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Effects of modified motor skills on the recovery of walking function of patients with stroke

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Abstract

This study aims at investigating whether modified motor skills can produce positive effects on the recovery of walking function of stroke patients. One hundred and fifty patients with stroke were randomly grouped into two groups, 75 each group. Patients in the control group were given conventional rehabilitation training, while patients in the test group were given training based on improved motor skills besides conventional training. The rehabilitation results of the two groups were evaluated using Functional Ambulation Category (FAC), simplified Fuq-Meyer assessment (FMA) and modified Barthel index (MBI). Moreover, 6-min walking test was performed. No significant differences were observed in the general data of the two groups, and the differences of different scores between the two groups before treatment were the same ($p > 0.05$); hence the results were comparable. There were remarkable differences in the two groups before and after rehabilitation treatment, and the differences of the scores between the two groups after treatment were statistically significant ($p < 0.05$). The results of the 6-min walking test demonstrated that the walking distance of the patients in the two groups had no remarkable difference before treatment ($p > 0.05$), but there was a difference after six weeks ($p < 0.05$). The test group had superior improvement of walking distance and better training effect compared to the control group. Modified motor skills can strengthen the training for the recovery of walking function of patients with stroke. The strengthened training skills can positively and effectively enhance the action capability of patients and help them recover.

Keywords: stroke, modified motor skills, walking function

1. Introduction

Stroke, one of acute cerebrovascular diseases (RODRÍGUEZ & al. [1]; GHIZONI & al. [2]), is caused by insufficient blood supply induced by acute rupture of blood vessels or angiemphraxis in the brain. Stroke has been the top one cause for death in China (XU [3]; SUBIRÁ & al. [4]) and also the primary reason for adult disability. Stroke can damage motor function of human body (CARTER & al. [5]; YANG & al. [6]), i.e. inducing movement disturbance (OOUCHIDA & al. [7]). Subcortical central motor which is inhibited previously is released through reflex, inducing muscle weakness and disorder of coordination function of muscle group. The recovery of walking ability of patients with stroke requires the assistance of rehabilitation treatment (YANG & al. [8]). To verify whether conventional brisk walking could promote the function recovery of patients with stroke, Batcho et al. [BATCHO & al. [9]) recruited 44 patients with chronic stroke in Belgium and Benin and found that all indexes were stable in the early intervention stage and improved in the late stage and that regular brisk walking was an effective approach for promoting the function recovery of patients with chronic stroke.

To investigate the influence of normal gait mode based functional electrical stimulation on the walking functions of stroke patients, Tan et al. (TAN & al. [10]) randomly divided 58 patients with stroke into three groups and treated them with four-channel functional electrical stimulation, single-channel functional electrical stimulation and placebo treatment. They found that the score of the group which was treated by four-channel functional electrical stimulation was higher than that of the other two groups and the modified Barthel index (MRI) of the three groups improved. The electromyogram results demonstrated that the muscle co-activation index of the group which was given four-channel functional electrical stimulation was significantly lower than that of the other two groups. Hence it was concluded that normal gait mode based functional electrical stimulation could enhance the walking function of patients with stroke. This study aims at investigating whether modified motor skills can affect the recovery of walking function of patients with stroke through controlling the content of rehabilitation training.

2. Materials and Methods

2.1. Research subjects

One hundred and fifty stroke patients who were admitted to our hospital to undergo rehabilitation treatment between April 2015 and January 2017 were selected.

The included subjects were those who were confirmed as stroke by computed tomography (CT) and Magnetic Resonance Imaging (MRI), satisfied the diagnostic standards formulated in the Fourth National Cerebrovascular Disease Conference, had limbs dysfunction, were willing to coordinate with inspection, had no severe lalopathy and cognitive disorder, and had no brain organic disease and mental disturbance.

The 150 patients were divided into a test group and a control group. Seventy patients in the test group were given modified motor skill based training, while patients in the control group received conventional rehabilitation training.

The general data of the two groups had significant differences ($p > 0.05$); hence the results were comparable. The specific data are shown in Table 1.

Table 1. Comparison of general data between the two groups

Group	Number of cases	Gender		Average age (year)	Average treatment time (day)	Nature of lesion		Affected side	
		Male	Female			Cerebral infarction	Cerebral hemorrhage	Left	Right
Test group	75	45	30	59.57±6.48	10.64±6.12	49	26	37	38
Control group	75	34	41	61.84±7.02	10.07±6.71	46	29	42	33

2.2. Training and test methods

Patients in the two groups were treated by the same neurological drugs and started rehabilitation training within 48 h after the vital signs and neurological signs turned stable. Patients in the test group did modified motor skills based training besides conventional training, while patients in the other group received conventional rehabilitation training only.

