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Rhythmic auditory stimulation with visual stimuli on motor and balance function of patients with Parkinson's disease

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Abstract. – OBJECTIVE: Discuss the effect of rhythmic auditory stimulation with visual stimuli on motor and balance function in patients with Parkinson's disease (PD).

PATIENTS AND METHODS: One hundred and sixteen patients with PD participated in this study. The control group used a routine drug treatment for eight weeks. The comprehensive treatment group used conventional drug treatment with sound rhythm metronome released as the rhythmical auditory stimulation, in accordance with the ground fixed ribbon rhythmic visual stimulation walking training for eight weeks. After four and eight weeks, the two groups of subjects took the walking parameters test, and used the disease Parkinson score scale to assess the damaged degree of motor function of PD patients. The Berg Balance Scale was used to evaluate the balance function of the PD patients. A six minute walk test was used to evaluate the walking motor function of the patients.

RESULTS: The comparison between the groups suggests that after treatment of rhythmic auditory stimulation with visual stimulation group, the step size increased, frequency decreased, pace increased, and PD score scale part II decreased. As well, the PD score scale part III reduced, the six minute walking distance increased, and the Berg Balance Scale score increased significantly. There were significant differences compared with the control group after the treatment ($p < 0.01$). Comparison of time points suggests that after rhythmic auditory stimulation with visual stimulation group trained for eight weeks, the step size increased, frequency decreased, pace increased, and PD score scale part II were reduced. As well the PD score scale part III reduced, six minute walking distance increased, Berg Balance Scale increased. There were significant differences compared with the parameters of training for four weeks ($p < 0.01$).

CONCLUSIONS: Rhythmic auditory stimulation with visual stimulation can improve motor and balance function of patients with PD.

Key Words:
Rhythmic auditory stimulation, Rhythm of visual stimulation, PD.

Introduction

Parkinson's disease (PD) is the most common elderly degenerative disease of the central nervous system. It is usually manifested by tremors, muscle rigidity, bradykinesia and postural and gait abnormalities. The abnormal gait and posture is one of the main reasons that cause motor dysfunction in patients with PD. Posture and gait abnormalities in the kinematic characteristics can be gait performance instability, increased frequency, decreased stride, reduced speed, freezing of gait and so on[1]. Drugs commonly used in the clinical treatment of gait disorder in Parkinson disease are dopamine precursor (levodopa) and dopamine receptor agonists[2]. The drug treatment makes a contribution to a part of Parkinson disease patients to control gait disturbance, improve gait flexibility and quality of life. However, only these drugs are effective to the gait disturbance and postural instability. With the passage of time, these drugs become diminished efficacy because of the switching phenomena, side effects of the drugs also affect the treatment effect of patients, most of patients with Parkinson disease (PD) are still abnormal gait and posture. It affects independent activity and safety of patients with Parkinson's disease; thus, affects the quality of life in patients with Parkinson's disease. Therefore, solving the impairments in motor dysfunction and balance has very important clinical significance. It is necessary to learn the use of rehabilitation measures and to help maintain including

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gait, body movement function and balance function in this patients. The stimulation is an important part of rehabilitation strategy, which means using time or space to adjust the stimulus. The stimulation training is realized by the form of auditory stimulation or visual stimulation. The stimulation training can directly and better effect on pedestrian gait by training the human gait and the external stimulation of coordinated, to change the body movement function and balance function. The conclusion of the research on the effect of rhythm of visual stimulation and rhythm of the auditory stimulation on the gait of Parkinson disease patients is also inconsistent[3,4]. At present, the anti-PD treatments cannot solve the problem of abnormal gait and posture. Currently, there is no study that reports about the effect of the rhythm of visual stimuli and rhythmic auditory stimulation on gait in PD patients in China. The research concludes that the effect of the rhythm of visual stimuli and rhythmic auditory stimulation on the gait of PD patients in foreign countries is also not consistent[5]. The research takes measures the metronome release rhythm sound as a rhythmic auditory stimulation, and walking according to the ground fixed ribbon rhythmic visual stimulation, the effects of rhythmic visual stimulation and rhythmic auditory stimulation on motor function and balance function on PD patients. Patients with PD were observed after eight weeks of training.

Patients and Methods

Patients

One hundred and sixteen patients with PD were selected from January 2011 to December 2014, for treatment in the neurological department of internal medicine in Xiangyang Hospital, China. The condition of entering the group: (1) According to the Queen Square Brain Bank standard[6], clinical diagnosis of PD; (2) The mini mental state examination scale screening without cognitive impairment, can cooperate with this study. After taking the conventional anti-PD drugs, they can walk alone. Exclude any other disease affecting the nervous system of gait, heart and lung disease and bone, joint system disease, those patients with vision or hearing impairment. All were approved by the hospital Ethics Committee. All subjects participating in this study signed an informed consent.

