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The effect of dance on rehabilitation training after COVID-19

Y. WANG

Xinxiang Radio and Television University, Xinxiang, Henan, China

Abstract. – OBJECTIVE: This study aims at investigating the effect of dance on rehabilitation training after COVID-19.

PATIENTS AND METHODS: In this study, a total of 112 patients with COVID-19 were recruited for rehabilitation training. Before enrollment, a neurologist conducted medical history inquiry, basic information collection, MMSE (MiniMental State Examination), MoCA (Montreal Cognitive Assessment) and MHIS (Mental Health Information Systems) assessment. In the end, 68 patients with COVID-19 who met the entry criteria and signed the informed consent were included in the training. 8 patients with greater exercise risk after the ECG exercise test were not included in the group. Therefore, 60 patients were finally included in the group. The improved BMCE (Basic Medicine Comprehensive Examination) protocol was used to evaluate the cardiac function and exercise adaptability of the patients. The 12 lead ECG and gas metabolism instrument were used to monitor the changes of ECG and gas metabolism, and the blood pressure was measured at the same time. The exercise intensity was evaluated by subjective fatigue degree. The patient stopped the exercise test and rested for 15 minutes under the following conditions: (1) complained of any discomfort or intolerable fatigue; (2) horizontal or oblique ST segment pressure in ECG not shorter than 3 mm; (3) moderate to severe angina pectoris or reduction of systolic blood pressure greater than 10 mmhg. The heart rate when stopping the test was the maximum heart rate of the patient.

RESULTS: The average participation times of MCI patients in the aerobic dance group were 33.9 (IQR = 34, 36), 89.7% of MCI patients participated in 90% of aerobic dance training, and only 3.4% of MCI patients participated in less than 80% of aerobic dance courses. Compared with the control group, the 3-month change value of Wechsler's logical memory of MCI patients in the aerobic dance group was significantly improved ($p < 0.01$). The 3-month change value of digital connection test B score was significantly improved (mean value of difference between groups = -32. The treatment speed was significantly shortened at 6 months (P300 latency 6 months change value = -20 ms).

CONCLUSIONS: The intensity and frequency of aerobic dance play a key role in the effect of cognitive improvement, requiring long-term persistence and ensuring the intensity and frequency of training. Second, the patient's processing speed (P300 latency) tends to gradually extend with the passage of time, and aerobic dance intervention helps shortening the P300 latency, suggesting that patients can delay the decline of their cognitive function through early aerobic dance intervention.

Key Words:
Dance, COVID-19, Rehabilitation training, P300 latency.

Introduction

At present, there is not enough evidence to confirm the intervention effect of drug therapy on COVID-19 rehabilitation training, but the intervention of non-drug therapy, including lifestyle adjustment, risk factor control, cognitive training and sports training, has been gradually confirmed[1,2]. Dance is a common exercise intervention method. Dance is considered to be a kind of exercise that combines physical strength and cognition. In the process of dancing, it is necessary not only to complete the change of movements, but also to match the rhythm of music[3,4]. The process includes learning and making dance movements, matching with the rhythm of music, and cooperating with others, which is conducive to regulating emotions and promoting social communication. Research and report on dance can prevent the progress of rehabilitation training in COVID-19[5].

The purpose of this study is to explore the effect of moderate intensity aerobic dance on the cognitive function of the elderly after rehabilitation training of COVID-19. A randomized controlled single blind design was adopted to give aerobic dance intervention to the elderly

Corresponding Author: Ying Wang, MD; e-mail: miyangzi-wy@163.com

after rehabilitation training of COVID-19 for 3 months and 3 times a week[6]. The changes of multiple components of cognitive function (logical memory, executive ability, spatial conformation, attention) and activities of daily living (ADL) and quality of life of the participants were assessed, and a 3-month follow-up was conducted to observe the effect of aerobic dance intervention and whether there was a continuation effect[7,8]. The elderly in China have the habit of performing group dance and square dance in the community. However, the exercise intensity and time of their dance vary greatly, and there is no relevant study to observe the role of these dances[9]. If it can be confirmed through this study that moderate intensity aerobic dance has a positive intervention effect on rehabilitation training after COVID-19, it will provide a positive and effective community intervention method for patients undergoing rehabilitation training after COVID-19[10]. It is hoped to provide clinical research evidence for non-drug intervention of rehabilitation training after COVID-19.

