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Original Article

The effects of gait with use of smartphone on repositioning error and curvature of the lumbar spine

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Abstract. [Purpose] This study evaluated the effect of smartphone use on lumbar spine repositioning error and lumbar curvature while walking on a treadmill. [Subjects] A total of 20 healthy individuals (18 males and 2 females) volunteered for this study. [Methods] The subjects walked for 20 min on a treadmill while using a smartphone. To determine the effect of smartphone use, lumbar repositioning error was measured using an electronic goniometer while lumbar curvature was assessed using a Spinal Mouse before and immediately after treadmill use. Differences in the lumbar repositioning error and lumbar curvature data between the pre- and post-walking were compared using the paired t-test. [Results] The lumbar spine repositioning error was significantly greater post-walking compared with pre-walking (6.70±2.91° vs. 3.02±1.79°). There was no significant difference in lumbar curvature between pre- and post-walking (14.24±3.18° vs. 13.94±3.12°). [Conclusion] These findings indicate that the lumbar repositioning error increased immediately after walking while using a smartphone, but that the lumbar curvature was unchanged.
Key words: Lumbar spine, Repositioning error, Smartphone

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INTRODUCTION

Currently, about 6.8 billion people worldwide use mobile phones and global smartphone penetration was 29.5% in 2014. Worldwide smartphone shipments are forecast to grow 40% to 1.0 billion units per year[1, 2)]. An increase in smartphone use could lead to musculoskeletal disorders[3)]. Previous studies have shown that smartphone users tend to report neck and shoulder pain, and the symptom severity increases with the total time spent using a smartphone[4)]. Smartphone use can also lead to musculoskeletal disorders of the lower back. It has been reported that continuous smartphone use causes proprioception deficits in the cervical vertebra[5)], and postural changes in the cervical and lumbar vertebrae (slouched posture)[6)]. Slouched posture (lumbar flexion) is known to degrade proprioceptive function, which is associated with lower back pain (LBP)[7)]. Previous studies have demonstrated that patients with LBP have proprioceptive deficits, including greater variability and increased repositioning error compared to healthy subjects[8)].

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Smartphones, unlike other conventional visual display terminal (VDT) devices, have features that can be used during walking. However, the effects of smartphone use on the lumbar spine repositioning error and lumbar posture have not been investigated while a user is walking. Therefore, the aim of this study was to evaluate the effect of smartphone use on the lumbar spine repositioning error and lumbar curvature during gait on a treadmill.

SUBJECTS AND METHODS

A total of 20 healthy individuals (18 males and 2 females) volunteered for this study. They had no known musculoskeletal or neurological impairments that would have influenced gait on a treadmill. Volunteers were excluded if they had a history of lumbar spine pain requiring medical treatment within the previous 6 months, back surgery, or spinal deformities. The subjects' mean age was 28.35±2.68 years, and their mean height and weight were 171.33±7.74 cm and 66.78±9.23 kg, respectively. All subjects read and signed an informed consent form approved by the Inje University Institutional Research Review Committee prior to their participation.

Lumbar spine repositioning error was measured using an electronic goniometer (Dualer IQ^{TM}; JTECH Medical, Midvale, UT, USA) connected to a dual channel data logger. An examiner palpated T10 and S2, and these bony landmarks were marked with tape for the placement of two electrodes[9)].

Prior to measurement of the repositioning error, the 'upright' starting posture was aligned by a researcher who ensured the anterior and posterior superior iliac spines were level in the horizontal plane[9]. Subjects maintained this position for 5 s and were asked to remember this position. Subjects were then asked to relax for 5 s into full lumbar flexion and return to the neutral posture again[9]. All subjects were shown the required movement and were allowed to practice the sequence five times. After the practice trials, three test trials were performed. Lumbar spine repositioning error was defined as the absolute difference between the reproduction angle and the upright angle. The mean values of three absolute angles measured at pre- and post-walking were used in the statistical analysis.

Lumbar curvature was measured using a Spinal Mouse (Idig, Volketswil, Switzerland). The accuracy of this device was confirmed by Mannion et al[10]. To measure lumbar curvature, the Spinal Mouse was rolled paravertebrally along the spine from the seventh cervical vertebra to the first sacral vertebra while the subject was in a standing position. These landmarks were determined by palpation and marked on the skin surface with a cosmetic pencil. The lumbar curvature, the angle of the segments from the twelfth thoracic vertebra to the first sacral vertebra in the standing position was measured three times consecutively pre- and post-walking, and the mean values of the three trials were used in the data analysis[10].

After the measurement of the baseline data, subjects walked on a treadmill for 20 min while using a smartphone. The walking speed was set to a comfortable pace for each subject. All subjects adopted a comfortable posture without forcing the posture of the neck and back during walking. While walking, subjects were asked to play a smartphone game.

To compare the average lumbar spine repositioning error and lumbar curvature between pre- and post-walking, the paired t-test was used. Statistical analyses were performed using SPSS (ver. 20.0; IBM Corp., Armonk, NY, USA). P values < 0.05 were considered to indicate statistical significance.

RESULTS

The lumbar spine repositioning error was significantly greater post-walking compared to pre-walking (6.70±2.91° vs. 3.02±1.79°; $p = 0.000$). There was no significant difference in lumbar curvature between pre- and post-walking (14.24±3.18° vs. 13.94±3.12°, $p = 0.492$).

DISCUSSION

The findings of the present study show that the lumbar repositioning error had increased immediately after walking while using a smartphone; however, lumbar curvature did not significantly change.

In our study, after 20 min of walking on a treadmill using a smartphone the lumbar repositioning error increased. Proprioceptive deficits may be influenced by conditions of repetitive or prolonged loading of muscular, ligamentous, and capsular tissue, muscular fatigue, or load carrying as these conditions may induce strain on the structures of the lumbar spine[9]. Previous studies have shown that cervical and lumbar flexion increase after using a smartphone or VDT[5, 6]. Considering the findings of these previous studies, a slouched posture when using a smartphone increased the load on the muscles and capsular tissues of the lumbar spine, which led to an increase in the lumbar repositioning error in our study.

Although the use of a smartphone while walking for 20 min increased the lumbar repositioning error, the lumbar curvature did not change. Changes in spinal curvature occur due to changes in the surrounding skeletal structures[8]. Although smartphone use could change an individual's posture temporally[6], it may be difficult to induce structural changes in the muscles, ligaments, or capsular tissues of the lumbar spine through short-term use. Thus, it is our opinion that this is the reason why the lumbar curvature was unchanged immediately after walking while using a smartphone.

One of the major limitations of this study was that the participant group was only a small sample size of the general population. Also, this study had a relatively low proportion of females. Additional studies are required to consider the effects of long-term smartphone use on lumbar curvature.

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