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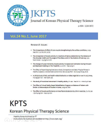

The Effects of Sitting Posture on Cervical Flexion Angle and Pain during Smart Phone Use in Young Adults

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Abstract

Purpose: This study aimed to investigate the effects of sitting posture on cervical flexion angle and pain during smart phone use. **Method:** This research was performed on 10 adult female students who use smart phones regularly, Each of the two groups of participants used the provided smart phone for 20 minutes while maintaining the given default posture. The evaluation order was randomly selected and the two groups were photographed twice before and after the experiment and were asked to answer if they felt pain during or after the experiment. **Result:** First, both upright sitting position and vertebra bent position pre and post experiment readings showed significant statistical difference ($p<.05$). And it is shown to be a factor that induces pain around the neck via increase in neck flexion angle. Second, although there were no significant statistical difference between the pre and post experiment readings of the upright sitting position results and the vertebra bent position results, the vertebra bent position readings showed bigger changes to the neck flexion angle then the upright sitting position readings. Third, all participants from both groups claimed pain in all the tested postures of smart phone usage. **Conclusion:** Smart phone usage for an extended amount of time in all body postures may prove to have a negative effect making the “optimal” smart phone usage position as a controlled time with neck stretches included in between short sessions.

Key words : Pain, Cervical Flexion Angle, Smart Phone Use

Ⅰ. Introduction

Smart phones are used in a variety of daily activities due to their vast functionality in accessing and searching the internet, playing games and watching videos using the countless applications at one’s disposal, or even shopping using electronic purchases, which makes it safe to say, they are one of the most widely used devices of this age. However, although smart phones possess such benefits to its users, it has its flaws of causing grave ef-

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fects to one's musculoskeletal system. The number of smart phone users has been increased worldwide during the last decade and nowadays, smart phones are equipped with a set of cheap but powerful embedded sensors that make the phone capable of detecting joint position and measuring joint range of motion (ROM) (Otter et al., 2015). None of the previously published papers have evaluated the validity of iPhone®10 applications 11 in neck pain patients (Quek et al., 2014; Tousignant and Laflamme et al., 2013).

According to Shin and Zhu (2011)'s research, when using portable touch screen devices for extended lengths of time, the usage of the arm increases along with the accumulation of fatigue to the neck and shoulder due to the drop in field of vision. This is due to the fact when looking at a small screened device, relatively speaking to bigger devices, the field of vision is lower resulting in a steeper angle of the neck angle when looking at the screen, making the extensor muscle stimulate in order to maintain balance, increasing fatigue to the neck muscle (Greig et al., 2005).

When extensive fatigue is applied to the muscle, pain is stimulated, and the pain originating from the neck is the result of bad posture which leads to misalignment to the anatomical array, or continuous muscular tension, and fatigue due to repeated motion (Hagen et al., 1997; Rachlin et al., 1994). Therefore, the forward head position which is a anatomically incorrect posture, creates dynamic stress due to continuous involuntary muscular contraction, resulting in muscular tissue impairments, providing a crucial factor in the continuous pain to muscles around the head (Mannheimer et al., 1991; Black et al., 1996).

When looking into the studies on the factors contributing shoulder arm neck syndromes, working posture and muscle tension show close relations to each other (Sang Hyuck Yim et al, 2000), and neck pain reported to have much correlations with muscle tension. Also, the posture and curvature of the neck are shown to create tension headache and other shoulder arm neck syndromes (Grace et al, 2005). Therefore, incorrect work posture triggers chronic and epidemiological stress to the musculoskeletal system and stress accumulated over a long period of time becomes a habit following the learning process of the muscular system, effecting posture, resulting in chronic postural disorder, and other musculoskeletal disorders.

Using statistics provided by the end of July of 2014, the total number of domestic smart phone users are estimated to be around 39million 350thousand users, which means more than 70 percent of the populous use smart phones. This suggests that a large portion of the population is in danger of musculoskeletal disorders, and the accompanying neck pain.

This research studies the curvature of the neck flexion angle during smart phone usage while sitting down, and the effects this has on the pain they feel.

Ⅱ. Method

1. Subjects

This research was performed on 10 adult female students who use smart phones regularly, and attends the G-college in Gimcheon in the province of Gyung-book.

All participants of the experiment were explained the purpose and experiment procedures of this study and given sufficient explanation before they gave their voluntary agreement to participate in this experiment. The factors in choosing the participants are as follows.

First, an adult who have used smart phones for at least over a year, and uses them as regularly as over 3 hours a day.

Second, an adult who was not exposed to any extensive physical fatigue to their body before the experiment.

Third, an adult without any inborn impairments to their upper extremity.

Fourth, an adult without any neck, shoulder, and arm impairments to their range of motion, and can perform the necessary motions needed for this experiment.