Patients and Methods

Research Process

In this study, a total of 112 patients with COVID-19 were recruited for rehabilitation training. Before enrollment, a neurologist conducted medical history inquiry, basic information collection, MMSE, MOCA and MHIS assessment. In the end, 68 patients with COVID-19 who met the entry criteria and signed the informed consent were included in the rehabilitation training. 8 patients with greater exercise risk after the ECG exercise test were not included in the group. Therefore, 60 patients were finally included in the group.

Intervention Modality

The patients were randomly divided into two groups: 3-month intervention and 3-month follow-up. All patients were interviewed by doctors at the time of enrollment; 3 months of intervention and 6 months of follow-up were considered, focusing on the concept of rehabilitation training after COVID-19, clinical manifestations and risk factors for progression to Alzheimer's disease, and teaching patients how to change their lifestyles, control risk factors and prevent cognitive decline. The aerobic dance group received moderate intensity aerobic dance intervention and health education guidance, while the control group received health education guidance only.

The aerobic group used the aerobic dance independently designed by the research group to conduct 35-minute intervention three times a week. The place was located in the playground of the First Affiliated Hospital of Nanjing Medical University. A dance teacher taught all participants the aerobic dance movements to ensure that they could complete them correctly. Each aerobic dance was performed in a group, led by a dance teacher, including at least 10 people in a group, with music accompaniment. After 3 months of collective aerobic dance, patients were encouraged to perform aerobic dance at home.

Sample Size Calculation

In this study, we used the change value of Wechsler's logical memory from before the intervention to 3 months after the intervention as the main index to calculate the required sample size. To achieve a moderate (i.e., standard deviation of 0.75) treatment effect and 80% statistical power, and to achieve a significance level of 0.05 in the two tailed test, we need at least 56 patients (28 in each group). Assuming a sample loss rate of 7%, we recruited a total of 60 patients.

Statistical Analysis

All data of this study were statistically analyzed by SAS software (Statistical Analysis System, Cary, NC, USA). We used frequency and percentage to describe categorical variables, and mean and standard deviation or median and interquartile range to describe continuous variables[11]. As the main analysis of this study, we used a linear random effect model to analyze the comparison of Wechsler's logical memory test results before and after the intervention within and between groups. In this model, Wechsler's test results were the dependent variables, and time, intervention group, and the interaction between time and thousand pre groups were the main variables. The results of the analysis were expressed as intra - and inter-group differences and corresponding to 95% confidence intervals. For other evaluation indicators such as MoCA, forward and reverse digit memory span, connection test A, B, symbolic digit test, SF-36 score, FAQ and P300 latency and peak, we adopted the same analysis method. In addition, the independent *t*-test was used for the comparison between groups of measurement data in baseline data, and

the chi square test was used for the comparison between groups of counting data. $p < 0.05$ was statistically significant.

Results

Analysis of the Difference Between the Baseline Evaluation Indexes of the Two Groups of Patients

Table I shows the difference in the scores of MoCA, Wechsler's logical memory score, digit memory span test, connection test A, connection test B and symbol number pattern test between the groups before the intervention ($p > 0.05$).

Comparison of Cognitive Scores Between Two Groups

Table II shows the results compared within and between groups. After 3 months of intervention, the scores of MoCA, Wechsler's logical memory and symbolic number pattern test in the aerobic dance group were significantly different from those before intervention ($p < 0.05$); There was no significant difference between the scores of all cognitive assessment scales in the control group and the baseline values before the intervention ($p > 0.05$). Compared with the control group, the change of Wechsler's logical memory score in the aerobic dance group was statistically significant ($p < 0.05$).

