Immediate Effects of walking assist device with auxiliary illuminator on patients with subacute and chronic stroke

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Introduction

Stroke, a disease results in brain damage, often causes loss of functional activity, or furthermore, disability, and even handicap among patients[1]. About 75% of patients with stroke suffer from walking disability that may lead to a high risk of falling and inability to be independent in daily life[2,3]. It is very important for stroke survivors to receive intensive rehabilitation programs to recover their walking ability after acute stage of stroke[4]. In order to improve dynamic balance during walking on uneven surface and the ability to adapt and overcome the barrier in different environments, repeated training and massed-practice of gait during rehabilitation is crucial[5]. The different assistive devices and the strategies of motor re-learning used in gait training both will affect the duration and clinical effect of the training.

Purpose/Methods

. To the best of our knowledge, no available study evaluated the clinical effectiveness in the use of quad-cane with auxiliary illuminator (quad-cane with laser,figure1) as visual feedback system among adult stroke patients in subacute and chronic stage. We aimed to provide visual feedback to the stroke patients by using a quad-cane with laser to explore the immediate effects on the gait cycle.

All the participants walked along a strait corridor with even surface for 20 meters without and with using a quad-cane with laser, respectively. A gait analyzer (Reha-Watch1 system) was used to measure the changes of the parameters of gait cycle, including stride length, cadence, gait speed, stance phase, swing phase, duration of single support and double support, the angle between toes and the ground at the time of toe-off (toe-off angle) and the angle between calcaneus and the ground at the time of heel-strike (heel-strike angle), before and with the use of a quad-cane with laser.

Results

This was a prospective study and thirty participants (male 23, female 7, group 1) with mean age 60.20 ± 11.12 years were recruited. Among them, 22 used ankle-foot orthosis [(AFO), group 2] and 8 did not use AFO (group 3) at usual walking. We observed a trend of decrease in stride length, cadence, walking speed and the duration of stance phase while a trend of increase in the swing phase and the toe-off angle in all the three groups. The increase in the heel-strike angle reach a significant difference in both group 1 and 2 (p=0.02 and <0.01). Moreover, the percentage of stance and swing phase in the gait cycle was approximately normal by using quad-cane with laser in group 3. (Table 2 and 3)

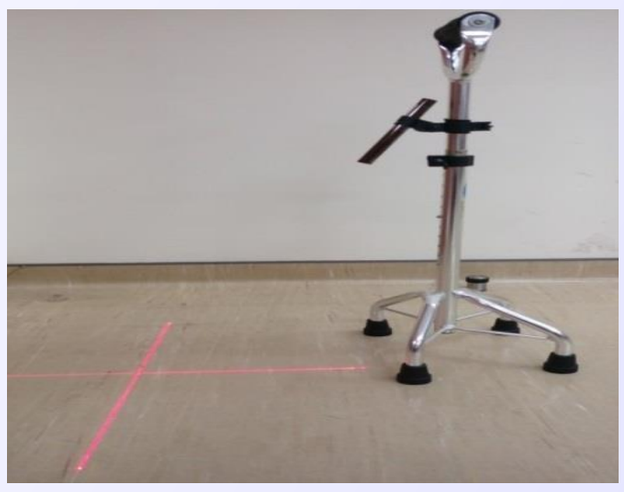

Figure 1. Walking assist device with auxiliary illuminator. The device was consisted of a quad-cane and a laser pointer. The laser pointer was placed on the shaft of the quad-cane with two laser beams vertical to each other which made a cross and provided with visual feedback.