The research objects were divided into two groups according to the method of random digits table. The control group had patients with PD, who received conventional drug treatment. The comprehensive training group received conventional drug treatment with rhythmic visual stimulation training and rhythmic auditory stimulation training.

Methods

In this study, the control group of PD patients was treated with conventional anti-PD drugs therapy (madopar, piribedil sustained-release tablets, pramipexole, and entacapone). According to the patients' condition, the dose was adjusted to four weeks for a course of treatment. Madopar equivalent dose has been calculated as follows: Madopar equivalent dose = total dose of benserazide tablets/day × 1 + Carbidopa and levodopa CR Tablets total dose/day × 0.75 + amantadine total dose/day × 1 + Piribedil Sustained-release tablets total dose/day × 10 + pramipexole total dose/day × 100. If patients used entacapone tablets, Madopar equivalent measurement corresponded to a total dose of levodopa and benserazide tablet/day × 1 + carbidopa and levodopa CR Tablets total dose/day × 0.75[7].

Comprehensive treatment group on the basis of drug therapy took rhythmic auditory stimulation combined with visual stimulation treatment. When starting treatment, the patients' daily walking speed was determined, and the beat box software according to the patient's basic walking speed was used. The issued rhythm consistent as the primary walking speed and as the rhythmic auditory stimulation signal was used. Participants were asked to walk on the beat of the rhythm of the software. While determining the object step, similar sidewalk fixing ribbon has been used. The ribbon spacing was the step of the study object, with the ribbon being at 20 cm long and 3 cm wide[8]. Participants were asked to place their feet on the ribbon when walking. After the training, the walking speed of the research object as the basis for the next treatment has been measured[9]. Then, the patient's step was measured as the basic step for the next treatment. Train for 30 min/times, one time/d, 5 d/ week, four weeks for a course of treatment.

The Evaluation of Curative Effect

After taking anti-PD drugs, we conducted an evaluation of curative effect on patients. Patients with hypokinesis symptoms significantly im-

Table I. Comparative study on the general situation of the objects of the two group

Group	Cases	Gender (cases) Male: Female	Age (years old)	Course of disease (years)	MMSE score	Hoehn-Yahr classification	Madopar equivalent dose (mg)
Control group	56	29 27	66.1 ± 7.9	6.7 ± 3.1	28.4 ± 1.7	2.8 ± 0.4	628.2 ± 230.6
The comprehensive training group	56	30 26	65.7 ± 8.1	6.9 ± 2.9	28.5 ± 1.9	2.9 ± 0.5	634.8 ± 224.4

proved in the "open" period. One to two hours after taking the drugs, the PD subjects accepted the assessment of cognition and motor function to ensure that it was in the "open period". When starting training, monitor the spatial gait parameters of the two groups of subjects, including the stepping pace, stride frequency, etc.[10]. While starting training, after training for four to eight weeks, the two groups of subjects all used unified PD rating scale, the UPDRS[11]. The part II and part III score assessment of damaged degree of motor function of PD patients with Parkinson disease were assessed using, use the Berg Balance Scale (BBS)[12] for evaluation of the patients' balance function. Six minute walking tests (6 min wT)[13] walking distance was used to evaluate the walking motion function.

Statistical Analysis

The statistical analysis was conducted using the SPSS 19 statistical software (SPSS Inc., Chicago, IL, USA). The data was represented by mean standard deviation ($\bar{x} \pm s$), and the variance of repeated measurement was used for statistical analysis. $p < 0.05$ was considered as statistical significant.

Results

Comparative Study on the General Situation of the Object

During the study, there were two cases missed in the two groups. The difference when comparing the gender, age, course of the disease, MMSE score, PD Hoehn-Yahr classification of the two groups of patients were not statistically significant ($p > 0.05$). The madopar equivalent dose comparison of the two groups had no statistical difference ($p > 0.05$), suggesting that the effects of the drug had no significant with comparability (Table I).

