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ORIGINAL RESEARCH

Determining Reliability of a Dual-Task Functional Mobility Protocol for Individuals With Lower Extremity Amputation

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Abstract

Objective: To determine the relative and absolute reliability of a dual-task functional mobility assessment.

Design: Cross-sectional study.

Setting: Academic rehabilitation hospital.

Participants: Individuals (N=60) with lower extremity amputation attending an outpatient amputee clinic (mean age, 58.21±12.59y; 18, 80% male) who were stratified into 3 groups: (1) transtibial amputation of vascular etiology (n=20); (2) transtibial amputation of nonvascular etiology (n=20); and (3) transfemoral or bilateral amputation of any etiology (n=20).

Interventions: Not applicable.

Main Outcome Measures: Time to complete the L Test measured functional mobility under single- and dual-task conditions. The addition of a cognitive task (serial subtractions by 3's) created dual-task conditions. Single-task performance on the cognitive task was also reported. Intraclass correlation coefficients (ICCs) measured relative reliability; SEM and minimal detectable change with a 95% confidence interval (MDC_{95}) measured absolute reliability. Bland-Altman plots measured agreement between assessments.

Results: Relative reliability results were excellent for all 3 groups. Values for the dual-task L Test for those with transtibial amputation of vascular etiology (n=20; mean age, 60.36±7.84y; 19, 90% men) were ICC=.98 (95% confidence interval [CI], .94−.99), SEM=1.36 seconds, and MDC_{95}=3.76 seconds; for those with transtibial amputation of nonvascular etiology (n=20; mean age, 55.85±14.08y; 17, 85% men), values were ICC=.93 (95% CI, .80−.98), SEM=1.34 seconds, and MDC_{95}=3.71 seconds; and for those with transfemoral or bilateral amputation (n=20; mean age, 58.21±14.88y; 13, 65% men), values were ICC=.998 (95% CI, .996−.999), SEM=1.03 seconds, and MDC_{95}=2.85 seconds. Bland-Altman plots indicated that assessments did not vary systematically for each group.

Conclusions: This dual-task assessment protocol achieved approved levels of relative reliability values for the 3 groups tested. This protocol may be used clinically or in research settings to assess the interaction between cognition and functional mobility in the population with lower extremity amputation.

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Most individuals undergoing new lower extremity amputation (LEA) in North America are older with multiple comorbidities.[1-4] The main etiology for this amputation is vascular disease or diabetes.[5,6] However, the population of individuals living with LEA display a bimodal distribution.[7] Younger individuals undergo amputation primarily owing to traumatic or congenital causes; these people tend to live longer and attain higher levels of mobility than did older adults whose amputation is primarily due to

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vascular or diabetic complications.[8-10] There is an established trend that mobility improves between 6 weeks and 4 months and up to 12 months after surgery for those with LEA before reaching a plateau.[11] Many individuals with LEA present with gait deviations, possibly because of the increased energy requirements and decreased efficiency of walking.[12,13] The presence of ongoing walking difficulties after rehabilitation in people with LEA is a concern because of its relation to an increased risk of accidental falls.[12,14] Importantly, falling may result in various adverse physical and psychological consequences including physical injuries, a fear of falling, and a decrease in mobility with self-imposed restriction of activity.[9,15-17]

Rehabilitation after LEA is a complex process because of expected differences in functional outcomes of patients based on age, number of comorbidities, etiology of amputation, and amputation level.[18] The goals of prosthetic rehabilitation are often to improve mobility and activity levels, so measures of functional performance are particularly important.[19] During prosthetic rehabilitation, individuals must have the cognitive and physical capacity to don/doff their prosthesis, learn new techniques for mobility, and adapt to different situations in their environment.[20-23] To assess functional performance, complex and straight path assessments are used; complex path walking can provide meaningful information about daily life walking ability.[24]

Certain cognitive domains are thought to be involved with the prosthetic skills necessary for ambulation in people with LEA.[25,26] The domains of memory, attention, visuospatial abilities, and organization are of particular importance.[26,27] Individuals with impairments in these domains are likely to face challenges associated with learning to use their limb and may fail to retain information or not be able to initiate new behaviors.[28] Impairment in cognition, as measured by the Montreal Cognitive Assessment (MoCA), is also associated with worse functional mobility at discharge from inpatient prosthetic rehabilitation.[4] The prevalence of cognitive impairment in the population with LEA may be as high as 56%; older populations and a higher percentage of amputations caused by vascular disease and diabetes increase the prevalence of cognitive impairment in this population.[4,25] The current literature[4,25,26,28,29] on LEA recognizes the relation between cognition and performance on mobility outcome measures after rehabilitation.

