Original Article

Correlation of Cervical Spinal Degeneration with Rise in Smartphone Usage Time in Young Adults

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ABSTRACT

Aims: The study aimed to define the association between spinal degeneration parameters and the rise in smartphone usage time. This was a cross-sectional study. **Subjects and Methods:** Young adults aged 20–35 years, who presented to our outpatient clinic due to neck pain between 2016 and 2018, were examined. Cervical disc degeneration, disc placement, Modic changes, and sagittal balance were retrospectively measured using magnetic resonance imaging (MRI) in 107 relatively patients. Data about daily phone usage times of the participants were obtained by a questionnaire filled in at the time of admission. **Results:** The total number of disc distances analyzed was 535 (Group 1; n = 200, Group 2; 335). In Group 1, the disc displacement was present in 30%, and in Group 2, the disc displacement was present in 35%. In terms of DD severity, the total DD score was >10 in 18 (18/40; 45%) patients in Group 1, and in 39 patients (39/67; 58%) in Group 2. The mean Cobb angle of Group 1 was 10.3° ± 6.57° (range, 2° to 34°), and that of Group 2 was 7.6° ± 5.14° (range, 1° to 26°) (Pcobb = 0.048). Modic changes were detected in 17 of the 107 patients (15.8%). Of the 17 patients, 3 (3/40, %7.5) were Group 1 and 14 (14/67, %20.9) were Group 2. MC was detected in 4 vertebrae in Group 1, and 24 vertebrae in Group 2 (P = 0.001) **Conclusions:** The analysis of cervical spine MRI data of young adult patients with neck pain shows that the smartphone usage time is effective in cervical sagittal balance disruption, disc degeneration, and development of Modic changes.

Keywords: *Cervical spine, disc degeneration, Modic changes, smartphone, young adult*

Introduction

Neck pain is becoming a major health problem in current society, and one of the most important causes of this is plausibly the increased use of handheld devices. For many reasons such as convenience and entertainment, the application of these devices has increased rapidly in recent years.[1] Nevertheless, as the use of these products increased, the rate of some physical complaints also increased.[2] Compared to other body regions, musculoskeletal complaints, especially in the neck region, have a higher prevalence among handheld device users, such as smartphones, ranging from 17.3% to 67.8% in different countries.[3] This condition influences mainly the young adult (20–35 years old) population.[4] Many mobile handheld device users utilize these machines in a non-neutral neck position with the head tilted forward and the neck flexed at 20° or more.[5-8] Hence, the use of mobile handheld devices is significantly associated with neck pain.[9,10] Prolonged positioning in this aspect may change the moment of the cervical spine and increase the burden on it.[11] The tension in the neck muscles throughout this posture is 3–5 times higher than the neutral position of the neck in the sitting form.[12]

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Moreover, it has been reported in previous studies that the load on the cervical discs in head-forward posture is 10 kg higher than the neutral neck position.[13] Besides, this position of the head leads to a reduction in the cervical lordosis.[14-16] Also, decreased segmental or global cervical lordosis accompanies degenerative changes of the cervical spine.[17]

Smartphone usage causes complaints such as neck pain, muscle fatigue, and cervical movement restriction.[9,14] Still, no studies are evaluating the impact of smartphone usage on the degeneration of the cervical spine. Accordingly, we used the cervical spinal radiological parameters to assess the outcomes of long-term exposure to the biomechanical imbalance. The study aimed to define the association between spinal degeneration parameters and the rise in smartphone usage time.

Subjects and Methods

In this cross-sectional study, young adults aged 20–35 years, who presented to our outpatient clinic due to neck pain between 2016 and 2018, were examined. The inclusion and exclusion criteria for the study are shown in Table 1. The study was approved by the local ethics committee and informed consent was obtained from each participant.

Data about age, body mass index, height, weight, smoking habits, and daily phone usage times of the participants were obtained by a questionnaire filled in at the time of admission. All patients underwent cervical spine magnetic resonance imaging (MRI). All images were obtained using the same imaging system (Siemens 1.5T, Germany), and the standard hospital protocol for the cervical spine was used. Every subject underwent sagittal T1-weighted and T2-weighted, and axial T2-weighted imaging. The study design did not require modifications to the routine clinical treatment of patients.