Rhythmic auditory stimulation with visual stimulation, the change of the step frequency, step, pace, UPDRS part II score, UPDRS part III score, 6 min wT and score of BBS is shown in Figure 1. The variance analysis of repeated measurements design showed that in the main effect of the group inspection, the F values of cadence, step, pace, UPDRS part II score, UPDRS part III score, 6 min wT, score of BBS were 821.080, 501.991, 171.580, 22.147, 94.989, 3242.764, 542.646. The p value was 0.000, showing that there is a significant difference between the groups. There was a significant difference between the control group and rhythmic auditory stimulation with visual stimulation group. The F values of the time were 407.172, 186.826, 95.689, 61.444, 59.375, 941.582, 137.708. The p value was 0.000, indicating that there were significant data differences among each time point. The time × the F values of groups were 405.777, 340.622, 110.457, 20.689, 40.866, 1081.266, 103.178. Then, p value was 0.000 illustrating the interaction of time and the groups, explaining that the time factor effect was different with the different grouping. The two group comparison for each time point of the test results of the main effect (i.e., compare data from the control group and rhythmic auditory stimulation with visual stimulation group when starting training, whose results suggested that when starting training the p values > 0.05 indicate that the comparison was not statistically significant between the two groups. After training for four to eight weeks, the p value was < 0.05, indicating that the comparison was statistically significant between the two groups.

Discussion

Most PD patients have abnormal gait, light ones reflect difficulties in walking stride with drag gait when starting, and that increases with

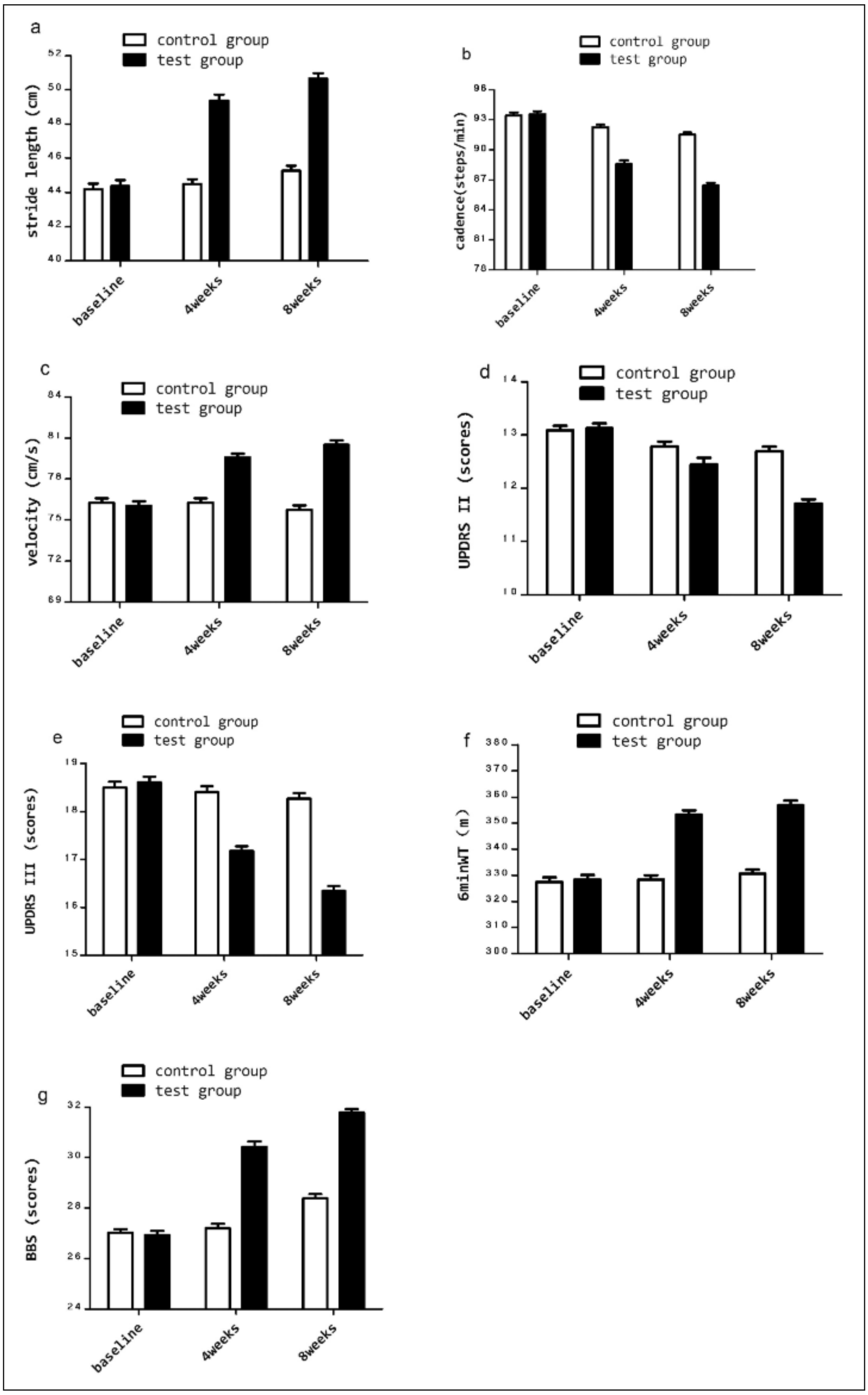

Figure 1. Before and after rhythmic auditory stimulation with visual stimulation, the change of stride length, cadence, velocity, UPDRS part II score, UPDRS part III score, 6 min wT and score of BBS.

