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Short communication

Light touch and medio-lateral postural stability during short distance gait

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HIGHLIGHTS

- Light touch on an external static reference enhances medio-lateral gait stability.
- Light touch on a self-moved stick does not contribute to medio-lateral stability.
- Light touch on a static reference provides spatial and self positional cues.

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ABSTRACT

While standing, light fingertip touch on an external stable object attenuates sway and improves balance in healthy adults as well as in individuals with poor postural control. The effect of light touch on balance during gait is, however, not well known. Therefore, the purpose of this work was to study the effects of light fingertip touch on balance during gait. We hypothesized that similar to its effect during stance light touch would increase postural stability.

Forty healthy young adults were tested under four gait conditions: (1) eyes open (EO), (2) eyes closed (EC), (3) eyes closed while lightly touching a static object on the right side of the walking lane (ECLTS), (4) eyes closed while lightly touching a dynamic object, namely, a stick that was moved forwards by the subject with the right hand (ECLTD). The main outcome measure was medio-lateral step width variability, a well established indicator of gait balance in the medio-lateral plane.

During the EC condition, light touch of an external static object (ECLTS) decreased medio-lateral variability (i.e., balance improved); however, this stabilizing effect was not observed with light touch on the stick.

The availability of self positional and spatial cues when touching a static external reference, and their absence when touching a stick that is moved forwards by the subject as he walks, can explain the different effects of light touch in the ECLTS vs the ECLTD gait conditions.

1. Introduction

In healthy subjects haptic information from light fingertip touch of an external stable plate, without force transfer onto the plate, reduces postural sway during stance [1,2]. Similarly, light touch (LT) of an external stable platform attenuates exaggerated sway in various patient groups [3–6]. In contrast, LT of an external platform that is sway referenced to subjects' own sway does not decrease postural sway [7,8].

Jeka and co-workers showed that during stance, light touch of a cane by the hand, at levels below those necessary to provide force transition and support, is as effective as higher force contact in reducing postural sway in healthy young and elderly adults [9–11], as well as in congenitally blind and healthy blindfolded subjects [10,11]. In addition, they showed that a slanted cane was more effective than a perpendicular cane in reducing postural sway [11]. In an another study a cane held in several different positions was also shown to be effective in reducing postural sway [9]. Moreover, in a recent study, the stabilizing effect of gripping a cane in several stance positions and at different force levels (1–9 N) was confirmed [12].

Although the favorable effects of somatosensory haptic information via LT on postural control and balance during stance have been studied in various stance conditions and populations, the effects of similar somatosensory cues on balance during gait have scarcely been addressed. During walking on a treadmill, light

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touch of the side rail seemed to be mandatory for maintaining balance in blindfolded healthy subjects, providing spatial orientation and preventing an unintended backward descent from the moving treadmill [13]. Similarly, light touch contributed to stabilization during treadmill walking in a virtual environment [14]. Regarding on-floor walking, Boonsinsukh et al. showed that in some post-stroke individuals, light touch of a cane increased pelvic medio-lateral stability to the same degree as force contact [15]. In another study a decrease in medio-lateral variability during gait when lightly touching a vertical wall was noted in elderly individuals with peripheral neuropathy [16]. These studies did not examine healthy controls; therefore, the unique contribution of somatosensory information supplied via light fingertip touch to balance during on-floor gait in healthy individuals is yet to be established.

Variability of gait parameters is a well-established indication of the dynamic control of balance during gait [17,18], with high variability being associated with poor balance. Elimination of vision increases gait variability in both the medio-lateral (ML) and anterior–posterior (A–P) planes, more so in the ML plane, [19–21], at all walking speeds [22]. Accordingly, ML variability represented by step width variability is a more accepted measure than A–P variability, and considered a meaningful descriptor of locomotion. Increased ML variability is associated with an increased risk of losing balance and falling [20,21].

Considering the importance of dynamic balance control to normal gait [23], and the adverse effects of its deficit, the aims of this study were twofold: (1) to gain insight into the contribution of light unilateral finger touch to ML balance control during gait in healthy young adults and (2) to compare the effect of light touch on a fixed external object to the effect of light touch on a stick moved by the subject. Based on previous studies [19,21], we used variability in step width during gait as a measure of ML balance control.