2.2.1. Conventional training method

Neurophysiological therapy including Bobath technology, Brunnstrom technology (YU & al. [11]), Rood technology and proprioceptive neuromuscular facilitation (STEPHENSON & al. [12]) were adopted. Training of body position setting and transfer, balance and walking was done using body position setting, bed exercise, guided associative reaction and associated movement, guided separation movement, sensory irritation reaction and postural control. The aforementioned training was done once each day, i.e. 45 min. It was done for five days and then interrupted for two days. The training lasted for 6 weeks.

2.2.2. Modified motor skills

First was training of sitting up. The patient sat on a chair which had a back and was 40 cm high, with half of his legs on the chair, feet on the floor and knee joint bending for 90 ~ 100 °. When the patient stood up, his hands were clasped before the chest. With the center of gravity forward, the patient stood up and then sat down in a constant speed. After the patient was familiar with the training, the speed improved, the chair was altered, and the patient was asked to do training with something in hand. The frequency of training was improved according to the recovery of physical strength; the frequency was kept at 250 ~ 350 times each day.

Next was balanced training. Accompanied by an assistant or a family member, the patient was asked to move his center of gravity in different directions while standing in front of a mirror and moreover grab the object which was placed not far away. The object should be placed at the place where the patient needed to change body balance to grab the object but did not need to do excessive move. If the patient was able to stand by two feet, then he was asked to stand by one leg, move towards one direction, and grab the object which was placed at a low spot. The training time was extended gradually according to the physical strength of the patients; 10 min each day previously could be increased to 30 ~ 40 min each day.

Next was walking training. Accompanied by an assistant or a family member, the patient was asked to walk in a constant speed on a footpath which was 100 m long. The assistor should carefully observe the patient to avoid poor posture. Walking time and distance were determined according to the physical strength of the patient. 100 m each day previously should be increased to 1000 m each day. After stable walking, mild weight training and training of spanning barrier could be carried out.

Last was training of walking up and down stairs. Stairs used for training had the same specification with conventional stairs. The patient was asked to walk up and down stairs with double lower limbs. Training with weight and something in hands was done in the late stage. After the patient was familiar with walking up and down stairs, he continued walking up and down on real stairs. The training time was determined by the body strength of the patients; 10 min each day previously could be extended to 30 min.

2.2.3. Test method

6-min walking test is mainly used for evaluating the efficacy of treatment intervention on patents with moderate ad severe heart and lung diseases and test the functional status of patients.

Firstly the longest distance which the patient could walk in 6 min was measured. Then the tolerance and fatigue degree of the patient was observed.

In a closed gallery, red packaging tape was used to mark the position of the starting and end points of a road which is 50 m long. The patient was informed with time every two minutes while walking. The patient could rest during test if needed. Test stopped if the patient could not insist, and the walking distance at that moment was taken as the final test result of the patient.

The test results could be divided into four grades according to the walking distance, as shown in Table 2.

Table 2. Division of four cardio-pulmonary function grades according to walking distance

Grade	Walking distance (m)
Grade one	$S<300$
Grade two	$300\leq S<375$
Grade three	$375\leq S<450$
Grade four	$450<S$

2.3. Evaluation methods

The walking ability, gait, lower limbs motor function and activity of daily living were evaluated using Functional Ambulation Category (FAC), simplified Fuq-Meyer assessment (FMA) and modified Barthel index (MBI) before training and six week after training. Assessment for the patient before and after training was made by the same doctor.

2.4. Statistical methods

SPSS ver. 22.0 was used. Measurement data were expressed as mean ± standard deviation. Comparison between groups was performed using t test. $p < 0.05$ meant difference was statistically significant.

3. Results

3.1. Comparison of FAC, FAM and MBI scores

Table 3 and 4 demonstrate that the differences of FAC, FMA and MBI scores between the two groups were not statistically significant before training ($p > 0.05$), the FAC, FMA and MBI scores of the two groups improved after six weeks of training, and the differences of the scores before training and after training were significant ($p < 0.01$). The scores of the test group improved apparently, which were significantly different with the scores of the control group ($p < 0.05$).

Table 3. Comparison of FAC, FAM and MRI scores between the two groups before and after training

Time	FAC score		FMA score				MBI score	
	Test group	Control group	Test group		Control group		Test group	Control group
			Lower limbs motor function	Balance capacity	Lower limbs motor function	Balance capacity		
Before training	2.34±0.94	2.67±0.64	7.16±1.36	2.92±1.65	7.67±3.16	3.41±1.71	17.36±4.44	17.56±4.41
After training	2.95±0.51	2.78±0.71	22.49±4.16	6.98±1.71	14.94±3.69	5.42±1.35	54.03±6.56	50.07±4.67
t	-8.64	-4.06	-16.15	-11.06	-10.37	-7.32	-30.41	-33.82
P	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 4. Comparison of FAC, FAM and MIB scores between the two groups after training