Comparison Between Groups of Evaluation Indexes After Intervention and Follow-Up of Patients with COVID-19 After Rehabilitation Training

Table III lists the difference between the aerobic dance group and the control group in the 3-month change value and the 6-month change value of each evaluation index.

Discussion

Aerobic Dancing Can Improve Patients' Cognitive Function, but it Needs Long-Term Adherence

In this study, it was found that 3-month aerobic dance intervention with moderate intensity can improve the logical memory ability and reaction speed of patients after rehabilitation training in COVID-19. Our research results further confirmed that dance can improve the cognitive function of patients after rehabilitation training in COVID-19, which is consistent with foreign studies. Previous studies have emphasized the changes and complexity of dance movements. Our research focuses on the exercise intensity of dance, and through heart rate monitoring, we can ensure that patients in COVID-19 rehabilitation training will reach the set bull's-eye rate during each aerobic dance. In addition, our dance movements repeat and change alternately, and the rhythm is different from that of ordinary dance, which requires patients in COVID-19 rehabilitation training to concentrate, study and remember hard and keep up with the music rhythm. Our research results confirm that this aerobic dance can improve patients' memory ability (Wechsler's logical memory score increased) and processing speed (P300 latency was reduced), indicating that it has a significant effect on cognitive improvement. At the same time, we conducted a 3-month follow-up after the patients stopped training, and found that the improvement of memory in these patients could not be maintained. In particular, the processing speed (CP300 latency) of the patients in the aerobic dance group who received rehabilitation training after the recovery of COVID-19 returned to the baseline level before the intervention, which may be related to the fact that the patients did not perform the same intensity and

Table I. Analysis on the difference of baseline evaluation indexes between two groups of patients with COVID-19 after rehabilitation training.

Project	Aerobic dance group (n = 16)	Control group (n = 16)	*p*-value
MoCA (score), mean (SD)	22.6 (2.1)	22.9 (1.7)	0.65
Wechsler logical memory (score), mean (SD)	14.1 (5.9)	16.7 (5.4)	0.21
Digital memory span test (score), mean (SD)	16.4 (2.9)	18.1 (3.4)	0.14
Connection test a (seconds), average value (SD)	107.3 (97.1)	72.2 (23.3)	0.17
Connection test B (seconds), average (SD)	190.6 (59.2)	182.2 (57.7)	0.69
Symbol number pattern test (score), mean value (SD)	31.8 (1.4)	34.1 (10.9)	0.53

SD = standard deviation.

Table II. To study the intra group and inter group comparison of cognitive evaluation indexes of patients with COVID-19 after rehabilitation training

Grouping	Values at different time points (SD)		3 months compared with baseline (SD)		Comparison of two groups	
	Baseline	3 months	Intra group changes	*p*-value	Difference between groups	*p*-value
Wechsler logical memory (points)						
Aerobic dance group	14.1 (5.9)	17.9 (4.4)	3.8 (4.7)	0.01	5.3 (4.7)	0.00
Control group	16.7 (5.4)	15.2 (3.3)	-1.5 (4.6)	0.21		
MoCA (points)						
Aerobic dance group	22.6 (2.1)	24.3 (2.2)	1.6 (2.2)	0.01	0.9 (2.4)	0.21
Control group	22.9 (1.7)	23.7 (2.0)	0.8 (1.7)	0.09		
Digit memory span test (forward and reverse) (score)						
Aerobic dance group	16.4 (2.9)	16.4 (2.6)	0.1 (3.8)	0.95	1.0 (4.3)	0.37
Control group	18.1 (3.4)	17.1 (2.9)	-0.9 (2.2)	0.11		
Connection test a (seconds)						
Aerobic dance group	107.3 (97.1)	71.0 (29.3)	-36.3 (81.3)	0.10	-32.9 (72.7)	0.13
Control group	72.2 (23.3)	68.8 (19.1)	-3.4 (23.4)	0.57		
Connection test B (seconds)						
Aerobic dance group	190.6 (59.2)	161.6 (53.8)	-28.9 (75.7)	0.15	-28.3 (88.9)	0.2
Control group	182.2 (57.7)	181.6 (46.7)	-0.6 (39.9)	0.96		
Symbolic digital mode test (points)						
Aerobic dance group	31.8 (9.6)	34.5 (9.3)	2.8 (4.4)	0.03	3.3 (12.3)	0.23
Control group	34.1(10.9)	33.5 (10.5)	-0.6 (1.1)	0.82		