We hypothesized that light touch applied to either a fixed external object or to a stick during gait with eyes closed, would improve ML balance (gait stability), compared to “no-touch” gait. We further hypothesized that the effect of touching an external fixed object on ML gait balance would be greater than the effect of touching a stick that was moved forwards by the subject.

In order to isolate the effects of LT on balance during gait from the effects of vision, these hypotheses were investigated with closed eyes.

2. Material and methods

2.1. Subjects

Twenty five women and fifteen men young adults aged 18–40 years volunteered to participate in the study. Mean (SD) and median age were 26 (4.7) years and 25 years, respectively.

Exclusion criteria included cardiovascular, respiratory, orthopedic, visual, vestibular, or somatosensory disorders, as well as use of medications that could affect postural control. Alcohol intake was not permitted on the evening prior to testing.

The study was approved by the University Institutional Review Board (IRB), and eligible candidates signed an informed consent form complying with the IRB regulations prior to participation in the study.

2.2. Setting

Testing was performed during the daytime in a dedicated university lab, with each subject wearing his own comfortable clothes and sport shoes. Prior to testing weight and leg length (measured while standing, from the greater trochanter to the lateral malleolus) were recorded. The GaitRite walkway [17,24] was used for data collection.

2.3. Test conditions

Four gait conditions were used in random order:

a Baseline: eyes open, no touch (EO).
b Eyes closed, no touch (EC)
c Eyes closed, lightly touching a static external reference (ECLTS), namely, a Thera-Band strap stretched at subjects' waist height along the right side of the walkway. The 14 cm wide strap was anchored horizontally to two metal poles at the ends of the walkway on the right hand side. Use of this external touch reference eliminated the possibility of shifting forces and obtaining physical support. In order maintain contact while walking, the band was held between the index finger on the upper side of the band and the thumb on its lower-side.
d Eyes closed, lightly touching a dynamic reference point, namely, a long flexible stick that was moved forward by the subject with the right hand (ECLTD). The subject held the stick (length: 2 m; diameter: 0.5 cm; weight: 97 g) in its middle third, tilted antero-laterally (at an angle of approximately 45° to the floor) with their right index and middle fingers opposing the thumb. A similar light touch application was termed “light grip” by Albertsen et al. [9]. Vertical force transfer onto the stick was not viable.

In order to examine the effects of light touch, balance during gait in conditions 3 and 4 (ECLTS and ECLTD) was compared to balance under condition 2 (EC). The effect of vision was inferred from comparing the data of the baseline (EO) condition to the EC condition.

2.4. Testing protocol

For each testing condition, eight walking trials were performed consecutively. The total effective length of the pathway used for measurements for each condition was about 40 m (5.17 m single trial length × 8 trials).

For baseline testing, the subject stood with eyes open at the starting line (3 m before the GaitRite walkway) and was then asked to walk along the walkway to the finishing line (3 m past the walkway). After that the subject was asked to return to the starting line. Each trial was repeated eight times.

In conditions 2–4, the subject was asked to stand in front of the starting line and to look at the walking lane for about 1 min; then, when declared ready, he was asked to close his eyes and a blindfold was put over his eyes. Afterwards, he was asked to walk along the walkway at a comfortable pace. Use of that procedure is supported by prior demonstration of the ability to walk accurately to previously seen targets while walking blindfolded for relatively short distances [25]. Upon arrival at the finishing line, the subject was asked to remove the blindfold and return to the starting line.

The specific instructions for testing EC conditions were: “Once ready, walk along the walkway at your own comfortable speed”; for condition ECLTS: “During the whole trial, touch lightly the strap with your right index finger and thumb”, and, for the ECLTD condition: “For the whole trial, hold the stick with the pulps of the index and middle finger opposing the thumb, slant it forwards and to the right of your body, and slide it forwards on the floor as you walk.”

For safety reasons, when testing with closed eyes the examiner walked near the subject. One substitution was allowed for a missed trial (e.g., for stepping off the walkway).