

The Comparison of Cervical Repositioning Errors According to Smartphone Addiction Grades

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Abstract. [Purpose] The purpose of this study was to compare cervical repositioning errors according to smartphone addiction grades of adults in their 20s. [Subjects and Methods] A survey of smartphone addiction was conducted of 200 adults. Based on the survey results, 30 subjects were chosen to participate in this study, and they were divided into three groups of 10; a Normal Group, a Moderate Addiction Group, and a Severe Addiction Group. After attaching a C-ROM, we measured the cervical repositioning errors of flexion, extension, right lateral flexion and left lateral flexion. [Results] Significant differences in the cervical repositioning errors of flexion, extension, and right and left lateral flexion were found among the Normal Group, Moderate Addiction Group, and Severe Addiction Group. In particular, the Severe Addiction Group showed the largest errors. [Conclusion] The result indicates that as smartphone addiction becomes more severe, a person is more likely to show impaired proprioception, as well as impaired ability to recognize the right posture. Thus, musculoskeletal problems due to smartphone addiction should be resolved through social cognition and intervention, and physical therapeutic education and intervention to educate people about correct postures.

Key words: Cervical reposition, Proprioception, Smartphone addiction

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INTRODUCTION

In modern society, the use of smartphones has increased rapidly, and there are now more than 30 million smartphone subscribers in Korea. In particular, 91% of university students in their 20s use smartphones, which is much higher than other age groups¹⁾. Compared to general cell phones, a smartphone is capable of internet use which provides additional various conveniences for users²⁾. However, the use of smartphones may result in smartphone addiction, which is the convergence of existing internet and cell phone addiction problems into smartphone addiction³⁾. The characteristics of smartphones such as usefulness, convenience and accessibility have encouraged dependence. The smartphone addiction rate is now 8.4%, which is higher than the internet addiction rate of 7.7%, and this trend is expected to continue thanks to increasing smartphone penetration and use⁴⁾.

The continuous use of a smartphone for a long time can cause various musculoskeletal problems⁵⁾. In particular, it can encourage incorrect postures such as a hunched or neck-bending postures⁶⁾, and cause damage to the surrounding skeletal structures as well as to ligaments⁷⁾. Furthermore,

spinal structures are connected to one another and deformation of the cervical position can affect the lumbar vertebrae negatively⁸⁾. Neck flexion is expected to increase due to the frequent use of the relatively small screen of a smartphone compared to that of a desktop computer⁹⁾. One study reported that the long and continuous use of a smartphone not only incurred pain in the neck and waist but also impaired proprioception¹⁰⁾. A study by Kim et al.¹¹⁾ reported that long and continuous smartphone use causes posture change in the cervical and lumbar vertebrae, as well as proprioception deficits in the cervical vertebra. Furthermore, children who used a tablet computer had a more incorrect posture than those who used a desktop computer, and showed increased muscle activities of the trapezius and cervical vertebrae muscles¹²⁾. As mentioned above, the long and continuous use of a smartphone causes deformation of the cervical and lumbar vertebrae, as well as the surrounding soft tissues, sometimes resulting in severe pain.

Most previous studies of smartphone addiction have investigated musculoskeletal diseases of the cervical vertebrae due to the long and continuous use of a smartphone. However, no study has yet investigated changes in proprioception with respect to the grade of smartphone addiction. Therefore, the present study determined the degree of change in proprioception through cervical repositioning errors with respect to the smartphone addiction grade.

SUBJECTS AND METHODS

This study surveyed smartphone addiction of 200 uni-

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versity students in their 20s and selected 30 subjects in total. The subjects were divided into a Normal Group (scores below 40), Moderate Addiction Group (scores between 40 and 43), and Severe Addiction Group (scores over 43), with 10 subjects in each group. The subjects had no history of musculoskeletal pain or neurological diseases and they voluntarily consented to participate in the experiment after receiving sufficient explanation about the experiment's methods and limited information on the study's purpose. This study was approved by the Korea Nazarene University Institutional Review Board and was conducted in accordance with the ethical principles of the Declaration of Helsinki. The general characteristics of the subjects who participated in this study are summarized in Table 1.

