The effects on dynamic balance of dual-tasking using smartphone functions

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Abstract. [Purpose] This study aimed to compare dynamic balance with respect to completing a single task while not using smartphone function and completing two task while using different smartphone functions, thereby preventing falls or injuries resulting from completion of dual tasks. [Subjects and Methods] The subjects of this study were 36 healthy males and females. The experiment was conducted for five situations: a Star Excursion Balance Test (SEBT) was performed (1) during single-tasking without a smartphone and during dual-tasking with a smartphone, (2) when listening to music using a smartphone, (3) when sending message using a smartphone, (4) when surfing the web using a smartphone, and (5) when playing a game using a smartphone. The condition were the same for all five experiments. Random selection was done to prevent learning. All experiments were conducted three times, and the averaged values were used for analysis. The SEBT was performed in three directions: anterior, posterolateral, and posteromedial. In consideration the differences in leg length of the subjects, their actual leg length were measured to be used as percentages. Their leg length was measured from the anterior superior iliac spine of the femur to the medial malleolus. [Results] Compared with single task not done using a smartphone, dynamic balance statistically significantly changed for dual tasks done using a smartphone in all three directions. Dynamic balance decreased in all three directions when playing games, sending messages, web surfing, and listening to music. [Conclusion] Completing two tasks using a smartphone reduced cognitive ability, decreasing dynamic balance. Therefore, performing a single task rather than using the diverse functions of a smartphone while walking or working is considered a factor that can prevent falls and injuries.

Key words: Smart phone, Star excursion balance test, Fall

INTRODUCTION

Smartphones provide diverse data, information, and convenience to modern people. This means that smartphones are used as personal computers as often as they are used to make phone calls. Due to conveniences in terms of portability, various smartphone functions may be utilized while walking or working. In particular, listening to music, sending messages, web surfing, and playing games are frequent activities performed while walking.

Performing two tasks at the same time is called dual-tasking, while performing more than two tasks simultaneously is referred to as multitasking. Walking or working while using different functions of a smartphone may be called dual- or multitasking. However, such dual-tasking may lead to a fall or injury resulting from decreased cognitive ability in an accidental, unexpected situation. The ability to maintain balance in a static or dynamic situation is the basis for functional activities while performing various ordinary activities. The dynamic balance necessary for functional activities is the result of interaction among the ankle joints, knee joints, hip joints and their surrounding muscles, and shoulder joints and their surrounding muscles. Dynamic balance is also associated with cognitive ability. In particular, dual-tasking using a smartphone while walking, such as listening to music, sending a message, web surfing, or playing a game, is considered to affect the dynamic balance necessary for functional activities by reducing cognitive ability.

Most previous studies concerned electromyography according to the forward movement of the head bone from the perspective of musculoskeletal system postural misalignment or dispersion of cognitive ability according to the performance of dual task. Therefore, the aim of the this study was examine the effects of dual tasks while different functions of a smartphone while walking or working on dynamic balance, based on prior studies of cognitive ability dispersion while dual-tasking.

SUBJECTS AND METHODS

The subjects of this study were 36 healthy college students (18 male, 18 female). Their average age, weight, and height were 20.4 years, 63.4 kg, and 168.8 cm. The subjects
had no musculoskeletal or neurological problems, listened to the overall procedure and purpose of this study, and voluntarily consented to participate in the study. Their informed consent and approval from Korea Nazarene University’s Life Ethics Review Committee (Korea Nazarene University IRB 14-0417-02) were obtained.

The Samsung Galaxy NoteII (Samsung, Seoul, South Korea) was used for the experiment. The star excursion balance test (SEBT) was performed during single-tasking without a smartphone and during dual-tasking with a smartphone, that is, when listening to music using a smartphone, when sending a message using a smartphone, when web surfing using a smartphone, and when playing games using a smartphone. In the experiment conducted while performing a dual task using smartphone functions, the subjects used earphones to listen to music as they completed their tasks. Subjects were assigned experiments via a casting of lots, to prevent them from learning about experimental tasks. After each experiment, the subjects rested for five minutes before going on to the next experiment.

