Gait & Posture 43 (2016) 170–175

Contents lists available at ScienceDirect

Gait & Posture

journal homepage: www.elsevier.com/locate/gaitpost

Full length Article

A novel and simple test of gait adaptability predicts gold standard measures of functional mobility in stroke survivors

K.L. Hollands [a,*], T.A. Pelton [b], S. van der Veen [a], S. Alharbi [a], M.A. Hollands [c]

[a] School of Health Sciences, University of Salford, Manchester, UK
[b] School of Psychology, University of Birmingham, Birmingham, UK
[c] Research Institute for Sport and Exercise Science, Liverpool John Moores University, Liverpool, UK

ARTICLE INFO

Article history:
Received 19 December 2014
Received in revised form 3 September 2015
Accepted 17 September 2015

Keywords:
Gait
Adaptability
Stroke
Vision

ABSTRACT

Background: Although there is evidence that stroke survivors have reduced gait adaptability, the underlying mechanisms and the relationship to functional recovery are largely unknown. We explored the relationships between walking adaptability and clinical measures of balance, motor recovery and functional ability in stroke survivors.
Methods: Stroke survivors ($n = 42$) stepped to targets, on a 6 m walkway, placed to elicit step lengthening, shortening and narrowing on paretic and non-paretic sides. The number of targets missed during six walks and target stepping speed was recorded. Fugl–Meyer (FM), Berg Balance Scale (BBS), self-selected walking speed (SWWS) and single support (SS) and step length (SL) symmetry (using GaitRite when not walking to targets) were also assessed. Stepwise multiple-linear regression was used to model the relationships between: total targets missed, number missed with paretic and non-paretic legs, target stepping speed, and each clinical measure.
Results: Regression revealed a significant model for each outcome variable that included only one independent variable. Targets missed by the paretic limb, was a significant predictor of FM ($F_{(1,40)} = 6.54$, $p = 0.014$,). Speed of target stepping was a significant predictor of each of BBS ($F_{(1,40)} = 26.36$, $p < 0.0001$), SSWS ($F_{(1,40)} = 37.00$, $p < 0.0001$). No variables were significant predictors of SL or SS asymmetry.
Discussion: Speed of target stepping was significantly predictive of BBS and SSWS and paretic targets missed predicted FM, suggesting that fast target stepping requires good balance and accurate stepping demands good paretic leg function. The relationships between these parameters indicate gait adaptability is a clinically meaningful target for measurement and treatment of functionally adaptive walking ability in stroke survivors.

© 2015 Elsevier B.V. All rights reserved.

1. Background

The ability to adjust the on-going walking pattern in response to environmental and task goals is key to regaining independent mobility in the community following stroke. However, reports indicate few stroke survivors can independently climb stairs and inclines, and walk the speeds and distances required for mobility in the community [1,2]. Further reports indicate that after a stroke most falls are caused by trips, slips, or misplaced steps while walking [3,4]. This suggests that an inability to adapt the walking pattern in response to the environment may be a key factor limiting recovery of independent mobility in stroke survivors. Indeed, there is strong evidence to indicate that stroke survivors have reduced gait adaptability; indicated by impairments in obstacle avoidance (e.g. [5,6]), turning (e.g. [7–9]) and in initiating and executing step adjustments (particularly to place the foot medially) in response to external cues [10,11]. However, the relationships between poor gait adaptability and functional recovery/mobility are still largely unknown.

Adaptability of gait has been defined as: “the ability to adjust gait to environmental circumstances, such as obstacles and targets” [12, pg 1453]. However, in line with dynamic systems theories of what constitutes stable movement patterns [13], it could be argued that this definition of adaptability should also include the stipulations that adjustments to gait be achievable while maintaining forward progression and postural equilibrium. A recent review [14] described adaptability as part of a tri-parte model of walking (including adaptability, stepping and stability).

* Corresponding author. Tel.: +44 0 161 295 3238.
E-mail address: k.hollands@salford.ac.uk (K.L. Hollands).

http://dx.doi.org/10.1016/j.gaitpost.2015.09.018
0966-6362/© 2015 Elsevier B.V. All rights reserved.

This multifaceted nature of adaptability may be a key reason why it is difficult to measure. Many clinical measures aimed at capturing aspects of adaptability (e.g. Timed Up and Go, Dynamic Gait Index, Modified 10 m walk test) quantify overall success of and time taken to perform, rather than how the adaptations are achieved [14].

Biomechanical analyses of how locomotor adaptations such as obstacle avoidance, turning and target stepping paradigms are achieved have however suggested that impaired ability to alter foot-placement in order to target a specific footfall location may underlie impaired adaptability [5,6,10,15]. For example, individuals with stroke have shown inaccurate foot placement of the affected lead foot when clearing obstacles [5,15]. Further, stroke survivors have been shown to have difficulties making medial-lateral step corrections [10] and deficits in adjusting foot-placement are exacerbated under time pressure [5,6,10]. In healthy older and younger adults target stepping paradigms to test the ability to adapt and control foot placement have shown discriminatory power for age and been associated with falls risk and cognitive function [16–20]. Control and adaptability of footfall location may therefore be a mechanistic component facilitating overall gait adaptability; especially given that foot placement adjustments are one of the most effective mechanisms for dynamic balance control during walking [10] and many falls have been reported due to misplaced step [4].