MRI data from 107 patients were analyzed by two radiologists. Cervical disc displacement (DD), on mid-sagittal T2-weighted images at each of the five disc levels (C2–C7), was calculated using the modified Pfirrmann grading system. Modic changes (MCs) were determined according to the protocol previously mentioned in the literature. The disc displacement was determined by assessing sagittal and axial T2-weighted images of all participants and classified as bulging or protrusion. For the cervical sagittal balance examination, the Cobb angle was measured. The Cobb angle (sagittal lordosis) was ruled as the angle between two lines parallel to the lower endplates of C2 and C7.

Statistical analysis

The subjects were divided into two groups according to the daily telephone usage time (Group 1 $\leq$ 3 h and Group 2 $>$ 3 h). Descriptive statistics were presented using mean and standard deviation for the normally distributed variables, and median (and minimum-maximum) for the nonnormally distributed variables. Independent samples Student's t test tests were used to compare the Cobb angle measurement, the grade of disc degeneration, disc placement, and MC between both groups. Statistical significance was accepted when a two-sided P value was lower than 0.05. Statistical analysis was performed using the MedCalc Statistical Software version 12.7.7 (MedCalc Software bvba, Ostend, Belgium; http://www.medcalc.org; 2013).

Results

A total of 107 patients (Group 1; n = 40, Group 2; n = 67) were included in the study. The mean age of all participants was 28.8 ± 4.72 (range 20–35). The mean age of group 1 was 27.8 ± 5.25, and the mean age of Group 2 was 29.4 ± 4.28 (P = 0.091). No statistically significant difference was observed between the two groups in terms of BMI, weight, height, and smoking.

The total number of disc distances analyzed was 535 (Group 1; n = 200, Group 2; 335). In Group 1, the disc displacement was present in 30% (60/200), of which 58 (97%) were bulging and 2 (3%) were protrusion. The most commonly affected disc distances were C5–C6 (60%), C6–C7 (35%), and C4–C5 (35%), respectively. In Group 2, the disc displacement was present in 35% (117/335), of which 110 (94%) were bulging and 7 (6%) were protrusion. The most commonly affected disc distances were C5–C6 (61%), C4–C5 (48%), and C6–C7 (31%), respectively [Table 2]. In terms of DD severity, the total DD score was >10 in 18 (18/40; 45%) patients in Group 1, and in

Table 1: Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
At least 2 years' experience in smartphone use	Abnormal findings in physical and neurological examination
At least 1 h per day for smartphone use	Spinal congenital anomaly
	History of cervical surgery
Cervical symptoms during smartphone use	Neck and shoulder pain due to traumatic injuries
Nonspecific pain in the neck and/or shoulder girdle for more than 3 months	Fibromyalgia, systemic disease, or a connective tissue disorder
Presence of pain at the time of admission	Refusal to give informed consent

Table 2: Cervical spine disc placement of subjects in each spinal unit

	Group 1			Group 2		
	Bulging	Protrusion	Total	Bulging	Protrusion	Total
C2-3	0(%0)	0(%0)	0 (%0)	4 (%6)	0 (%0)	4 (%6)
C3-4	8 (%20)	0 (%0)	8 (%20)	21 (%31.3)	0 (%0)	21 (%31.3)
C4-5	14 (%35)	0 (%0)	14 (%35)	31 (%46.2)	1 (% 1.5)	32 (%47.7)
C5-6	23 (%57.5)	1(%2.5)	24 (%60)	36 (%53.7)	5(%7.5)	41 (%61.2)
C6-7	13 (%32.5)	1 (%2.5)	14 (%35)	18 (%26.9)	1(%1.5)	19 (%28.4)
Total	58 (%29)	2 (%1)	60 (%30)	110 (%32.8)	7 (%2.1)	117 (%34.9)

Table 3: Cervical disc degeneration scores using the modified Pfirrmann classification system in each group

	Group 1	Group 2
C2-3	2.2±0.56	2.36±0.48
C3-4	2.32±0.65	2.43±0.65
C4-5	2.27±0.55	2.40±0.52
C5-6	2.27±0.5	2.7±0.46
C6-7	2.1±0.54	2.23±0.57
Total	11.2±2.33	11.9±2.2
Total DD skoru >10	45%	59%

Values are mean±SD

Table 4: Modic changes of subjects in each cervical vertebrae

	Group 1 (*n*=40)	Group 2 (*n*=67)
C2	0 (%0)	0 (%0)
C3	0 (%0)	1 (%1.5)
C4	0 (%0)	2 (%3)
C5	0 (%0)	7 (%10.5)
C6	2 (5%)	9 (%13.4)
C7	2 (%5)	5 (%7.5)

