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The Effects of Screen Smart Devices on the Neck Flexion Angle

The purpose of this study was to investigate the effect of the screen size of smart devices on the bending angle of the cervical spine. The subjects of this study were 30 healthy adults(15 men and 15 women) who used smartphones and tablet PC(personal computer).
The changes in the bending angle of the upper and lower cervical spine were measured in the subjects after they had used a smartphone and a tablet PC for 300 seconds each. To make sure that all subjects began in the same starting position, an angle-measuring instrument was used to set the angles of the ankle, knee, hip, and arm joints to 90 degree. The subjects were asked to keep the trunk straight. They were asked to hold a smartphone in their hand and to bend their neck so that they could look down at the screen. Once they began using the smartphone in this manner, they were free to change their posture. We used a paired t-test to compare the bending angle of the cervical spine on subjects who used smartphones and tablet PC in the long-term and short-term there production error of cervical and the significance level was cervical. The results showed that, when using a smartphone and a tablet PC for 300 seconds, there was no significant difference in the bending angle of the upper cervical spine($p>.05$), although there was a significant difference in the bending angle of the lower cervical spine($p<.05$).

Key words: *Neck fexion angle; Smart device; Screen size; Cervical spine; Tablet PC*

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INTRODUCTION

A smartphone is a mobile device with an open operating system that provides multiple advanced functions, including access to the Internet, e-mail, maps, and messaging apps, and to media functions, such as music, photos, videos, and office programs like PDF and MS(1).

Smart devices have screens, or visual display terminals(VDT). VDT syndrome refers to the pain in the neck and shoulders in people who spend a lot of time monitoring or operating a computer or smartphone. Having bad posture while using a computer might also develop symptoms in the neck or shoulder(2, 3).

The widespread use of VDTs has led to an epidemic of bad posture. In 2013, Korea had the world's highest smartphone penetration rate at 67.6%. Since then, the smartphone addiction rate among people has increased. The smartphone addiction rate(11.8%) has reportedly surpassed the Internet addiction rate(7.0%). In fact, 25.0% of Internet addicts have reported symptoms of smartphone addiction. When we looked at smartphone addiction risk by age, the addiction rate was 25.5% for teenagers, 15% for people in their 20s, and 8.2% for people in their 30s. The addiction rate was 9.7% for male adults and 8.0% for female adults. On average, smartphone addicts used their phones for 5.4 hours per day(h/d) compared with normal smartphone users, who used their phones for 4 h/d. The usual activities included using mobile messenger(40.6%), reading news articles(17.6%), playing online games(8.3%), and studying or working(7.1%)(4).

Smartphone addiction negatively affects mental health, causing obsession, depression, psychosis, anxiety, and stress(5). It also reduces physical activity, which can lead to obesity and tired eyes(6). The increased use of smartphones has also caused neck and shoulder pain(7). This pain, known as turtle neck syndrome, is the anterior positioning of the cervical spine. Stiff muscles behind the neck and around the shoulders affect the spin(8,9).

The continuous use of a smartphone can damage the surrounding structures of the cervical vertebra and lumbar vertebra, as well as the ligaments(10). The prolonged use of smartphones leads to reduced neck flexion and pain(11). Since the spinal structures are interconnected, bad neck posture can negatively affect the spine.

Bad smartphone posture, which involves leaning over a cellphone, was reported more in children who used portable PCs than those who used desk-top computers. These children were reported to have increased muscle activities of the trapezius muscle and the sternocleidomastoid muscle.(12,13) While the use of VDTs in smartphones and tablet PCs have become widespread, few studies have investigated the relationship between the screen size of the device and bad smartphone posture.

For this reason, this study used the Zebris CMS20 and smart devices to examine the relationship between the size of a VDT and neck flexion angle. The neck flexion angle was measured as subjects used a 4-inch iPhone and a 9-inch tablet PC (iPad) for 300 seconds.

METHODS

Subjects

Table 1. General characteristics of the subjects

	Mean ± SD	Range
Age (yer)	24.3±1.9	22~26
Height (cm)	172.3±4.6	158~184
Weight (kg)	64.7±5.7	49~83
Smartphone use (h)	6.4±1.8	4~9

This study was conducted on 30 healthy adults(15 males and 15 females) who used a smartphone or a tablet PC for more than one hour a day. The subjects voluntarily participated in the study. They were partially informed of the purpose of the study and fully informed of the test methods to exclude prejudice against the study. Subjects who had a congenital deformity of the neck/spine, a serious surgical/neurological disease that left the to perform the actions required in the study, or had injured or felt pain in their neck or spine over the past six months were excluded from the study.