continued walking[14-16]. Some patients showed a small, shuffling steps, walking head and trunk forward cannot control, lower extremity hip, knee, and ankle joint flexion movement decrease, making the stride length reduced, easy to fall. It is difficult to stop immediately and turn. With the aggravation of the illness, walking stride gradually shortens, and eventually patients lose the ability to walk. Gait disorder of patients with PD is one of the reasons leading to the decline in functional ability of patients that has important clinical significance.

Comparison between the groups suggests that after treatment of rhythmic auditory stimulation with visual stimulation group, the step size increased, frequency decreased, the pace increased, UPDRS part II decreased, UPDRS part III reduced, 6 minute walking distance increased, and BBS score increased significantly. There were significant differences compared with the control group after treatment ($p < 0.01$), indicating that rhythmic auditory stimulation with visual stimulation treatment group improved ambulation function and balance function in PD patients than simple drug treatment. Comparison of time points suggests that after rhythmic auditory stimulation with visual stimulation group trained for eight weeks, the step size increased, frequency decreased, the pace increased, UPDRS part II reduced, UPDRS part III reduced, 6 minute walking distance increased, and the BBS increased. There, and there were significant differences compared with the training parameters of training for four weeks ($p < 0.01$). This means that eight weeks of training improves the ambulation and balance function of patients with PD better than over four weeks of training, and the quality of life improves than before treatment.

Rhythmic auditory stimulation has been demonstrated by a series of questionnaires and clinical studies to increase the pace[17]. This form of implied stimulation is a new rehabilitation strategy for PD. The use of strategies such as music, counter or a metronome beat as rhythmic rhythmical auditory stimulation. The applied metronome beat of rehabilitation training matches the foundation frequency of PD patients, and then increases or decreases the frequency, and then try to determine an optimal frequency to improve gait. In randomized controlled trials of PD rhythmic auditory stimuli, the iPod music player of some scholars tested provides a metronome beat as suggest stimulation. Their results showed that when hinted stimulus frequency was 10% lower than basic frequency of patients with Parkinson disease, gait in patients with PD was improved[18]. In addition, some scholars research to determine that the frequency of rehabilitation training PD patients matches the speed 10% faster than baseline. This rhythmic auditory stimulation also significantly improves cadence, stride and pace of PD patients[19]. The rhythm of visual stimuli has also been found that can help improve the gait of patients with Parkinson disease[20-22]. These rhythmic visual stimuli include the use of laser pointer, adaptive glasses or the tag line on the floor. Rhythmic visual stimulation of equal stride marker is an example. Along the walking direction the corresponding interval distance, vertically place a marker. Some scholars have proven that through the use of visual stimulation glasses at least 10% walking hours can be reduced[23]. And the results of some study indicate that patients with PD by the rhythmic visual stimulation training can enhance the stride[24]. In this study, the rhythm of visual stimulation intervenes and affects pedestrian activities, that performance is the improvement of cadence, stride length and walking speed of patients. Rhythmic visual stimulation combined with auditory stimulation can promote the combined effects of the movement and balance function improvement of PD patients.

The reasons why rhythmic auditory stimulation with visual stimulation therapy can improve the walking function may include the following aspects. (1) There is a tendency of resonance of biology between two things. Rhythmic auditory stimulation uses a close walk natural frequency issue to suggest stimulation; patients can take the resonant effect to improve abnormal walking rhythm[25,26]. (2) The Contact between the occurrence of freezing of gait, frontal lobe dysfunction, frontal lobe and basal interrupts. Therefore, the interruption between the frontal lobe dysfunction or frontal lobe and basal ganglia, can be compensated by certain stimulate reflection, which leads to the improvement of freezing gait[27-29]. (3) Exogenous rhythm suggestive stimulus especially the cues stimulation of the beat of the music can relieve the patient's mental stress to a certain extent, and thus more easily finish walking[24,29].

Conclusions

Our results show that rhythmic auditory stimulation with visual stimulation can improve gait function of patients with PD and promote motor function and balance function of patients with PD.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

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