbow extension from about 135 degree to full range of motion (See figure 2C)

Component 7: right and left contralateral lateral flexion (See figure 2D)

Component 8: component 7 without any feeling of tension

Participants were asked to perform the quick test and notified to report tension at the first feeling of tension (R1) and the highest feeling of tension (R2). Higher number of component indicates lesser tension of the nerve.

The statistical analysis showed significant difference. The elbow extension range of motion was tested for normal distribution with Kolmogorov-Smirnov Goodness of Fit-test. One-way repeated analysis of variance with Bonferroni test was used to determine the altered R1 and R2. Friedman test was used to determine the self-quick test.

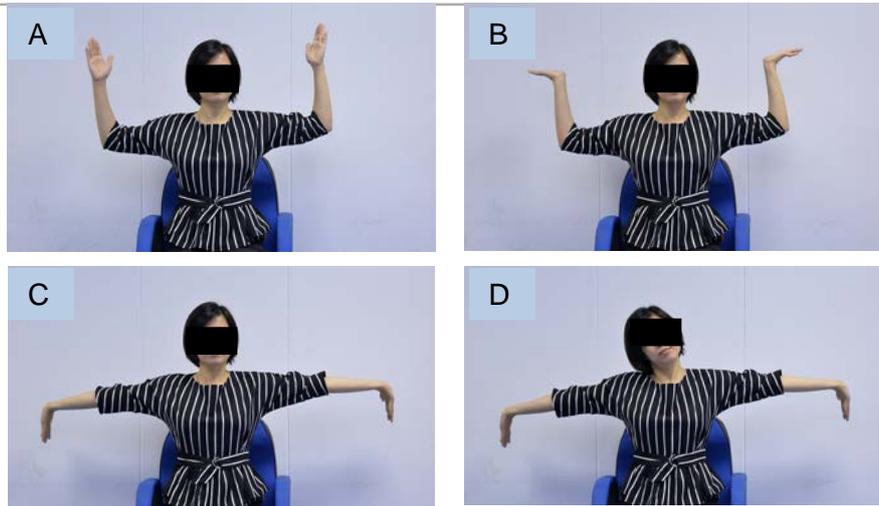


Figure 2: Self-quick test, A=component 1, B=component 4, C=component 6, D=component 7.

### 3. RESULTS

Median nerve tension was investigated in 16 females and 4 males in total of 40 arms. From the standard ULNT1, the elbow extension ranges of motion at R1 and R2 were normally distributed. The elbow extension at R1 and R2 was significantly decreased (more tension) over the time with  $p$ -value  $< 0.05$  (Table 1).

Table 1: Elbow extension ranges of motion at R1 and R2 at baseline (0), 2<sup>nd</sup> hour, 4<sup>th</sup> hour

|    | Baseline (0)  | 2 <sup>nd</sup> hour        | 4 <sup>th</sup> hour          | p-value    |
|----|---------------|-----------------------------|-------------------------------|------------|
| R1 | 70.9 (12.23)  | 64.16 (7.87) <sup>a</sup>   | 61.55 (8.10) <sup>b</sup>     | $<0.001^*$ |
| R2 | 131.92 (9.72) | 122.89 (11.44) <sup>a</sup> | 113.2 (17.04) <sup>b, c</sup> | $<0.001^*$ |

Data presented as Mean (SD)

\* Significant difference among Baseline (0), 2<sup>nd</sup> hour, and 4<sup>th</sup> hour by Repeated measured ANOVA ( $p < 0.05$ )

<sup>a</sup> Significant versus Baseline, <sup>b</sup> Significant versus Baseline, <sup>c</sup> Significant versus 2<sup>nd</sup> hour:  $p < 0.017$  paired with post hoc Bonferroni test

Then the multiple comparisons, Bonferroni test, were used for comparison of range of elbow extension at baseline (0), 2<sup>nd</sup> hour and 4<sup>th</sup> hour. The range of R1 at baseline, 2<sup>nd</sup> hour and 4<sup>th</sup> hour had significant difference. The range of R2 had significant difference between baseline and 2<sup>nd</sup> hour, baseline and 4<sup>th</sup> hour.

The component measurement at R1 and R2 had significant difference at  $p < 0.005$  on dominant hand. On left hand, the different significance was at R2. A trend of component measurement from the self-quick test was decreased (more tension) over the time. Interestingly, after the break (2-af), the tension of the nerve seems to rebound to be the same as those measured at before the task. (Figure 3).

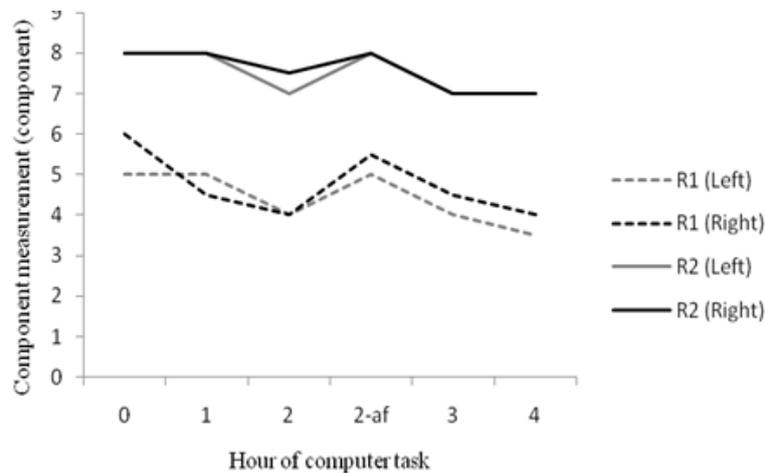


Figure 3: Observation of component measurement at Baseline (0), 1<sup>st</sup> hour, 2<sup>nd</sup> hour, 2-af (after a 20- minute break), 3<sup>rd</sup> hour, and 4<sup>th</sup> hour after computer task at R1 and R2

#### 4. DISCUSSION AND CONCLUSION

Both standard test and self-quick test showed the similar result. The tension at R1 and R2 were lowest (more degree or more component) at the baseline. This may indicate the self-quick test which is commonly used in clinic, can be applied for computer users to monitor themselves.

From the result, after starting the tasks the tension increased over the time. This increase of the tension may be from that using a computer continuously prones to expose to static and awkward posture with repetition of the upper extremities, head, and neck [1-4]. The increase of muscle work may mechanically interfere neural tissue pressure [9]. These result was similar to Byng's study in 1997. They found 100 percent of positive median tension in the patient group. In addition, asymptomatic keyboard user group were elicited the changed on neural tissue from the control group (not having computer use) by the ULTT1 [16]. This may show the sensitivity of neural tissue. It is earlier detected than the adjacent structures [9]. As an explanation, the characteristics as mechanical stimuli to nociceptors bring to inflammatory process of the neural tissue [15]. Its activation can increase the intraneural pressure, decrease axonal transport, cell nutrition and communication. Consequently, median mononeuropathy can be developed [8].

This study found that computer use can increase median nerve tension. Fortunately, we also found a trend of rebound after a short break from the self-quick test. A break may help reduce the tension. To gain more benefit, a small short break or active break [19] should be provided every hour of computer using. As a result the tension at 3<sup>rd</sup> hour increased, rather than the beginning. It may be a result from repetitive task which produces low opportunity of body tissue regeneration and affects the cumulative vicious cycle [6]. In addition, the test may be applied as a self-indicating test particularly for those who have suffered from musculoskeletal disorder.

For further study, the alteration of median nerve tension should be observed to indicate how often the short break should be and whether ergonomic intervention can be beneficial.

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