Table III. Comparison of the indexes before and after training between the aerobic dance group and the control group.

Grouping	Values at different time points (SD)			3 months compared with baseline (95% CI)		6 months compared with baseline (95% CI)	
	Baseline	3 months	6 months	Intra group changes	Difference between groups	Intra group changes	Difference between groups
Wechsler logical memory							
Aerobic dance group	14.3 (5.4)	17.5 (3.8)	16.7 (6.3)	3.4 (1.6,5.1)*	4.6 (2.2,7.0)**	2.8 (0.9,4.6)*	2.8 (0.2,5.4)
Control group	15.5 (5.2)	14.3 (4.3)	15.5 (5.4)	-1.2 (-2.9,0.4)		0.0 (-1.8,1.8)	
MoCA							
Aerobic dance group	23.2 (1.9)	24.7 (2.2)	25.0 (2.4)	1.6 (0.8,2.3)**	0.8 (-0.1,1.8)	1.9 (1.0,2.8)**	0.2 (-1.0.1.4)
Control group	22.9 (2.1)	23.6 (1.8)	24.7 (2.4)	0.7 (0.0,1.4)*		1.7 (0.8,2.6)**	
Digit memory span test							
Aerobic dance group	16.8 (2.7)	16.9 (2.3)	16.8 (2.2)	0.1 (-1.1,1.3)	0.2 (-1.4,1.9)	0.0 (-1.0,1.0)	1.2 (-0.2,2.6)
Control group	17.2 (2.9)	17.0 (2.9)	15.9 (3.0)	-0.2 (-1.3,0.9)		-1.2 (-2.2,-0.2)*	
Connection test a							
Aerobic dance group	74 (29)	66 (25)	60 (20)	-8.7 (-17.2,0.2)	-7.4 (-19.0,4.3)	-15 (-2.4,-6)*	-10 (-23,2)
Control group	70 (23)	69 (20)	66 (22)	3 (-9.4,6.7)		-4.9 (-13.6,3.8)	
Connection test B							
Aerobic dance group	200 (73)	158 (49)	171 (91)	-42 (-62,23)	-32 (-59,-4)*	-30 (-52,7)	-20 (-52,11)
Control group	187 (67)	177 (48)	179 (69)	-11 (-30,8)		-9 (-32,13)	
Symbolic digital mode test							
Aerobic dance group	32 (9)	36 (9)	37 (9)	3.6 (0.8,6.5)*	3.4 (-0.6,7.3)	5.2 (2.3,8.0)*	1.7 (-2.3,5.7)
Control group	33 (11)	33 (11)	35 (13)	0.3 (-2.4,2.9)		3.5 (0.6,6.3)*	

frequency of aerobic dance at home after the end of the group dance intervention in the period of 3-6 months. At the same time, we found that the processing speed of the patients with COVID-19 after rehabilitation training in the control group showed a significant prolongation of the P300 latency during the 6-month follow-up, suggesting that the processing speed of the patients with COVID-19 after rehabilitation training without intervention decreased with the passage of time, which was a manifestation of the cognitive function decline of the patients with COVID-19 after rehabilitation training[12].