2. Experiment equipment and tools

1) Smart phone

For this research, an LG G Pro II was used with the size of 157.9, and the weight of 172g. Participants were asked to use this smart phone for 20 minutes in the posture requested by the experiment conductor.

2) Camera

To compare the pre and post experiment changes in posture of the participants, the LG G Pro II (LG-F350) was set in a fixed position and filmed by camera.

3. Experiment methods

1) Experiment posture

The 10 participants that corresponded with the presented conditions were randomly divided into 2 groups. Each group was given a default posture of not leaning on the back of the chair, and a 90 degree angle to both the hip joint and the knee joint with the feet resting comfortably on the floor. The upper arm was asked to maintain a position where it is attached to the torso, and the neck and field of vision was asked to maintain its natural angle.

2) Attach method and parts

In order to calculate the neck flexion angle of the participants more efficiently, each participants were attached with stickers on their C7 and their mastoid process.

3) Experiment plan

Each participants, divided into 2 groups, used the provided smart phone for 20 minutes maintaining their given default posture. In order to calculate the natural change in position, no external stimulation was applied what so ever during the time the participants were using the provided smart phone. The assessment order was chosen at random, both group was filmed twice before and after the experiment, and was asked to reply if they felt any pain during or after the experiment.

4. Measurement method and processing the statistics

1) Measurement method

The neck flexion angle of before and after the experiment was measured using Adobe Photoshop CS3. Using the horizontal line including the C7 point as the focal point, the angle between the prolongation of the C7 point and mastoid process and the previously mentioned line was measured. In doing so, positive numbers mean the mastoid process was higher up then the C7 point, and negative numbers mean the mastoid process was positioned beneath the C7 point.

2) Processing of statistics

The statistics of this research was processed using the program PASW Ver. 18 for window, calculating the mean and standard deviation of each factor's readings. The participant's general characteristic was processed by descriptive statistic, and in order to test for normality, the Kolmogorov-Smirnov was conducted to check the normality distribution. In comparing the pre and post experiment angle of neck flexion, each group was processed through the maneuver paired t-test, and in order to compare between the before and after the experiment neck flexion angle, the difference between before and after neck flexion angle was calculated and processed through an independent t-test for each group. All statistical significance level, "α" was set to 0.05.

III. Results

1. General statistic of the experiment participants

After researching the general statistics of the experiment participants, the participants were 10 in total between the age group of 22.60 ± 0.55, and the average height being 163.00 ± 2.12cm for the group that sat upright, and 165.40 ± 3.58cm for the group that sat with their vertebra bent. The weight was 56.00 ± 1.58kg for the sitting upright group and 51.00 ± 1.58kg for the group with the bent vertebra (Table 1).

2. The comparison between the readings before and after the experiment in each group

1) Comparison of the pre and post experiment readings in upright sitting position.

After processing the pre and post experiment readings through the matching sample t-assessment in sitting upright posture, the pre experiment readings were 44.48 ± 9.79, and the post experiment readings were 36.44 ± 14.50, showing significant statistical difference before and after the means of the readings ($p<.05$).

2) Comparison of the pre and post experiment readings in vertebra bent position

After processing the pre and post experiment readings through the matching sample t-assessment in vertebra bent posture, the pre experiment readings were 14.28 ± 12.57, and the post experiment readings were -2.18 ± 19.22 showing significant statistical difference before and after the means of the readings ($p<.05$) (Table 2).

3) Comparison of the difference between the pre and post experiment readings between the 2 groups

After processing the difference between pre and post experiment readings through the matching sample t-assessment between the 2 groups, sitting upright posture showed smaller results of 8.04 ± 4.97 then the 16.46 ± 7.28 of the vertebra bent group but there were no significant statistical difference in mean between the 2 groups (Table 3).

4) The existence of pain between the groups

After asking if the participants experienced any pain during or after the experiment, all participants proclaimed they felt pain during or after the experiment (Table 4).

IV. Discussion

This research was conducted in order to study the effects neck flexion angle has on neck pain when using smart phone for 20 minutes in sitting upright and vertebra bent positions.

According to the studies conducted by Szeto and Lee (2002), it has been reported that the neck flexion angle increases as the screen size of the visual device diminishes. Also, neck flexure induced by visual device usage such as smart phones may result in neck pain via damages to the neck bone and its surrounding structures and ligaments. Furthermore, repeated and sustained maintenance of posture is reported to have the danger of chronic neck pain. (Veiersted and Westgaard et al., 1993) This research calculated the neck flexion angle using the horizontal line including the C7 point as the focal point, and measuring the angle between the prolongation of the C7 point and mastoid process and the previously mentioned line was measured. As a result, with the angle calculated, larger the angle the curvature of the neck flexion angle decreased, and smaller the angle the curvature of the neck flexion angle increased. Therefore, this research showed similar results as formal researches, confirming that usage of small visual devices such as smart phones induce neck flexure of the neck bone as a result.

