Effect of Cellular Phone Weight on the Muscle Recruitment in Neck and Upper Extremity: a preliminary report

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ABSTRACT

Objective: The aim of this study was to understand the effects of phone weight on the muscle recruitment in the neck and upper extremity while texting a message with one hand. Background: Too much use of a cellular phone can lead to musculoskeletal disorders in the neck and upper extremity. Phone makers tend to make their new models bigger, lighter, faster and smarter. Method: Fourteen healthy volunteers without any history of neuromuscular disorders or ongoing pain who used their smartphone more than one year were recruited. A 112g phone (iphone5) and a 142g phone (iphone4) were used for texting the lyric of the Korean national anthem with their dominant hand. Muscle recruitment of neck (middle trapezius and levator scapula), shoulder (infraspinatus and mid deltoid), elbow (biceps brachii and brachioradialis), thumb (extensor and abductor pollicis brevis) was collected using surface electromyography. Typing error was counted and typing speed was calculated in characters per min. The data were analyzed using the repeated measures ANOVA for the effects of phone weight on the posture, muscle recruitment and typing error and speed. Results: The result is under analysis for further detail. Conclusion: Typing text message with iPhone5 took longer but had less muscle recruitment in brachioradialis, and extensor and abductor pollicis brevis muscles. Application: Findings of this study can be valuable information for phone designers to develop more productive device and for smartphone users to prevent the musculoskeletal disorders in the upper extremities.

Keywords: Drilling, Perceived fatigue, Neck, Posture

1. Introduction

The number of obsolete mobile phones worldwide is estimated to be higher than 500 million (Monteiro et al., 2007). More than 1.15 billion mobile phones were sold worldwide in 2007, a 16 percent increase from the 991 million mobile phones sold in 2006 (CNET News, 2008). In 2008, more than 23 million mobile phones were sold in Korea (KOSIS, 2008). Smart phone has been replaced in market of mobile phone since several years before. Smart phones are frequently replaced by new models having a more modern design and/or a larger number of functions. The large consumer demand for newer smart products and the advanced development of information and communication technologies has resulted in a tremendous amount of obsolete smart phones.

There has been a rapid increase in the use of smartphone for communication, text messaging and games. With each new generation of the smart phone, there are more built-in functions such as web surfing and games which
lead to increased exposure time which affects thumb and related musculoskeletal structure as sustained posture and using repetition with small built-in keypads and hold smart phone. These exposures may be increased as a result of these repetitive massage sending and gaming activities. However, today there is a lack of knowledge on the physical exposures associated with smart phone use and how to best measure and characterize these exposures. Besides, there is no study characterizing and quantifying the biomechanical exposures associated with smart phone use. Therefore it is of importance to evaluate the physical exposures during smart phone use, particularly the exposures associated with operating the small keypads.

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 working population and among computer users (Strazdins and Bammer, 2004; Roquelaure et al., 2006 ). The intensive use of smart phones 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 ). However, there is no data how weight and screen size of smart phone can affect differently thumb and related musculoskeletal structure in user.

Too much use of a cellular phone can lead the musculoskeletal disorders in the neck and upper extremity. Phone makers tend to make their new models bigger, lighter, faster and smarter. The aim of this study was to understand the effects of phone weight on the muscle recruitment in the neck and upper extremity while texting a message with one hand.

2. Method

2.1 Subject Recruitment

Fourteen (7 female) 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 extremities were recruited. All participants were asked to read and sign the consent form. All participants have used their smart phone more than 1 year and 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) with their dominant hand as fast as possible. 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. The order of the testing conditions was randomized. There was a 1-minute break between trials. Participants were asked to stop at any time when there are unbearable discomfort.

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).

2.3 Instruments

An iphone4 is 140g and its dimension is 115.2*58.6*9.3mm. An iphone5 is 112g and its dimension is 123.8*58.6*7.6mm. An iPhone5 is lighter, shorter and thinner than an iPhone4.

The 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 ration (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 Analysis

Paired t-test was used to test the effect of phone weight on the typing duration, the mean, 10th, 25th, 50th, 75th, and
90th percentiles of muscle contraction and the typing error. SPSS version 13 was used for statistical analysis.

3. Results

Effect of phone weight on typing duration
The iPhone5 took 24 seconds (+/- 18.3) longer to complete the typing task.

Effect of phone weight on the mean muscle contraction
The typing with the iPhone5 had less mean recruitment level of BR and EPB (p=0.01 and p<0.01)

Effect of phone weight on the 10th percentile of muscle contraction
The typing with the iPhone5 had less recruitment level of BR and EPB (p=0.01 and p<0.01)

Effect of phone weight on the 25th percentile of muscle contraction
The typing with the iPhone5 had less recruitment level of BR and EPB (p=0.01 and p<0.01)

Effect of phone weight on the 50th percentile of muscle contraction
The typing with the iPhone5 had less recruitment level of BR and EPB (p=0.02 and p<0.01)

Effect of phone weight on the 75th percentile of muscle contraction
The typing with the iPhone5 had less recruitment level of BR, APB and EPB (p=0.02, p=0.03 and p<0.01)

Effect of phone weight on the 90th percentile of muscle contraction
The typing with the iPhone5 had less recruitment level of BR, APB and EPB (p=0.02, p=0.04 and p<0.01)

Effect of phone weight on the resting gap between muscle contraction
The typing with the iPhone5 had less recruitment level of LS and BB (p=0.02, and p=0.02)

Effect of phone weight on the typing error
There was no significant difference in the typing error by phone weight

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.

4. Conclusion

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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