Effect of Smartphone Typing on the Muscle Recruitment in Neck and Upper Extremity: a preliminary report

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ABSTRACT

Background: Too much use of a smartphone can lead the musculoskeletal disorders in the neck and upper extremity. People spend more time in typing on it than using it as a phone. Objective: The aims of this study were to test which way we can type faster and better, and to understand the muscle recruitment in the neck and upper extremity while texting identical messages with one hand and two hands, and put the phone vertically and horizontally. Method: Fourteen healthy college students without any history of neuromuscular disorders or ongoing pain who used the smartphone more than one year were recruited. An iphone4 were used for texting the lyric of the Korean national anthem (79 characters with space) with one hand (dominant side) and two hands and put the phone vertically and horizontally. Muscle recruitment of neck (levator scapuare and middle trapezius), shoulder (infraspinatus and mid deltoid), elbow (biceps, brachioradialis), wrist (flexor and extensor carpi radialis), thumb (extensor and abductor policis, dorsal interossei) was collected with an electromyography system. The data were analyzed using the repeated measures ANOVA. Results: Typing with one hand took longer but not twice longer. After typing with one hand, more fatigue was reported. Placing the phone vertically or horizontally did not affect the typing speed. Typing error were less with two hand and with horizontally placed phone but not statistically significant. Less muscle activities were found in elbow and thumb with one hand use and in the neck with horizontally located phone. Application: Findings of this study can be valuable information for smartphone users to prevent the musculoskeletal disorders in the upper extremities.

Keywords: Smartphone, Electromyography, Perceived fatigue, Phone orientation, Typing

1. Introduction

1.1. Current situation of smartphone sale and use

A smartphone is a mobile phone built on a mobile operating system and it became the hottest electrical device (Wikipedia 2013). Worldwide smartphone sales passed 1.2 million units in 2011(Arthur 2012). Smartphones are now being used like a digital ‘Swiss Army Knife’, replacing everything (Richmond 2012). The average smartphone owner spends more than two hours each day using the device and about forty minutes typing messages (Richmond 2012).

1.2. Problems in using smartphone

Sustained and prolonged gripping and repetitive movements with the thumb have all been identified as risk factors which may lead to disorders of the thumb and extrinsic thumb musculature in the forearm (Fredriksson,
1995; Moore, 1997; Barr et al., 2004). Upper extremity musculoskeletal symptoms have been shown to be common in the computer users (Strazdins and Bammer, 2004; Roquelaure et al., 2006). The intensive use of smartphones could expose the thumbs and fingers to operational stresses which may generate pain and musculoskeletal disorders in the thumbs and the associated joints (Per Jonsson et al., 2011).

1.3. Purpose of study

There are a few popular ways to type on the keypad of smartphone: some prefers to use one hand with the phone in the portrait orientation while others like to type both hand with the phone in the landscape orientation. There is a gap in ergonomic study on how the use of smartphone can affect differently thumb and related musculoskeletal muscles. The aim of this study was to understand the effects of the two-hand typing and the phone orientation on the muscle recruitment in the neck and upper extremity.

2. Method

2.1. Participants

Fourteen (7 females) young (19-25 years of age) voluntary participants without any recent pain during the past month or any history of neuromuscular disorders in the neck and upper extremity were recruited. All participants were asked to read and sign the consent form. The mean height of the participants was 169.29 (±10.32) cm, and their weight was 64.43 (±13.78) kg. All participants have used their smartphone more than 1 year and they said that they spend 6.36 hours per day (± 3.43) with the phone and send 3.71 text messages daily (± 2.52).

2.2. Testing Procedure

Participants were seated in a chair with back rest and no arm rest. Participants were instructed to type the lyric of the Korean national anthem (79 characters with space) as fast as possible. The iPhone4 ((Apple 2013) 140g, 115.2*58.6*9.3mm) was used with standard Korean keypad. Test condition 1 was one-hand typing with the phone in portrait orientation. Test condition 2 was two-hand typing with the phone in portrait orientation. Test condition 3 was two-hand typing with the phone in landscape orientation. The order of the testing conditions was randomized. Sufficient (at least 5 minutes) typing practice period was provided prior to data collection. The phone was located in front of the xiphoid process of sternum. The elbow was kept in contact to the side of trunk and the wrist was maintained in neutral position. There was a 1-minute break between trials. Participants were asked to stop at any time when there is unbearable discomfort.

2.3. Instruments

Surface EMG electrodes were placed on the right middle trapezius (MT), biceps brachii (BB), brachioradialis (BR), extensor pollicis brevis (EPB), and abductor pollicis brevis muscles (APB). The electromyography (EMG) system (BagnoliTM, Delsys Inc., Boston, MA) was used for collecting the muscle recruitment data of right nine superficial muscles at a sampling rate of 1000 Hz with common mode rejection ratio (CMRR) of -92 dB and input impedance greater than 1015. The MotionMonitorTM software (version 6, innovative Sports Training, Inc. Chicago, IL) was used to visually inspect the data.

