Does texting while walking affect gait's plantar pressure parameters?

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Background: This study aims to examine the possible effects of mobile phone use on plantar pressure and spatiotemporal parameters during walking. Materials and Methods: Thirty volunteers (18 males and 12 females) participated in the study. A 10-m walking path was prepared, and a messaging connection was established. They were asked to write three posts without word or character mistakes and participants walked on the path walk as much as they wanted on the trail to make sure they were walking at their own pace. The gait's spatiotemporal parameters and plantar pressure parameters were recorded while walking. A paired samples t-test was used to determine whether there was a difference between normal walking and walking while texting. Results: While walking and writing a message, cadence, speed, and step length decreased significantly ($P < 0.05$). In the plantar pressure parameters, the fore- and midfoot load and pressure were significantly increased ($P < 0.05$). Conclusions: Compared to normal walking, the forces on the forefoot and midfoot and the pressure per unit area increased in walking while texting. It is thought that the pace of walking slows down, and focus and attention shift to the front of the body.

Introduction

The use of mobile phones is increasing in all areas of life. In addition to providing communication, it has become an important part of education and business life.[1],[2] Regardless of the time of day, during meals, economic and social activities, and on transportation, there is constant interaction with mobile phones. Despite advances, using the phone at the current technological level still requires hand-eye coordination and concentration. Walking in city life requires compliance with traffic signs, attention when crossing the streets, and paying attention to cars and other vehicles, such as scooters, bicycles, and other people.[3] Over the last few years, numerous publications have shown an increase in accidents and injuries associated with the use of the phone while walking.[4],[5] In a study, it was reported that as many as one-third of pedestrians were using messaging services while walking, and consequently there was an increase in pedestrian accidents between 2004 and 2010.[6] Injuries were reported as severe injuries, such as broken bones, and moderate injuries, such as abrasions and sprains. It is also known that there were a smaller number of fatal accidents and injuries.[7] The majority of injury accidents were associated with males under the age of 30.[1],[2]

With the widespread use of mobile phones, communication between people has increased and messaging has become a daily necessity. Many studies have been conducted on the changes in texting and spatiotemporal gait parameters during walking.[7],[8],[9],[10],[11] Agostini et al. [10] showed that walking speed was reduced for safety. Similarly, Chen et al. [11] found that walking speed decreased and body oscillations increased. In another study by Strubhar et al. ,[12] it was reported that gait speed slowed and lateral oscillations increased during message writing. The study reported a general decrease in walking speed and an increase in lateral deviations. In addition to the methods mentioned above, in other studies, two different strategies were used. These methods consist of varying message writing tasks and obstacles placed on the walking surface.[9],[13],[14]

When the effects of mobile phone use on gait parameters are examined together with dual-task activities, there is a consensus in the literature that gait speed decreases and oscillations increase. However, to our knowledge, there has yet to be a study of foot pressure parameters in the literature. In addition to the previously discussed effects of mobile phone use on gait parameters, variations have been found in stride lengths, joint kinematics change, and muscle activation patterns.[10] These gait adaptations that occur during texting may have effects on plantar pressure parameters. The aim of this study is to examine the possible effects of mobile phone use on plantar pressure and spatiotemporal parameters during walking.

Material and Methods

Participants

Thirty participants (18 males, 12 females) aged 18-30 years old were recruited for the study. Before collecting the participants' demographic information, the frequency of daily texting and phone usage times were obtained with a short questionnaire. Participants were included after they agreed to participate in the study and signed the voluntary consent forms. The criteria for inclusion in the study were the absence of any orthopedic disorder, a neurological or musculoskeletal disease that would affect his gait, and to habitually send at least 250 messages daily. Participants had at least one year of experience using their phones. All participants had a frequently and commonly used messaging program on their phones, which had an auto-completion function. In this function, auto-completion is performed by typing the first letters of frequently used words. Ethical permission for the study was obtained by the Non-Interventional Ethics Committee of Dokuz Eylul University.