Table 2. Immediate effects of gait cycles in patients with stroke before and after using the walking assist device with auxiliary illuminator (n=30)

	Not using illuminator (95% C.I.)	Using illuminator (95% C.I.)	P value
Stride length (meter)	0.93±0.59 (0.74~1.08)	0.92±0.53 (0.79~1.16)	0.91
Gait speed (meter/sec)	0.66±0.87 (0.40~0.91)	0.57±0.68 (0.39~0.89)	0.66
Cadence(step/min)	39.76±15.89 (33.12~45.75)	36.33±12.95 (31.98~40.09)	0.36
Stance phase (%)	76.86±9.95 (72.92~80.72)	76.00±12.77 (71.67~79.88)	0.76
Swing phase (%)	23.15±9.95 (19.28~27.09)	24.05±12.77 (20.13~28.33)	0.76
Single-support phase (%)	15.77±7.31 (13.71~20.33)	14.71±5.62 (12.84~17.73)	0.53
Double-support phase (%)	17.91±11.48 (14.48~21.62)	18.95±10.78 (15.53~22.71)	0.72
Heel-strike angle (degree)	0.34±5.76 (-2.68~3.11)	4.00±6.01 (1.11~6.75)	0.02*
Toe-off angle (degree)	-11.23±12.98 (-18.73~-7.97)	-11.26±11.31 (-17.85~-7.84)	0.99

95% C.I., 95% confidence interval; 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
*p<0.05

Table 3. Immediate effects of gait cycles in patients with chronic stroke who use AFOs and those who do not use AFOs after using the walking assist device with auxiliary illuminator

	Used AFOs (n=22)			Did not use AFOs (n=8)		
	No Illuminator (95% C.I.)	Illuminator use (95% C.I.)	p value	No Iluminator (95% C.I.)	Illuminator use (95% C.I.)	p value
Stride length (meter)	0.96±0.64 (0.71~1.23)	0.98±0.55 (0.75~1.22)	0.94	0.85±0.44 (0.59~1.19)	0.75±0.47 (0.55~1.09)	0.79
Gait speed (m/sec)	0.74±0.98 (0.40~1.15)	0.63±0.73 (0.36~0.95)	0.51	0.46±0.45 (0.24~0.83)	0.41±0.52 (0.20~0.79)	0.79
Cadence (step/min)	37.38±15.22 (31.26~43.92)	34.11±14.24 (28.62~39.87)	0.04*	46.33±16.86 (34.18~55.47)	42.43±5.40 (39.00~46.13)	0.16
Stance phase (%)	78.51±9.21 (74.56~82.34)	78.77±10.11 (74.55~82.78)	0.79	72.35±11.13 (65.59~80.00)	68.21±16.60 (56.63~76.41)	0.87
Swing phase (%)	21.51±9.21 (17.67~25.45)	21.24±10.11 (17.23~25.45)	0.79	27.66±11.13 (20.01~34.41)	31.80±16.59 (23.61~43.39)	0.87
Single-support phase (%)	14.44±7.51 (11.55~17.74)	13.74±5.96 (11.29~16.35)	0.35	19.45±5.62 (16.38~23.35)	17.38±3.62 (14.99~19.67)	0.09
Double-support phase (%)	18.64±12.22 (14.07~24.02)	19.20±11.92 (14.74~24.10)	0.46	15.93±9.57 (10.23~22.17)	18.29±7.37 (13.44~22.95)	0.67
Heel strike angle (degree)	1.10±5.19 (-1.05~3.15)	4.56±6.39 (1.90~7.31)	<0.01*	-1.73±7.07 (-6.39~2.61)	2.39±4.82 (-0.66~5.52)	0.05
Toe off angle (degree)	-9.53±13.77 (-15.66~-4.47)	-10.05±12.50 (-15.34~-5.43)	0.47	-15.91±9.74 (-22.51~-9.93)	-14.61±6.56 (-19.35~-10.64)	0.83

AFO, ankle-foot orthosis; 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
*p<0.05

Conclusions

Since lower gait speed and cadence might reduce the risk of fall and imbalance, and increase in the heel-strike and toe-off angle might correct gait pattern, patients with subacute and chronic stroke could walk more normal by using a quad-cane with laser.

Key word: Gait, Stroke, Walking assist device, Auxiliary illuminator
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