The classification of smartphone addiction was done using a smartphone addiction scale survey form developed by the Internet Addiction Response Center. The sub-scales for the measurement of smartphone addiction are divided into four categories of daily living difficulty, virtual word orientation, withdrawal, and resistance comprising 15 questions in total. All the questions are multiple-choice questions. Each answer is scored on a 4-point Likert scale ranging from 'Disagree very strongly' (1) to 'Agree very strongly' (4). As the scores increase, smartphone addiction is considered to be higher. If a subject's score was over 43 points, the subject was placed in the Severe Addiction Group which had severe levels of difficulty with daily living, resistance, and withdrawal. If a subject's score was less than 40, the subject was placed in the Normal Group, which was considered as having no smartphone addiction with no difficulty with daily living, withdrawal or resistance. The scores were determined in accordance with the scoring guidelines of the questionnaire's scale, which classifies scores as Normal (below 40), Moderate Addiction (between 40 and 43), and Severe Addiction (over 43)¹³.

To measure the range of motion (ROM) around the neck, a range of motion meter (Performance Attainment Associates, West-Germany) was used. The range of motion meter was placed on the ridge of the nose and ears, similar to wearing glasses, and was attached to the head by a Velcro strap. In order for all subjects to have a uniform start posture, their trunks were maintained in a neutral posture, and their ankle, knee, and hip joints were kept at 90° flexion with the head and eyes facing the front. The normal angles of the neck were set as follows: the angle of flexion was 0–60°, the angle of extension was 0–50°, and the right and left lateral flexion was 0–50°, while the target position was set at 30°, which is 60% of the normal ROM angle. The subjects memorized the target position of 30° for three seconds, and then returned to the neutral position. Then, the subjects held the target position by themselves, and kept the position for three seconds followed by measurement of the angles, and return to the neutral posture again. The measurements were conducted three times per posture and the absolute value of the repositioning errors compared to the target position (30°) was calculated. The researcher instructed the subjects orally to not move their trunk and to keep the posture in order to maintain the neutral posture during the measurements. The order of the measurements was flexion,

Table 1. General characteristics of the subjects

| | Normal group (n=10) | Moderate addiction group (n=10) | Severe addiction group (n=10) |
|-------------|------------------------|---------------------------------------|-------------------------------------|
| Sex (M/F) | 5/5 | 4/6 | 3/7 |
| Age (yrs) | 22.6 ± 1.3 | 21.5 ± 1.9 | 22.4 ± 2.0 |
| Height (cm) | 170.0 ± 9.8 | 167.0 ± 8.0 | 165.0 ± 5.2 |
| Weight (kg) | 60.3 ± 12.4 | 60.3 ± 16.0 | 54.8 ± 5.8 |

Values are mean ± SD

extension, right lateral flexion and left lateral flexion and the target position (30°) for each posture was given before the measurements¹⁴.

The Data analysis was performed using SPSS 12.0 for Window. The subjects were divided into a Normal Group, Moderate Addiction Group, and Severe Addiction Group. A one-way analysis of variance (ANOVA) was used to compare the repositioning errors of the postures among the groups. The least significant difference (LSD) was used for post-hoc analysis. The statistical significance level, α , was chosen as 0.05.

RESULTS

A significant difference in repositioning errors of neck flexion was revealed among the three groups ($p < 0.05$), and the post hoc analysis showed that there was a significant difference between the Normal Group and the Severe Addiction Group ($p < 0.05$). The three groups showed a significant difference in repositioning errors of neck extension ($p < 0.05$), and the post hoc analysis indicated there were significant differences between the Normal Group and the Moderate Addiction Group, and between the Normal Group and the Severe Addiction Group ($p < 0.05$). The three groups showed a significant difference in repositioning errors of right lateral flexion ($p < 0.05$), and the post hoc analysis also showed significant differences between the Normal Group and the Moderate Addiction Group and between the Normal Group and the Severe Addiction Group ($p < 0.05$). The three groups showed a significant difference in repositioning errors of left lateral flexion ($p < 0.05$), and the post hoc analysis also showed there were significant differences between the Normal Group and the Moderate Addiction Group, and between the Normal Group and the Severe Addiction Group ($p < 0.05$) (Table 2).