Study protocol

Before data collection, the participants were informed about the experimental design. A 10-m-long walking path was prepared in a well-lit and temperature-controlled room. All objects that may distract the participants on the walking track were removed. Each participant was asked to walk only as much as desired, and no more, on the walking trail to ensure a natural pace. Participants were asked to go back and forth along the walking path. To be able to text while walking, participants were asked to message with the most common messaging program used by the participants' company (WhatsApp). Before messaging, the application connection was established and a test message was sent to detect possible problems. The automatic word completion program on their mobile phones was turned off. They were asked to write three messages without word or character errors. These messages were: 'I am a student at the physiotherapy and rehabilitation department of Dokuz Eylul University.'; 'Today I participated in the walking study of the prosthesis and orthotics department.'; and 'I will become a physiotherapist after I finish the physiotherapy and rehabilitation program.' Participants practiced writing each message once before the walk. They were not asked to write these messages as quickly as possible; they were allowed to write during their time on the walking platform, but they were informed that misspelled words would not be accepted. The same investigator made all briefings and test protocols. Participants were examined under two conditions (normal and texting gait) a total of three times. The average of the data from each walk was recorded.

The gait's spatiotemporal parameters were recorded while walking using BTS G-Walk (BTS Bioengineering Corp.) device. Its sensor was placed at the S1 level in the lumbar region. The device has a three-axis accelerometer, gyroscope, and magnetic sensor, and it was possible to collect and transfer data wirelessly. The anthropometric data of the participants (height, leg length, foot length) were recorded in the software to perform the analysis. Height, leg length, and foot length were entered into the system as anthropometric data. The data collected were gait time, cadence, speed, stride length, propulsion angle, and pelvic tilt-oblique-rotation angles.

*Pelvic Tilt Angle (°): forward or backward movement of the pelvis in the sagittal plane *Pelvic Oblique Angle (°): up or down movement of the pelvis in the frontal plane *Pelvic Rotation Angle (°): internal or external rotation in the transverse plane *Propulsion: The forward acceleration of the patient's center of mass during both the left and right single support phases.

RS Scan Footscan V9 (RSscan International, Olen, Belgium) device was used to collect plantar pressure parameters during walking. The pressure platform has a length of 1 m and a width of 40 cm. This records and analyzes the plantar pressure parameters during walking. The force sensor device is placed in the middle of the walking track. The platform collected the following data:

*Fore-mid-rear foot force (N): The device software divides the sole of the foot into three regions. These regions are the front-, middle-, and hindfeet. It records the amount of force acting on each region. *Fore-mid-rear foot pressure (N/cm2): The device software divides the sole of the foot into three regions. These regions are the front-, middle-, and hind-feet. It records the amount of force acting on each region as pressure by proportioning it to the contact area.

Statistical analysis

Statistical data analysis was performed using the SPSS 25 (SPSS Inc., Chicago, IL) program. Descriptive data are given as mean and standard deviation. A paired samples t -test was used to determine any difference between the participants' normal walking and walking while texting. The significance level was accepted as $P < 0.05$.

Results

The demographic features of the participants are shown in [Table 1]. When the participants' spatiotemporal parameters were compared, it was determined that while writing a message during walking, cadence (11%), speed (20%), and step length (11%) decreased significantly ($P < 0.05$) [Table 2]. In addition, it was determined that pelvic tilt movement decreased by 25% on average, and pelvic rotation movements decreased by 27% during message writing ($P < 0.05$) [Table 2]. The plantar pressure parameters show that the load on the fore- and midfoot and the pressure exerted increased significantly ($P < 0.05$) [Table 3].{Table 1}{Table 2}{Table 3}

Discussion

The growing phone use rate in recent years has increased the frequency of mobile phone use during walking. In addition to messaging, talking on the phone or listening to music has become common in daily routines. Texting during walking diverts attention to the phone and brings changes in walking parameters. Our study shows that gait parameters change depending on the need for attention, and this causes plantar pressure parameters to change.