The aims of this study were to measure the ability of stroke survivors to adapt their gait in order to step on irregularly spaced targets and to assess the strength of the relationship between this measure of adaptability and clinically valid measures of balance and motor recovery.

Understanding the relationships between the ability of stroke survivors to adjust foot-placement and clinically relevant measures of balance, functional mobility and motor recovery will offer insight into whether or not adaptability of walking is relevant to functional recovery. Further, exploration of the relationships between adaptability and recovery may provide insights into the mechanisms that might underpin altered gait adaptability in stroke patients. For example, if target stepping performance correlated highly with Berg Balance Scale scores but not self-selected walking speed then this would suggest that the mechanism underlying poor gait adaptability is compromised balance rather than walking ability.

2. Methods

Participants were people taking part in a larger clinical trial [21]. Community dwelling adult stroke survivors were identified either at discharge from inpatient stroke services or at referral to community and outpatient services at six hospitals across the West-Midlands in the UK. Participants were included if they:

(1) had a gait impairment (speed <0.8 m/s corresponding with limited community ambulation ability [22] and residual lower limb paresis (Fugl–Meyer [23] lower limb score <34) due to their stroke (premorbid (retrospective) modified Rankin Scale [24] score >3);
(2) were able to walk with minimal assistance (functional ambulation category [25] of 3 or more);
(3) were able to follow a three-step command (as assessed by Modified Mini-mental Status Exam [26]) and able to give informed consent; and
(4) had no severe visual impairments that would prevent sight of stepping targets.

Potentially eligible participants were excluded if:

(1) mobility limitations were attributable to non-stroke pathology and/or they had a co-morbidity preventing mobilization or
(2) they required palliative care.

The study was approved by the National Research Ethics Committee—West Midlands and all participants provided informed written consent.

As part of the baseline assessment within the larger clinical trial participants underwent the Berg Balance Scale assessment, the Fugl–Meyer lower limb assessment, a spatio-temporal analysis of their unconstrained over-ground walking pattern (using GaitRite) and a target stepping task of gait adaptability.

The target stepping task required participants to step to targets eliciting step length adjustments of (8 cm deep × 40 cm wide × 1 mm thick) adhered to a 6 m walkway (see Fig. 1). The depth of the targets corresponds to the variability in step length reported in stroke patients [27]. The width of step-length targets

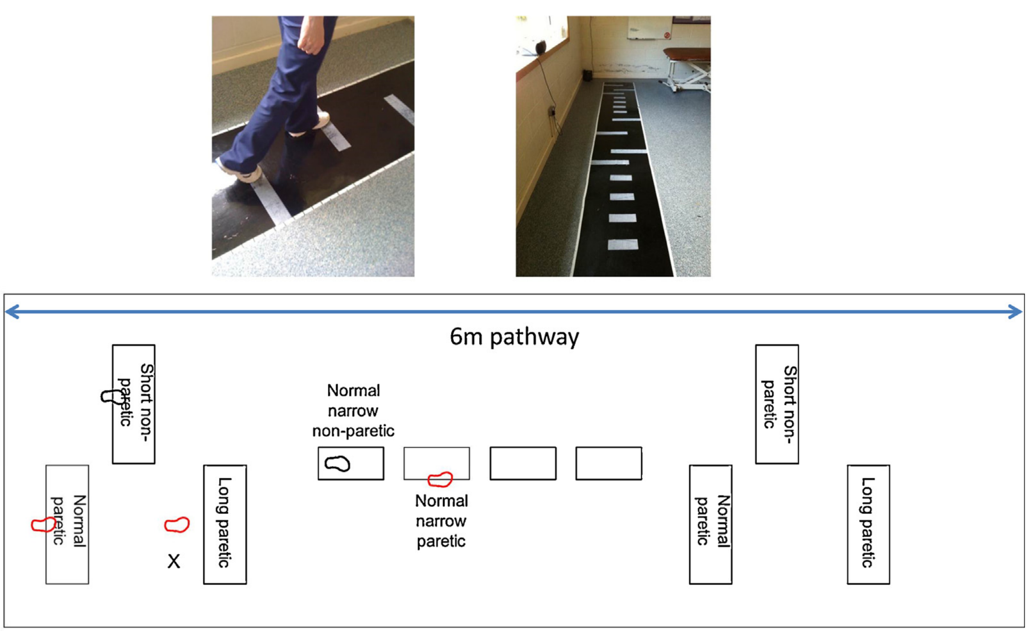

Fig. 1. shows photographs of the target stepping layout and a schematic of an example of when a target is classed as missed (second paretic step with an X showing the target is recorded as missed).

Download English Version:

https://daneshyari.com/en/article/4055846

Download Persian Version:

https://daneshyari.com/article/4055846

Daneshyari.com