Influence of a Walking Aid on Temporal and Spatial Parameters of Gait in Healthy Adults

Prasath Jayakaran, MPT, Lorraine DeSouza, PhD, John Cossar, MSc, Kenneth Gilhooly, PhD

Objective: To determine the effect of using a walking aid on temporal and spatial parameters of gait when used for balance versus support on the dominant and nondominant hand side.
Design: Repeated measures observational study design.
Setting: University gymnasium.
Participants: Twenty-seven healthy male and female adults of mean ± standard deviation age 44.74 ± 10.00 years.
Methods: Five walking conditions (C) were completed by all participants on the GAITRite pressure mat. Normal walking (C1), walking with a cane in the dominant hand (C2) and nondominant hand (C3) as if using for balance, walking with a cane in the dominant hand (C4) and nondominant hand (C5) while allowing approximately 10% of the body weight through the cane.
Main Outcome Measurements: Temporal measurements (swing time, stance time, single limb support time, double limb support time) as percentage of a gait cycle and the base of support for the left and the right foot for all 5 walking conditions.
Results: A significant difference ($P < .001$) was observed between C1, C2, and C3 in percentage swing time and percentage stance time of the ipsilateral side, and in percentage single limb support time of the contralateral side. The double limb support time was significantly different ($P \leq .04$) for both ipsilateral and contralateral sides. Comparisons among C1, C4, and C5 demonstrated significance ($P < .001$) for all variables. Post hoc analysis showed significance between C1 and C4, and C1 and C5 for all variables except percentage stance time of the ipsilateral side and percentage single limb support of the contralateral side.
Conclusions: In healthy adults, use of a cane for balance modifies swing and stance parameters of the ipsilateral side and does not affect the base of support formed by the feet. When used for support, the cane alters the swing and stance parameters, and also the base of support formed by the feet.

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INTRODUCTION

The prescription of mobility or walking aids is often necessary to provide support or to supplement balance [1]. A recent estimate indicates that 30.6 million people who live in the United States have difficulty with mobility that requires use of a walking aid [2]. Walking aids may be used to increase balance ability, thereby increasing balance confidence and decreasing frequency of falling [3]. However, when used as a support, they may reduce the weight loading on the affected limbs [4].

Generally, determination of ipsilateral or contralateral use of a walking aid in clinical populations is based on factors such as the level and the side of most instability, pain, or weakness [5,6]; whereas, when used for balance, the side of use may depend more on the individual's preference [7]. For example, in people with unilateral hip pain or dysfunction, a walking aid when held on the contralateral side and advanced along with the affected limb effectively offloads the affected hip [8,9] and also replicates a reciprocal walking

P.J. Centre for Research in Rehabilitation, School of Health Sciences and Social Care, Brunel University, London, United Kingdom Centre for Health, Activity, and Rehabilitation Research, School of Physiotherapy, P.O. Box 56, University of Otago, New Zealand 9054. Address correspondence to: P.J.; e-mail: prasath.jayakaran@otago.ac.nz
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L.D. Centre for Research in Rehabilitation, School of Health Sciences and Social Care, Brunel University, London, United Kingdom
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J.C. Centre for Research in Rehabilitation, School of Health Sciences and Social Care, Brunel University, London, United Kingdom
Disclosure: nothing to disclose

K.G. Centre for Research in Rehabilitation, School of Health Sciences and Social Care, Brunel University, London, United Kingdom
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pattern. However, when used for balance, the side of use may depend on the convenience or hand preference of the individual [7,10,11].

Although walking aids are frequently used for different clinical populations [9,12,13], there is a lack of quantitative data on how they may influence gait. A few studies have explored the impact of different types of walking aids on gait in healthy [14] and clinical population [13], and other studies that detailed the muscle activation patterns in upper [15] and lower limbs [8,9]. However, the objective evidence of the effect of walking aids on key temporospatial gait parameters is limited. The aim of this study was to determine the effect of using a walking aid on the temporal and spatial parameters of gait when used for balance versus support on the dominant or nondominant hand side.

METHODS

Participants

A convenience sample of male and female volunteers ages 18 years and older was recruited from the Brunel University staff cohort. Selection was based on the self-declared ability to complete repeated 20-m walks without aids, within a short period of time. Exclusion from the study was based on participants having a history of trauma to the lower limbs within the past year, a known balance disorder, or current pain in any part of the body that could potentially affect walking. The study was approved by the School of Health Sciences and Social Care Research Ethics Committee, and all the participants provided written informed consent before participation.

Equipment and Setting

The GAITRite Electronic walkway system (CIR Systems Inc. Sparta, NJ) was used to measure the gait parameters. The system includes a portable 8.8-m roll-up pressure mat and accompanying software, version 4.0; the sampling frequency of the data was 120 Hz. Through a grid of pressure sensors, the system identifies the location and timing of each footfall and processes the spatiotemporal parameters from these data. The GAITRite system has previously been used in both clinical [16] and nonclinical populations [17], and the measurements have been reported to have acceptable psychometric properties in healthy adults [17,18]. For the purposes of this study, a height adjustable single-point aluminium cane was used by all the participants when completing the walking tasks. Five walking tasks were used to selectively test the effects of the cane when used for support versus balance, and when used in the dominant or nondominant hand. The study was completed within a large gymnasium, which provided adequate space for use of the GAITRite system.

Tasks

Five different walking conditions (C) that were determined to be useful to address the aims of the study were:

- Condition 1 (C1). Normal comfortable walking at self-selected pace, without using a cane.
- Condition 2 (C2). Comfortable self-selected pace of walking while using a cane on the dominant hand side as if using for balance.
- Condition 3 (C3). Comfortable self-selected pace of walking while using a cane on the nondominant hand side as if using for balance.
- Condition 4 (C4). Comfortable self-selected pace of walking while holding a cane on the dominant hand side and allowing approximately 10% of the body weight through the cane.
- Condition 5 (C5). Comfortable self-selected pace of walking while holding a cane on the nondominant hand side and allowing approximately 10% of the body weight through the cane.

C2 and C3 were considered as balance conditions in which the cane was held and touched the ground in a reciprocal pattern without any weight transfer through the cane. C4 and C5 were determined as support conditions in which the cane was used as a supplement to transfer at least 10% of body weight through the cane.

Measurements

The measurements and their operational definitions are as follows; cadence (the number of steps/min), % swing time (the duration between last contact of current foot fall and first contact of next footfall of the ipsilateral foot, expressed as percentage of gait cycle), % stance time (the time elapsed between first and last contact of the ipsilateral foot, expressed as percentage of gait cycle), % single support time (the time between last contact of current foot fall and first contact of next foot fall of the ipsilateral foot, expressed as percentage of gait cycle), % double support time (the time when both feet were on the floor, which includes initial and terminal double support periods; the double support time of the left foot is the summation of double support during heel strike and toe off of the left foot vice versa for the right foot, expressed as percentage of gait cycle), and the base of support (the area of the triangle formed by heel centers of 2 successive foot falls of the ipsilateral foot and 1 foot fall of the contralateral foot, in cm). All the measurements except cadence were estimated separately for left and right foot, and were averaged over all included foot falls in a trial.

Procedure

All the participants completed a questionnaire to obtain their demographic details and to determine their eligibility to