Such results suggest that: (1) the intensity and frequency of aerobic dance play a key role in the effect of cognitive improvement, requiring long-term adherence and ensuring the intensity and frequency of training; (2) the processing speed (P300 latency) of patients undergoing rehabilitation training after COVID-19 is gradually prolonged with the passage of time, while aerobic dance intervention helps to reduce the P300 latency, suggesting that patients undergoing rehabilitation training after COVID-19 can delay the decline of their cognitive function through early aerobic dance intervention.

Aerobic Dance Can Improve Patients' Logical Memory and May Improve Their Overall Cognitive Function and Executive Ability

After 3 months of aerobic dance intervention, the patients with COVID-19 recovered from rehabilitation training found significant differences in Wechsler's logical memory scores between groups, which was consistent with the results of the first part of the study. However, the overall cognitive function, logical memory and symbolic number pattern test were significantly improved before and after the intervention in the group, suggesting that aerobic dance Qianyu may be a better nondrug intervention method to help patients with COVID-19 recover from rehabilitation training to improve cognitive function and slow down cognitive decline. Our results further confirmed that dance can improve the cognitive function of patients with COVID-19 after rehabilitation training, which is consistent with literature. Because the sample size of this study is small, although the MoCA score and symbolic number pattern test of the patients after the rehabilitation training of COVID-19 after the aerobic dance intervention have improved within the group, no significant difference between the groups has been found, which suggests that the sample size needs to be expanded in the future to further confirm the intervention effect.

Conclusions

RS fMRI showed that the spontaneous activity level (ALFF value) of neurons in bilateral frontal glume, entorhinal cortex, anterior cingulate gyrus and parahippocampal cortex increased significantly in the aerobic dance group, but there was no significant change in these areas in the control group. Only a small number of functional areas in the right glume and posterior cingulate gyrus were activated. Bilateral prefrontal lobes are closely related to the planning and execution of exercise, and are closely related to the executive function in the cognitive function of patients with COVID-19 after rehabilitation training, while the medial temporal lobe and parahippocampal cortex are closely related to memory tasks. The above results indicate that the improvement of cognitive function of patients with COVID-19 after rehabilitation training *via* aerobic dance may be due to the fact that there are many activities of memory, thinking and execution in aerobic dance training, which promote the enhancement of cortical activity level related to resting state cognition, and may also be a manifestation of brain function remodeling.

The intensity and frequency of aerobic dance play a key role in the effect of cognitive improvement, requiring long-term persistence and ensuring the intensity and frequency of training. Second, the patient's processing speed (P300 latency) tends to gradually extend with the passage of time, and aerobic dance intervention helps shorten the P300 latency, suggesting that patients can delay the decline of their cognitive function through early aerobic dance intervention.

Although the intervention effect of dance on rehabilitation training and cognition after COVID-19 has been confirmed by literature there is no clear report on whether the intervention can produce changes in brain function. The innovation of this study is to use resting-state functional Magnetic Resonance Imaging (rsfMRI) to creatively study the effect of aerobic dance intervention on the local cortical activity level of rsfMRI in patients with COVID-19 after rehabilitation training. It was also found that after the intervention of aerobic dance, the level of extensive brain spontaneous activity in bilateral frontotemporal

lobes, entorhinal cortex, anterior cingulate gyrus and parahippocampal cortex increased, which was synchronized with the improvement of patients' clinical cognitive scale, providing a functional imaging basis for the clinical application of aerobic dance in the rehabilitation training of patients after COVID-19.

Conflict of Interest

The Author declares that he has no conflict of interests.

Ethics Approval

The protocol of this study was approved by the Ethics Committee of our hospital and the clinical research was registered in China Clinical Trial Registration Center (registration number: ChiCTR-INR-15007420).

Informed Consent

All patients provided a written informed consent before being enrolled in the study.

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