Group	FAC score	FMA score		MBI score
		Lower limbs motor function	Balance capacity	
Test group	2.95±0.51	22.49±4.16	6.98±1.71	54.03±6.56
Control group	2.78±0.71	14.94±3.69	5.42±1.35	50.07±4.67
t	4.43	5.64	3.78	4.98
P	<0.05	<0.05	<0.05	<0.05

3.2. Results of 6-min walking test

The walking distance of the patients in the two groups suggested no apparent difference before rehabilitation training ($p > 0.05$). After three weeks, the walking distance of the test group increased from (111.34±18.07) to (176.73±23.74), and the walking distance of the control group increased from (107.48±17.64) to (129.65±17.88); the walking distance of patients in both groups improved. After six weeks, the walking distance of the test group increased from (176.73±23.74) at the 3rd week to (217.41±26.09), and the walking distance of the control group increased from (129.65±17.88) at the 3rd week to (148.91±18.01). The walking distance of the test group before training and six weeks after training was very significantly different ($p < 0.01$); but the difference of the other data had no statistical significance ($p > 0.05$). There was a remarkable difference between the two groups at the 6th week ($p < 0.05$). The walking ability of the test group improved more obviously after patients did modified motor skills based rehabilitation training.

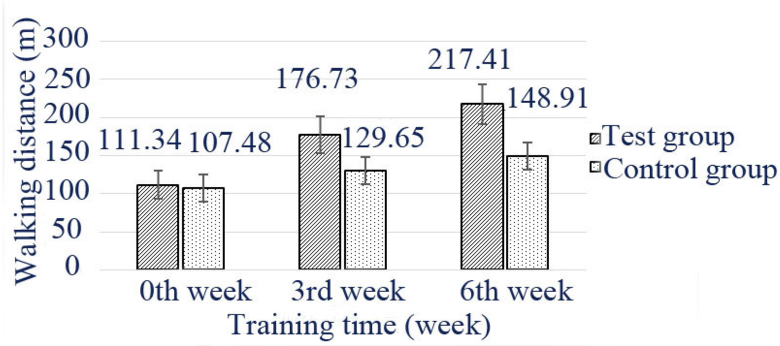

Figure 1. Comparison of 6-min walking test results between the two groups.

4. Discussion and conclusion

The main purpose of rehabilitation treatment is to optimize the motor performance of patients in functional activities (JUNG & al. [13]). Walking function can reflect the most basic activity function of lower limbs. The recovery of walking function can clearly reflect the recovery of body control ability of patients with stroke. Patients with stroke are of high risks to have disorder of lower limbs activity (TYSON & al. [14]) including slow walking speed, small stride, long support time, curved walking path, body swing during walking and discontinuous walking. The presence of those problems can severely affect the living quality of patients. Therefore, rehabilitation treatment is needed for training the walking ability of patients. To improve gait symmetry, walking stability and stride and reduce support time, the control ability of the lower limbs must be strengthened.

If rehabilitation training was not performed timely, fixed hemiplegic gait may form (JOEN & al. [15]). Rehabilitation method relying on neurodevelopmental technique is difficult to rehabilitate most of patients to the previous level. Hence the original rehabilitation method is expected to be modified to prevent the occurrence of mistaken motor behaviors and improve effect.

In this study, the 150 patients were divided into two groups, and the FAC, FMA and MBI scores of the two groups were compared. It was found that the FAC, FMA and MBI scores of the two groups had no obvious difference before rehabilitation training ($p > 0.05$). The scores of both groups increased after training, and there were very significant differences ($p < 0.01$). Though the scores of the patients who only received the traditional rehabilitation training improved after training, there was still a gap with the test group. The FAC, FMA and MBI scores of the two groups suggested apparent differences ($p < 0.05$).

The analysis of 6-min walking test results demonstrated that the walking distance of the two groups had no remarkable difference before training ($p > 0.05$); the walking distance of both groups improved after 3 and 6 weeks of training, and the improvement of the test group was more obvious; the difference of walking distance between the two groups at the 6th week was statistically remarkable ($p < 0.05$). The walking ability of the patients who received the traditional rehabilitation training and modified motor skills based rehabilitation training recovered better than that of those who received the traditional rehabilitation training only.

Therefore modified motor skills based rehabilitation training can produce positive effects on the recovery of walking function of stroke patients, and the training method is quite scientific and effective.

There were some limitations in this study. Firstly, clinical samples, i.e. the number of patients selected was not enough, and moreover the age span of the samples was not large enough. The final conclusions were limited and not universal. Secondly, the duration of rehabilitation training was short; as a result, the effect of rehabilitation was not fully played. The conclusion will be more accurate if the training extended 6 weeks. Finally, the test was not comprehensive enough to fully reflect the effect of the improved training method; the kinematic mechanics of lower limbs can be combined with analysis of brain based on scanning instruments such as nuclear magnetic resonance spectrometer.

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