Test Devices

A Motion analysis data collection and analysis system to measure a person's neck flexion angles and repeatability error in the cervical vertebra when using a smartphone, we used the Zebris CMS20 ultrasound-based motion analysis system (CMS20, Zebris MedicalGmbH, Isny, Germany), a three-dimensional motion analysis system. Four active single markers were used to measure the upper and lower neck flexion angles. The marker was attached to the sternum, the C7 spinous process, the external acoustic meatus, and the zygoma(14). The transducer sensor, which was composed of three microphones that sensed ultra-sonic waves, was placed in parallel with the sagittal plane and 80cm to the left of the subject. The use of a smartphone and tablet PC a 4-inch iPhone(58.6× 123.8 × 7.6mm and 112g) and a 9.7-inch tablet PC(iPad)(240 × 169.5 × 7.5mm and 469g) were used for the study. When using the devices, the subjects were allowed to use the Internet or play games.

Test Methods

To make sure that all subjects began in the same starting position, an angle-measuring instrument was used to set the angles of the ankle, knee, hip, and arm joints to 90 degree. The subjects were asked to keep the trunk straight and to place their upper arm next to their trunk. They were asked to hold a smartphone in their hand and to bend their neck so that they could look down at the screen. Once they began using the smartphone in this manner, they were free to change their posture.

The subjects were asked to use both a smartphone and a tablet PC for 300 seconds that changes in the upper and lower neck flexion angles could be measured. The data were recorded 30 times per second in real time by a sensor. After using the devices, data for the starting and ending point of the upper and lower neck were measured 30 times per second to calculate the average and analyze them.

Analysis Methods

A paired t-test was conducted to compare the neck flexion angles and the repeatability errors for the smartphone users depending on the duration of smartphone use. SPSS Statistics software, version 18.0 was used to analyze the statistics. The significance level was set to p<.05.

RESULTS

Thirty subjects participated in the study. The average age of the participants was 24.3±1.9 years, the average height was 172.3±4.6 cm, and the average weight was 64.7±5.7 kg. The average duration of smartphone use was 6.4±1.8 hours per week.

The comparison of the neck flexion angles for users of a smartphone and tablet PC. After using a smartphone and a tablet PC for 300 seconds each, no significant difference was found in the upper neck flexion angles between the two devices(p>.05). However, there was a significant difference in the lower neck flexion angles between them (p<.05).

The significance probability of a smartphone was 0.01(p<.05), which was lower than that of a tablet PC, which was 0.04(p<.05). However, there was no significant difference between the changes in the upper and lower neck flexion angles between a smartphone and tablet PC(p>.05).

Table 2. Comparison of cervical angle

		Mean±SD	t	P
S	A1-A2	.78±3.83	.741	.473
T	A1-A2	−0.81±4.10	−.712	.657
S	B1-B2	5.15±6.03	3.07	.001*
T	B1-B2	5.58±8.71	2.29	.004*
ST	A1-A2	−1.6±3.63	−1.58	.459
ST	B1-B2	−1.19±18.66	−.231	.489

* P<.05
S: smartphone, T: tablet PC, A1: A upper cervical part starting, A2: A upper cervical part ending, B1: A lower cervical part starting, B2: A lower cervical part ending.

DISCUSSION

This study examined the impacts of the use of a smartphone on neck flexion angles. It turned out there was no significant difference in the lower neck flexion angles between the use of a smartphone and a tablet PC, although there was a significant difference in the lower neck flexion angles(p<.05). While using a smartphone, the lower neck flexion angles increased significantly (p<.05), but no difference was found in the upper neck flexion angles (p>.05)

The study found that the prolonged use of a smartphone leads to a greater lower neck flexion than the prolonged use of a tablet PC(p<.05). The use of VDTs in a computer leads to a deeper neck flexion(2, 15)while a smaller VDT produces greater neck flexion(16).

Neck flexion resulting from the use of VDTs might lead to damage to the surrounding structures and ligaments of the neck, causing pain in the neck(1) and increasing muscle activities of the trapezius muscle and cervical erector spinae.(13) The use of a smartphone for more than 10min(19) or 20 min(15) lead to reduced neck angles, causing pain. Bending the neck for a long time might risk causing chronic neck pain.(19). Therefore, it is recommended to hold the device just below eye level, take a break every 10 min, and to stretch muscles around the neck and shoulders(20).

To summarize, prolonged use of a smartphone, which has a smaller VDT that of a tablet PC or computer, can cause severe damage to the neck and surrounding structures. This is because the use of a smartphone increased the lower neck flexion angles more than the use of a tablet PC. Therefore, the prolonged use of a smartphone causes damage to the surrounding structures and proprioceptive sensibility of the soft tissues of the neck, affecting the musculoskeletal system, and eventually leading to potential neck pain.

There are some limitations of the study. First, the number of subjects was small, making it difficult for researchers to generalize the findings of the study. Second, the study depended only on the neck angles without measuring the muscle activities. Third, the time was limited to 300 seconds so that changes according to time were not observed. The study found that the prolonged use of a smartphone and tablet PC led to a deeper neck flexion in the lower part of the neck than in the upper part. While changes in neck flexion depending on the size of the VDT of the device were insignificant, the duration of smartphone use affected the lower neck flexion angles. The prolonged use of a smartphone and tablet PC might cause pain in the neck and shoulders, and changes in the musculoskeletal system.

