



Efficacy of a Novel Walking Assist Device with Auxiliary Laser Illuminator on Stroke Patients

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Introduction

In order to achieve independence of ADLs in patients with stroke, locomotion and ambulation trainings are the most common and important programs in community-dwelling stroke patients. The initial use of walking aids has been suggested to improve the quality, stability, and also prevent falls in stroke patients in the rehabilitation. Quad-canes are one of the most common walking aids in gait training among patients after stroke since most of them presented with hemi-paretic gait. It had been proved that quad canes could improve symmetry and help to achieve normal muscle activation patterns in patients with stroke presenting with asymmetric gait. Interactive therapy with visual feedback appears to be an important option to engage patients' participation and could be a useful approach to stroke rehabilitation.

Purpose

To our knowledge, no available study evaluated the clinical effectiveness in the use of quad-cane with auxiliary laser illuminator (laser-cane) as visual feedback system among adult and community-dwelling stroke patients. We aimed to evaluate the long-term clinical effects of the laser quad-cane on the gait pattern, balance, function of daily living, and risk of fall, among community dwelling stroke patients in this study.

Methods

This was a randomized-prospective study (NCT03786341). Patients in the experimental group (EG) received 30-minutes rehabilitation, consisting of 15-minutes of walking training with laser-cane and 15-minutes of traditional physical therapy. Patients in the control group (CG) received the same rehabilitation without laser-cane. The rehabilitation lasted for 4 weeks, twice per week. Primary outcome were gait parameters. Secondary outcomes were Berg balance scale (BBS), timed-up-and-go test (TUG), and Barthel index (BI). Outcomes were measured before the rehabilitation (baseline), at the end of the rehabilitation (visit-1), and 4 weeks later (visit-2).

Table 1. Descriptive characteristics of the stroke patients^a

	Experimental group (n=15)	Control group (n=15)	P value ^a
Age (years)	57.0(9.5)	66.1(9.0)	0.18
Height (cm)	168.5(10.3)	165.0(6.6)	0.18
Weight (kg)	68.5(12.7)	66.4(10.5)	0.93
Stroke duration (months)	55.5(64.2)	88.4(83.9)	0.66
Gender (Male/Female) (n/%)	12(80%)/3(20%)	12(80%)/3(20%)	1.00
Hemiparetic side (right/left) (n/%)	10(67%)/5(33%)	10(67%)/5(33%)	1.00
Stroke type			
Cerebral infarction (n/%)	7(47%)	7(47%)	
Cerebral hemorrhage (n/%)	8(53%)	8(53%)	1.00
AFO usage			
With AFO	11(73%)	10(67%)	
Without AFO	4(27%)	5(33%)	0.69

Experimental group, stroke patient trained by quad-cane with auxiliary laser illuminator; control group, stroke patients trained by conventional rehabilitation; AFO, ankle-foot orthosis.

^aThe chi-square test and independent t-test were used to test for differences in the distribution between categorized variables and continuous variables between two groups.

Table 2. Comparison of primary and secondary outcomes between experimental and control groups^a