The SEBT was used to measure the subjects’ dynamic balance. It was also used to measure the distances a leg could reach when the subjects stretched his/her nondominant leg to maximum extension in eight directions (anterior, anterior lateral, lateral, posterolateral, lateral, posteromedial, medial, anter medial) with a 45-degree interval while maintain his/her balance with the dominant leg. The SEBT is a method used to measure dynamic balance, with a level of reliability (ICC 0.88–0.96). Hyong and Kim presented three directions—anterior, posterolateral, and posteromedial—as the base directions for a simple SEBT; this study conducted the experiment based on these directions. Measurements were taken for each direction and averaged values were used for analysis. Due to differences in each subject’s leg length, a each subject’s actual leg length was measured, the percentages of their leg length were used as the measured values. The actual leg length were measured from the anterior superior iliac spine of the femur to the medial malleolus. The measured values were analyzed with repeated measures analysis of variance using SPSS version 17.0. The significance level was set at α=0.05.

RESULTS

According to the SEBT, the subjects who performed dual tasks using a smartphone saw significant changes in their dynamic balance in the three tested directions relative to those who carried out single tasks without a smartphone (p<0.05) (Table 1). Dynamic balance decreased in all three for playing games, sending messages, web surfing, and listening to music (Table 1).

DISCUSSION

Dual-tasking while using different function of a smartphone is common. Such dual-tasking reduces cognitive ability, affecting postural control. For postural control, sensation, cognition, and the motor system should act integratedly. This study aimed to look at the effects of dual-tasking using a smart phone on dynamic balance. According to the results of measuring dynamic balance using the SEBT, dynamic balance decreased in all three directions during dual-tasking using smartphone functions relative to single-tasking without using a smartphone.

In addition, dynamic balance decreased in all three directions for playing games, sending messages, web surfing, and listening to music using a smartphone. Playing games most significantly decreased cognitive ability, resulting in the greatest decrease in dynamic balance. This was followed by sending a message, web surfing, and listening to music in their effect on decrease in dynamic balance. In this experiment, double tasking while listening to music. In this experiment, dual-tasking was significantly significant relative to single-tasking, and caution is needed even when listening to music with a smartphone while performing other work (p<0.05).

Using the SEBT, Won also measured, in eight directions, dynamic balance during single-tasking without using a smartphone and during dual-tasking when listening to music, making a phone call, and sending a message. According to the dynamic balance results, sending messages most greatly decreased dynamic balance and making a phone call also led to reduced dynamic balance in the lateral direction.

Nonetheless, listening to music did not affect dynamic balance. In the present study, dynamic balance decreased in all three directions while sending a message, with a greater decrease in dynamic balance in the posteroateral and posteromedial directions than in the anterior direction. Won asserted that dynamic balance decreased while sending a message, and that caution was needed while performing the task. On the other hand, the present study showed that playing games reduced dynamic balance more than sending messages. In Won’s study, the dual task of listening to music did not influence dynamic balance, but it did in the present study. This differences is attributed to difference in the kind of and speed of music; in the present study, the subjects lis-

| Table 1. SEBT results according to the type of double task (N=36) |
|-----------------|-----------------|-----------------|-----------------|-----------------|
|                | NUS             | Music           | Message         | Web surfing     | Game           |
| Anterior (%)   | 99.9±6.7        | 96.3±7.2*       | 91.7±7.7*       | 92±7.3*         | 89.9±7.2*      |
| Posterolateral (%) | 82.4±10.7 | 75.6±10.3*       | 69.1±10.2*      | 70±9.8*         | 66.7±10.2*     |
| Posteromedial (%) | 73.8±11.03 | 65.1±11.2*       | 57.6±11.6*      | 60±12.1*        | 53.8±9.8*      |

NUS: Did not use a smartphone  
*a: NUS, music, b: NUS, message, c: NUS, web surfing, d: NUS, game  
*p: p<0.05
tended to the fast-beat K-pop (Korean pop) enjoyed by young people. Nonetheless, in the present study the dual task of making a phone call, which had been included in the experiment by Won\(^1\), was excluded due to the characteristics of the smart phone used.

Lacour et al.\(^{10}\) noted that, although there was no problem with postural control while performing a single task, during a dual task, postural control ability decreased; the more difficult a cognitive task, the more reduced the postural control ability became.

Such an assertion is consistent with the results of the present study. In particular, although playing game is an ordinary adolescent hobby, playing games while walking reduces cognitive ability, which decreases dynamic balance and may lead to injury. Dual-tasking using a smartphone, while walking or working, which may look trivial, can be a cause of fall or injury. Accordingly, performing a single task rather than employing the diverse functions of a smartphone while walking or working is considered to be a good way to prevent falls or injuries. A limitation of this study was that it did not take into account balance when just holding a smartphone.

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