Words per minute (WPM) and error rate (ER) parameters are widely used to measure writing performance. WPM is calculated by dividing the number of written words by the time in minutes. Every five characters, including letters, numbers, punctuation marks, and spaces in the text is considered a word. The ER is the ratio of the number of misspelled characters to the number of characters in the overall text and is expressed as a percentage (%).[15] In our study, the ER was accepted as 0% since the participants were asked to write the given sentence per word with full accuracy. This rate was obtained by dividing the number of words misspelled by the number of words they had to spell correctly. The number of WPM was calculated to evaluate writing performance. Palin et al. [15] worked with 37,000 volunteers and found that the average WPM was 36.2 and that the average WPM value of those aged 20-29 was 36.5. The average message writing speed in the study was 88 [+ or -] 20 characters, and in the study of Agostini et al. ,[10] it was found to be 80 [+ or -] 13 characters. The number of messaging characters produced was similar across studies. We argue/propose that the decrease in texting speed during walking, which is the subject of discussion by Agostini et al. ,[10] is due to the dual task performed in our study. This conclusion is supported by Hinton et al. ,[16] who recorded a significant decrease in typing performance while walking, with the focus shifting to messaging. In addition, they found no significant decrease in the ER during the messaging walk, i.e., asking the participants to write the text accurately created no additional negative results for the study.

Texting on a mobile phone requires visual fixation on the screen, so the central visual area is constantly occupied, resulting in reduced visual information from the environment. In addition, forward positioning of the arms and reduced mobility during messaging creates an additional motor workload. This affects walking performance due to increasing motor workload and decreases environmental visual notification.[17] The decrease in performance is reflected in the gait's spatiotemporal parameters. Our results are consistent with previous research reporting that the younger population focus attention on the task of texting rather than walking.[18] Among our results, the texting gait's spatiotemporal parameters show similarities to previous studies. With texting during walking, there is a significant decrease in stride length, cadence, and walking speed and a significant increase in walking time. In addition, the amount of pelvic tilt movement and pelvic rotation angular movement amount decreases significantly. The decrease in pelvic movements and gait parameters was found to be highly consistent. It was understood that the participants paid more attention to the phone because they were focused on the accuracy of words. A similar result was reported in the study of Plummer et al. ,[19] who found that cadence decreased by 11% and walking speed by 20% for walking and texting compared to normal walking. Earlier studies reported a decrease of 23%, while another a reported decrease of 17%.[2],[3],[4],[5],[6] The literature shows that the decrease in walking speed is in the range of 15%-35%. Our results confirm these findings.

Step length and cadence can be shown among the parameters that cause a decrease in walking speed. It has been determined that there is a 10% decrease in cadence and an 11% decrease in stride lengths. Considering the pelvic movements, our measuring device revealed that the reduction in pelvic movements was also shown to be influential in decreasing the walking speed. The analysis shows a 30% decrease in the pelvis' rotation, tilt, and oblique movements. Using mobile phones during walking has also been shown to reduce pelvic movements, and walking speed decreases when attention is thus focused. In addition, increased thoracic kyphosis with messaging gait increases compression and shear forces in the thoracic spine.[20],[21] Furthermore, increasing kyphosis angle is accompanied by increasing lumbar lordosis as a compass. Increased lumbar lordosis results in a decrease in extensor muscle moment.[22] Along with these postural changes, this increase in internal forces and decreased muscle moment arms may also contribute to decreased pelvic mobility.

From our results, plantar pressure parameters were also affected by the gait's spatiotemporal parameters, causing changes in the plantar pressure parameters obtained during normal walking. Compared to normal, there were increased forces on the forefoot and midfoot and the pressure per unit area; in contrast, the forces and pressure on the hindfoot decreased. Agostini et al. [10] found that, in the messaging gait, the dorsiflexion angle of the foot increased slightly (about 2 degrees), and the plantar flexion angle decreased. In addition, postural changes such as forward positioning of the arms and increased head flexion angle cause a forward shift in the body's center of gravity.[17],[23] Body weight shifts from the rear to the front of the foot when using a cell phone because the pace of walking slows and the focus and attention shift to the front of the body.

Conclusions

This study is the first to show that the force loaded on the sole of the foot and plantar pressure increases in the fore- and midfoot, as well as the decreases in cadence, speed, and step length parameters while walking while texting. According to the study, the decrease in pelvic movements was coherent with the decrease in gait parameters. The findings about plantar pressure parameters indicate that body weight was moved forward compared to normal walking suggesting that there may be postural changes. More studies are needed to evaluate postural alignment in walking while texting.

Ethics approval and consent to participate

Ethical permission for the study was obtained by the Non-Interventional Ethics Committee of Dokuz Eylul University (protocol code: 2022/31-14). All participants received verbal and written information about the study and gave their written informed consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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