Therefore, an in-depth study needs to be conducted to see the impacts of the duration of smartphone use and screen size on muscle fatigue in the neck and shoulders, as well as in the wrists.

CONCLUSIONS

This study was conducted on 30 subjects(average age 24.3±1.9 years)to see the impacts of short- and long-term use of smartphones on upper and lower neck flexion angles.

The results showed that, when subjects used a smartphone and a tablet PC for 300 seconds each, there was a significant difference in the lower neck flexion angles($p<.05$), while no difference was observed in the upper neck flexion angles($p>.05$). For the lower neck flexion angles, the significance probability of a smartphone was smaller than that of a tablet PC.

However, there was no significant difference in the changes in the lower neck flexion angles between a smartphone and a tablet PC($p>.05$). The study found that the prolonged use of a smartphone and tablet PC led to greater lower neck flexion angles than upper neck flexion angles. While changes in neck flexion depending on the sizes of the devices for VDTs were insignificant, the duration of use of the devices led to changes in the lower neck flexion angles, which can cause pain in the neck and shoulders, and changes in the musculoskeletal system. This means that the prolonged use of a smartphone might negatively affect the lower neck, and cause changes in the proprioceptive sense of the neck and damage in the surrounding ligaments of the lower neck.

Therefore, smartphone users should make sure to maintain proper posture, take breaks while using their devices, and avoid using the devices for a long time. More research needs be done to examine the angles of cervical vertebra and lumbar vertebra, as well as muscle activities.

REFERENCES

1. Chang MO. Segmentation of Smartphone market for young generation based on the motivation factors. Ponghang University of Science & Technology, Master's Thesis. 2010.
2. Segawa K. Protective effect of bilberry-derived anthocyanins-containing diet on VDT work-induced subjective asthenopic symptoms and the accommodativeeye function impairment in healthy adults. Japanese Pharmacology and Therapeutics 2013;41(2):155-166.
3. Tittiranonda P et. al., Effect of four computer keyboards in computer users with upper extremity musculoskeletal disorders. Am J Industrial Med 1999;35(6):647-661.
4. National Information Society Agency. Survey of Internet addiction. 201323-37. 2014.
5. Kim BY. The correlation amongst highschool student's Internet game addition, smartphone addition, the lack of sleep and stress. University of Sahamyook, Master's Thesis. 2012.
6. Berolo S, Wells RP, Amick BC III. Musculoskeletal symptoms among mobile hand-held device users and their relationship to device use: A preliminary study in a Canadian University population. Appl Ergon 2011;42(2):371-378.
7. Greig AM, Straker LM, Briggs AM. Cervical erector spinae and upper trapezius muscle activity in children using different information technologies. Physiotherapy 2005 ;91(2):119-126.
8. Park YM. A study on adult's smart phone addition and mental health. Sangji University, Master's Thesis. 2011.
9. Zhang FR et. al., Quantify work load and muscle functional activation patterns in neck-shoulder muscles of female sewing machine operators using surface electromyogram. Chin Med J. 2011; 124(22):3731-3737.
10. Kim SH, Kim KU. Change of cervical angle according to smartphone using time. J Korean Soc Phys Med. 2014;9(2):141-149.
11. Straker LM et. al., A comparison of posture and muscle activity during tablet computer, desktop computer and paper use by young children. Ergonomics 2008;51(4):540-555.
12. Park JH, Kang SY, Jeon HE. The effect of using smart-phones on neck and shoulder muscle activities and fatigue. Phys Ther Kor 2013;20(3);19-26.

13. Kuo LC et. al., Functional workspace for precision manipulation between thumb and fingers in normal hands. J Electromyography and Kinesiology 2009;19(5):829-839
14. Kim YG et. al., Influence of the duration of smartphone usage on flexion angles of the cervical and lumbar spine and on reposition error in the cervical spine. Phys Ther Kor 2013; 20(1):10-17.
15. Szeto GP, Lee R. An ergonomic evaluation comparing desktop, notebook, and subnote-book computers. Arch Phys Med Rehabil 2002;83(4):527-532.
16. Bonney RA, Corlett EN. Head posture and loading of the cervical spine. Applied Ergonomics 2002;33(5): 415-417.
17. Lee HK. The effects of forearm muscle activity on use of smart phone. Masan University Thesis. 2013a; 32:169-175.
18. Veiersted KB, Westgaard RH, Andersen P. Electromyographic evaluation of muscular work pattern as a predictor of trapezius myalgia. Scandinavian J.ofWork, Environment &Health 1993;19(4):284.
19. Lee YS. A study on the effects of mobile phone use addition on teenage health; focused on neck pain. Kwangwon University, Master's Thesis. 2013.
20. Shin G, Zhu X. User discomfort, work posture and muscle activity while using atouchscreen in a desktop PC setting. Ergonomics 2011;54(8): 733-744.