DISCUSSION

It has been reported that smartphone addiction can make it difficult for users to control themselves¹⁵, resulting in excessive smartphones use, feelings of dependence on the smartphone, and experiences of compulsive symptoms¹⁶. It has also been reported that the long and continuous use of a smartphone causes incorrect posture, such as neck flexion or a hunched posture which results in damage not only to the surrounding soft tissues but also the surrounding structures and ligaments¹⁷. This study calculated survey¹³

Table 2. The Comparison of repositioning errors according to addiction grade

| Motion | Normal group | Moderate addiction group | Severe addiction group |
|----------------------------|--------------|--------------------------|-------------------------|
| Flexion (°)* | 1.0 ± 0.2 | 1.7 ± 0.4 | 3.2 ± 0.8 ^b |
| Extension (°)* | 0.9 ± 0.1 | 3.6 ± 0.7 | 4.9 ± 1.1 ^{ab} |
| Right lateral flexion (°)* | 0.4 ± 0.1 | 2.8 ± 0.8 | 3.9 ± 1.0 ^{ab} |
| Left lateral flexion (°)* | 0.6 ± 0.1 | 3.6 ± 0.7 | 4.1 ± 0.7 ^{ab} |

Values are mean ± SD. * $p < 0.05$, ^a Significant difference between the normals and moderate addiction groups. ^b Significant difference between the normal and severe addiction group

scores to categorize the subject's levels of dependence on smartphones into three addiction grades, and determined the effect of each addiction grade on each subject's repositioning errors with respect to neck movements (flexion, extension, and lateral flexion).

The study subjects were divided by their addiction levels into three groups: the Normal Group, the Moderate Addiction Group, and the Severe Addiction Group. The analysis of the measurement results of the repositioning errors showed that there were significant differences in the repositioning errors of flexion, extension, right lateral flexion and left lateral flexion between the groups. In particular, the Severe Addiction Group had the largest cervical vertebrae repositioning errors.

Kim et al.¹¹⁾ reported that the long and continuous use of smartphones increased repositioning errors of the upper and lower cervical vertebrae while Cheng et al.¹⁸⁾ reported that patients with chronic neck pain had larger repositioning errors than normal healthy adults. In addition, neck flexion resulting from the use of smartphone video screens can cause damage to the surrounding structure around the cervical vertebrae and ligaments, which can develop into neck pain¹⁹⁾. Furthermore, repetitive and continuous movements of the cervical vertebra had a high risk of causing chronic neck pain²⁰⁾. A significant difference was shown in the neck flexion movement between patients with chronic neck pain and normal healthy adults²¹⁾, and sitting with a bending posture for a long time could increase the angle of waist flexion with the head leaning forward which may cause a lumbar problem²²⁾.

A difference between the current study and other previous studies is that the current study did not measure the repositioning errors through time variables, but through assessment of grade of smartphone addiction and measurement of repositioning errors. On the other hand, a commonality of the current and previous studies is that differences in repositioning errors occurred due to pain, time variables, and addiction degree. Our present results indicate that as smartphone addiction becomes more severe, the accuracy of proprioception is likely to decrease, as well as the ability to recognize the right posture. In addition, when smartphones are used for a long time, the muscle activity in the neck changes causing micro-injury which eventually results in neck pain later.

In conclusion, our present results suggest that if a smartphone is used regularly for a long time, it could affect the correct perception of the proprioceptive sense thereby encouraging abnormal motion of the musculoskeletal system.

If this condition were to continue, it would negatively affect the quality of life of daily living through pain. Therefore, musculoskeletal problems due to smartphone addiction should be resolved through social cognition and intervention, and physical therapeutic education and intervention to educate people on about correct postures. In future studies, the muscle activity of the cervical vertebrae muscles and mobilization order, according to the grade of smartphone addiction, should be studied to provide information on correct postures.

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