Variables	Experimental group (n=15)				Control group (n=15)				Percentage of change of variables ^e			
	Baseline	Week 4	Week 8	P value ¹	P value ²	Baseline	Week 4	Week 8	P value ¹	P value ²	P value ¹	P value ²
Primary outcomes ^b												
Stride length (meter)	0.6(0.2)	0.7(0.2)	0.7(0.2)	0.008*	0.004*	0.6(0.2)	0.6(0.1)	0.6(0.1)	0.496*	1.000*	0.045*	0.244*
Cadence (step/min)	43.1(9.3)	49.2(12.9)	51.0(15.8)	0.016*	0.023*	44.6(10.9)	49.8(11.1)	51.7(11.6)	0.009*	0.001*	0.980*	0.555*
Stance phase (%)												
Sound side	84.9(5.2)	78.0(9.7)	79.3(8.6)	0.002*	0.004*	83.0(6.4)	81.4(5.7)	81.4(5.9)	0.013*	0.006*	0.048*	0.091*
Hemiparetic side	75.8(9.3)	73.2(9.0)	67.0(9.6)	0.050*	0.013*	70.6(10.4)	70.0(10.4)	68.5(8.5)	0.382*	0.506*	0.369*	0.03*
Swing phase (%)												
Sound side	15.1(5.2)	22.0(9.7)	20.7(8.6)	0.002*	0.004*	17.0(6.4)	18.6(5.7)	18.6(5.9)	0.015*	0.008*	0.086*	0.106*
Hemiparetic side	24.2(9.3)	26.8(9.0)	33.0(9.6)	0.050*	0.013*	29.4(10.4)	30.1(10.4)	30.6(7.9)	0.382*	0.814*	0.339*	0.052*
Heel-strike angle (°)												
Sound side	2.4(2.9)	4.4(4.2)	4.5(3.9)	0.001*	0.083*	3.8(3.1)	4.3(4.2)	4.2(3.8)	0.589*	0.232*	0.878*	0.939*
Hemiparetic side	2.7(5.4)	4.0(3.2)	3.7(4.8)	0.441*	0.721*	0.4(4.9)	1.8(5.7)	1.8(5.6)	0.248*	0.064*	0.099*	0.434*
Toe-off angle (°)												
Sound side	-34.6(7.7)	-36.2(8.9)	-38.0(6.7)	0.125*	0.015*	-35.7(8.9)	-35.6(12.0)	-37.9(9.5)	0.955*	0.280*	0.590*	0.778*
Hemiparetic side	-11.3(11.0)	-13.6(13.1)	-13.0(10.5)	0.374*	0.169*	-12.4(6.8)	-16.0(10.0)	-15.8(11.4)	0.075*	0.136*	0.582*	0.931*
Secondary outcomes ^b												
Berg balance scale ^c	32.8(10.3)	41.0(11.1)	42.3(10.2)	0.001*	0.001*	32.1(9.9)	38.6(10.9)	39.2(11.9)	0.001*	0.003*	0.45*	0.52*
Barthel index ^c	79.0(19.3)	89.3(12.1)	91.7(11.9)	0.007*	0.002*	81.0(18.5)	87.0(12.8)	90.7(10.7)	0.09*	0.01*	0.68*	0.69*
Timed up and go test ^c	49.2(16.3)	38.5(15.5)	37.0(13.0)	0.001*	0.002*	49.1(20.2)	37.4(12.8)	35.7(12.7)	0.007*	<0.001*	0.70*	0.77*

Data were presented as mean (standard deviation)^d

^a P value 1: Intra-group comparison between data of baseline and week 4 by Wilcoxon signed-rank test^d

^b P value 2: Intra-group comparison between data of baseline and week 8 by Wilcoxon signed-rank test^d

^c P value 1: Inter-group comparison between change of data of baseline and week 4 by Mann-Whitney U test^d

^d P value 2: Inter-group comparison between change of data of baseline and week 8 by Mann-Whitney U test^d

^e Percentage of change of variables: change between week 4 or week 8 and baseline divided by data of baseline^d

heel-strike angle, angle between calcaneus and the ground at the time of heel-strike during a gait cycle; toe-off angle, angle between toes and the ground at the time of toe-off during a gait cycle^d

*p<0.05^d

Results

Comparing with the baseline, intragroup analysis of EG (n=15) showed significant improvement of stride length, cadence, stance and swing phase of both sides, heel-strike angle of the sound side, BBS, TUG, and BI at both visits; toe-off angle of sound side increased significantly at the visit-2; while intragroup analysis of CG (n=15) showed significant improvement of cadence, stance and swing phase of the sound side, BBS and TUG at both visits; BI increased significantly at the visit-2. Comparing with the CG, stride length increased (p=0.045) and stance phase of the sound site decreased (p=0.048) significantly at the visit-1, stance phase of the affected side decreased significantly (p=0.03) at the visit-2 in the EG.

Conclusions & Comments

With the characteristic to provide visual feedback during walking, we proved that laser-cane could improve parameters of gait cycle, balance, and basic ADLs of stroke patients after acute stage. In comparison to the conventional ambulation training, stroke patients using laser-cane had significant less stance phase of both the paretic and the sound sides, which meant that they walked in a more normal pattern. To sum up, laser-cane might provide visual-feedback that help stroke patients in subacute and chronic stage to correct their gait pattern. Larger and national-wide prospective blinded studies with long-term follow-up are warranted to assess the long-term clinical effectiveness of this promising, portable, and easy-to-use assistive device.

Key word: New staff nurses, Spiritual growth groups

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