As the neck flexion angle increase, muscles supporting the neck bone, especially the posterior neck bone muscles are put on continuous muscle tension, resulting in a gradual occurrence of pain, and continuous occurrence of this posture can lead to damages to the structures surrounding the neck bone and its ligaments. This research analyzes the difference in neck flexion angle during smart phone usage, and concluded that in upright sitting position, the difference was 8.04 ± 4.97, and in vertebra bent position, the difference was 16.46 ± 7.28 with both groups showing significant decreases to their neck flexion angle. Especially with the measurement methods used for this research, decrease in neck flexion angle points toward the increase of neck flexion, stating in both sitting upright position and vertebra bent position, an increase in curvature of the neck is inevitable. With these results, it could be concluded that whether used in upright position, or in vertebra bent position, smart phone usage is a factor in causing pain and damage to the neck and its surrounding structures. However, while it could be implied that since there were no significant differences to the statistical results, of before and after experiment readings, when comparing just the changes in reading. The results of the vertebra bent position showed bigger changes to the angle than the upright position results, showing higher danger potential for pain and damage to the neck and its surrounding structures by increase in neck flexion angle.

Smart phones show a lower field of vision compared to laptop computers with a smaller screen size which indicates more than 20 minutes of smart phone usage can induce higher exertion and pain than using other visual devices. This also means smart phone usage, with a smaller screen size compared to others, can cause a more severe damage to the neck and its surrounding structures (Bonney and Corlett et al., 2002; Fernandez de las Penas et al., 2006; Fredriksson et al., 2002).

Therefore, smart phone usage can induce damage to the proprioceptive sensibility of the neck, the surrounding structures, and its soft tissue, effecting the neck flexion angle and neck pain, and smart phone usage for an extended length of time in one position can expose the user to potential neck pain in the future. However, it is important to consider limitations related to smar tphone use. Clinicians may be reluctant to use their personal smart phones for assessment due to the direct contact between the smart phone and the patient's skin (Salamh et al., 2014; Kolber et al., 2013). The participants of this study did not claim any pain to their musculoskeletal system before the experiment but after the experiment, all participants claimed pain to the neck, shoulder, and waist. Integrating all the results, extended use of smart phones may prove to be a factor that can induce pain in many parts of the body. And it is advisable for smart phone users to recognize the proper posture in using smart phones and maintain this posture all while refraining from extended use of the device.

V. Conclusion

This research was conducted in order to study the effect neck flexion angle have on neck pain in accordance to different postures based on 10 adult female students attending G college in Gim Cheon of Kyong Book province.

First, both upright sitting position and vertebra bent position pre and post experiment readings showed significant statistical difference ($p<.05$), which is shown to be a factor that induces pain around the neck via increase in neck flexion angle.

Second, although there were no significant statistical difference between the pre and post experiment readings of the upright sitting position results and the vertebra bent position results, the vertebra bent position readings showed bigger changes to the neck flexion angle then the upright sitting position readings.

Third, all participants from both groups claimed pain in all the tested postures of smart phone usage.

Since both using smart phones in upright position and vertebra bent position decreased neck flexion angle, this can be considered as a factor inducing deformation and pain to the vertebra's posture. As a result, smart phone usage for an extended amount of time in all body postures may prove to have a negative effect making the "optimal" smart phone usage position as a controlled time with neck stretches included in between short sessions. Also, it advisable further research on more varied postures is conducted in the future.

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Appendix 1. Table

Table 1. The General Statistics of the Experiment Participants

	Sitting in upright posture (n=5)	Sitting with vertebra bent (n=5)	p
Age (year)	22.60 ± 0.55	22.60 ± 0.55	1.000
Height (cm)	163.00 ± 2.12	165.40 ± 3.58	0.177
Weight (kg)	56.00 ± 1.58	51.00 ± 1.58	1.000

Table 2. Comparison of the pre and post experiment readings in upright position and vertebra bent position (°)

Group	Pre experiment	Post experiment	t	p
Sitting upright	44.48 ± 9.79	36.44 ± 14.50	3.618	.022*
Vertebra bent	14.28 ± 12.57	−2.18 ± 19.22	5.058	.007*

*p<.05

Graph 3. Comparison of the difference in pre and post experiment readings for each group (°)

	Upright position (n=5)	Vertebra bent position (n=5)	t	p
Difference between pre and post experiment readings	8.04 ± 4.97	16.46 ± 7.28	−2.137	.065

Table 4. The existence of pain in each group after the experiment (n)

Group \ Pain	Yes	No
Upright position	5 participants	0 participants
Vertebra bent position	5 participants	0 participants