39 patients (39/67; 58%) in Group 2. Besides, the mean DD score of Group 1 was 11.2 ± 2.33, while that of Group 2 was 11.9 ± 2.2 [Table 3]. MC was observed only in 4 vertebrae in Group 1, and 24 vertebrae in Group 2 [Table 4]. The mean Cobb angle of Group 1 was 10.3° ± 6.57° (range, 2° to 34°), and that of Group 2 was 7.6° ± 5.14° (range, 1° to 26°) (Student's *t* test, Pcobb = 0.048).

MCs were detected in 17 of the 107 patients (15.8%). Of the 17 patients, 3 (3/40, %7.5) were group 1 and 14 (14/67, %20.9) were Group 2. MC was detected in 4 vertebrae in Group 1, and 24 vertebrae in Group 2 (P = 0.001). One of them was in C3, 2 in C4, 7 in C5, 11 in C6, and 7 in C7 [Table 4].

The subjects, who used telephones more than 3 h per day, had statistically significant differences in both cervical lordosis and MCs compared to those who used less than 3 h. On the contrary, though the disc herniation and DD affected these people more, the difference was not statistically significant.

Discussion

This research aimed to explore the association between smartphone usage time and degenerative changes in the cervical spine. In this study, the spinal degeneration parameters (DD, disc placement, MD) of patients with smartphone use time >3 h were more affected than those with smartphone use time ≤3 h. Also, there was a statistically significant difference between the two groups in terms of cervical lordosis. These findings indicate that longer use of smartphones affects the cervical spinal balance and degenerative processes.

In many studies conducted with smartphone users, the neck posture of the candidates during a smartphone use was in a flexed neck and/or a forward head position.[6-8,18-20] So, the positions requiring neck flexion for long hours imply that the sagittal balance of the cervical spine may deteriorate more rapidly. In the study, the mean Cobb angle was 7.6° ± 5.14° in the group with more than 3 h of smartphone usage, and 10.3° ± 6.57° in the group using less than 3 h (P = 0.048). These results show that the increase in smartphone usage time leads to a decrease in the angle of cervical lordosis. Whether this increase has a clinical implication is controversial. However, in recent studies, hypolordosis has been reported to cause neck pain or cervicogenic headache due to the increase in the length and tension in the posterior spinal muscles.[21]

The cervical DD and disc placement are some of the most common abnormal findings in healthy individuals.[22,23] In a recent large cross-sectional study, they reported that the cervical DD and disc placement in healthy individuals start in their 20s and progress with advancing age.[24] The decrease in water and proteoglycan content of the nucleolus with advancing age is the basis of degenerative changes in the disc.[25,26] In addition to physiological disc degeneration, some environmental factors such as nutrition and biomechanical factors contribute to disc degeneration.[26] Biomechanically, the deterioration of the balance of the cervical vertebrae changes the distribution of the intervertebral load and the momentum, and this causes the acceleration of degeneration in the segment subjected to maximum load.[27] In our study comparing patients in the same age group, we observed an increase in the number of spinal units that developed disc placement and in the severity of DD in patients with longer smartphone use [Table 3]. These results have shown that longer smartphone users may have an increase in disc degeneration along with irregularity in cervical sagittal balance.

In this study, which included young patients, the frequency of MCs was higher than in previous prevalence studies. In two large studies evaluating patients with neck pain and the mean age of almost 50, MCs were reported in rates of 16.1% and 19.2%.[28,29] In a prospective study evaluating 133 patients who followed up for 11 years after Whiplash injury, 25% development of new MCs was detected in the individuals over 40 years of age, while the individuals under 40 years of age did not develop any MCs.[30] These results indicate that the development of MCs is closely related to advancing age. Nevertheless, in our study, 15.8% of the patients (under 35 years of age) had MCs. Especially in patients with smartphone use for more than 3 h, it was seen as high as 20.9%. These results show that the increase in pressure on the vertebrae in the forward head position also affects the nutrition of vertebral endplates.

In conclusion, the analysis of cervical spine MRI data of young adult patients with neck pain shows that the smartphone usage time is effective in cervical sagittal balance disruption, disc degeneration, and development of MCs.

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Conflicts of interest

There are no conflicts of interest.

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