2.4. Data Processing

The EMG data were collected continuously throughout each typing trials. The visually inspected middle 30-second EMG data were processed. The mean, 10th, 25th, 50th, 75th, and 90th percentiles of EMG were calculated. Typing duration was measured from the beginning (“ready, set, and go,” announced by tester) to the end (“done,” reported by participants) of each task. Number of mistyping was counted and divided by total 79 characters.

At the end of each task, the subjects were asked to rate their perceived fatigue (0: no discomfort to 5: most discomfort) in their neck, shoulder, elbow, hand, and thumb. Ratings of perceived discomfort have been reported to be more reliable than ratings of fatigue based on electromyographic measurements (Sood, Nussbaum, & Hager, 2007).

2.5. Data Analysis
Repeated measures ANOVA was used to test the effect of testing conditions on the typing duration, the mean, 10th, 25th, 50th, 75th, and 90th percentiles of EMG and the typing error. When there was significant (p<.05) difference, pairwise comparisons were considered using repeated contrast. SPSS version 13 was used for statistical analysis.

3. Results

3.1. Typing Duration

Typing with one hand (123 ± 27s) were slower than with two hands (p=0.00 for both phone orientations). The phone orientation did not affect the typing duration with two hands (72 ± 13s and 75 ± 16s).

3.2. Typing error

The average typing error was twice more with one hand and the phone in the portrait orientation (12 ± 11%) than with two hands in the landscape orientation (6 ± 6%), but the ANOVA result failed to reach the significant level (p=.152) due to the large interpersonal variability. With two hands and the phone in the portrait orientation, it was 11 ± 6%.

3.3. Level of perceived fatigue and preference

Typing with two hands and the phone in the portrait orientation found to have the most preference and the least perceived fatigue. With one hand and the phone in the portrait orientation, participants in this study reported the greatest perceived fatigue and the least preference.

3.4. Mean EMG

Typing with one hand found to increase the mean EPB and APB muscle recruitment significantly (p=.045 and .019) than typing with two hands when the phone is in the portrait orientation. The phone in the landscape orientation increased the mean EMG of APB muscle but was not significant (p=.151).

3.5. 10th Percentile of EMG

Typing with one hand found to increase the 10th percentile of EPB and APB muscle recruitment significantly (p=.018 and .045) than typing with two hands when the phone is in the portrait orientation.

3.6. 25th Percentile of EMG

Typing with one hand found to increase the 25th percentile of EPB muscle recruitment significantly (p=.025) than typing with two hands when the phone is in the portrait orientation.

3.7. 50th Percentile of EMG

Typing with one hand found to increase the 50th percentile of EPB and APB muscle recruitment significantly (p=.028 and .026) than typing with two hands when the phone is in the portrait orientation.

3.8. 75th Percentile of EMG

Typing with one hand found to increase the 75th percentile of EPB and APB muscle recruitment significantly (p=.038 and .004) than typing with two hands when the phone is in the portrait orientation. The phone in the landscape orientation increased the 75th percentile of those muscles but was not significant (p=.548 and .152).

3.9. 90th Percentile of EMG

Typing with one hand found to increase the 90th percentile of APB muscle recruitment significantly (p=.029) than typing with two hands when the phone is in the portrait orientation. The phone in the landscape orientation increased the 90th percentile of this muscles but was not significant (p=.088).

3.10. Resting gap between EMG

Typing with one hand found to decrease the resting gap of BB muscle recruitment significantly (p=.017) than typing with two hands when the phone is in the portrait orientation. The phone in the landscape orientation decreased the resting of SC muscle (p=.040) than in the portrait orientation.
4. Conclusion

4.1. Typing Duration

Typing with one hand took almost twice longer than with two hands.

4.2. Typing Error and Fatigue

Typing with one hand had more error, perceived fatigue and less preference than with two hands.

4.3. EMG

Hand used and phone orientation did not change neck, shoulder, and elbow muscle recruitment. Typing with one hand had more muscle recruitment of thumb.

Limitation of this study was, firstly, the samples size was small. That may be why failing to show the statistical significance on the muscle contraction. Secondly, typing took about 1 minutes and it seems to be far less than what the people do in real.

The purpose of this study was to compare the performance of typing with iPhone4 and iPhone5. Fourteen young participants typed a text message. Typing text message with iPhone5 took longer but had less muscle recruitment in brachioradialis, and extensor and abductor pollicis brevis muscles. The purpose of this study was to compare the performance of typing with iPhone4 and iPhone5. Fourteen young participants typed a text message. Typing text message with iPhone5 took longer but had less muscle recruitment in brachioradialis, and extensor and abductor pollicis brevis muscles.

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