The dual-task paradigm can be used to assess the interaction between cognition and mobility, as individuals are observed simultaneously performing mobility and cognitive tasks.[30] One theory that has been used to describe the cognitive-motor interference observed during dual-task testing is the bottleneck theory.[30] This describes the simultaneous performance of cognitive and motor tasks as creating a bottleneck in information processing.[30] Another theory (capacity sharing model) postulates that changes in gait result from capacity interference caused by competing attentional demands between the 2 tasks.[30] This theory assumes that we are able to voluntarily allocate our attention to one task or another.[30] The dual-task paradigm is ecologically valid because most activities of daily living require multitasking on motor and cognitive tasks.[30] Studies[31,32] of individuals with transfemoral amputation (TFA) have demonstrated a decrease in gait quality during dual-task testing, consistent with the idea that more cognitive resources are needed for complex walking environments.

The population with LEA is one that presents unique challenges to mobility. To assess the interaction between cognition and mobility in those with LEA, a population-specific dual-task protocol should be developed. For a dual-task testing protocol to be used in a clinical setting as a measure to evaluate progress or change, reliability values must be established. The purpose of this study was to determine the relative and absolute test-retest reliability of a dual-task functional mobility protocol. It was hypothesized that (1) good to excellent relative test-retest reliability would be found across the population of major lower extremity amputees and (2) absolute agreement between test and retest assessments would be seen.

List of abbreviations:

ABC	**Activities-specific Balance Confidence**
CI	**Confidence interval**
ICC	**Intraclass correlation coefficient**
LEA	**Lower extremity amputation**
MDC_{95}	**Minimal detectable change with a 95% confidence interval**
MoCA	**Montreal Cognitive Assessment**
TFA	**Transfemoral amputation**
TTA	**Transtibial amputation**

Methods

Design and participants

This study was a cross-sectional analysis of functional mobility data. Recruitment took place in the outpatient amputee clinic at Parkwood Institute between March 24, 2016 and January 19, 2017. This study was approved by the Health Sciences Research Ethics Board at the University of Western Ontario and by the Clinical Resources Impact Committee of Lawson Health Research Institute.

Individuals were eligible to participate if they were 18 years or older, had a functional use of the English language, had an LEA as defined for 3 groups (transtibial amputation [TTA] of vascular etiology, TTA of nonvascular etiology, and complex amputations [TFA or bilateral amputation of any etiology]), were using their prosthesis for walking in the community, and had been using it for at least 6 months. Exclusion criteria were any physical problem that significantly limited ambulation if fitted with a prosthesis (eg, only use prosthesis for transfers or current problems with residual limb that limited ambulation with prosthesis) or if the person did not have a prosthesis. After a regularly scheduled appointment with their physician, individuals were recruited and stratified into the 3 groups as outlined in the inclusion criteria: (1) those with TTA of vascular etiology; (2) those with TTA of nonvascular etiology; and (3) those with complex amputations (TFA or bilateral amputation of any etiology). These groups require more energy and effort during walking because of the limitations of their prosthesis.[8,33]

An a priori power analysis identified a sample size of 20 that was necessary to identify a desired intraclass correlation coefficient (ICC) of .90 with a lower confidence interval (CI) of ICC=.70, α=.05, and β=.20 in the reliability analysis.[34] The total sample size for this study was 60, 20 from each of the aforementioned groups. Eighty-one individuals were approached for inclusion in the study, and 68 were enrolled. Of the 13 individuals not enrolled, 61.5% lived too far from the center to return for follow-up assessment and 23.1% did not have time to complete initial testing after their clinic appointment. Of the 68