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Evaluation of the Efficacy of the Quadruple-Limb Linkage Trainer Combined with Rehabilitation Training in Patients with Parkinson's Disease

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Abstract: *Objective*: This paper is an in-depth research that explores the effect of limb linkage training instruments combined with rehabilitation training on the treatment of Parkinson's disease patients. *Methods*: 92 cases of Parkinson's disease patients were randomly selected for analysis and research in the hospital from January 2023 to December 2023. 46 cases of the implementation of rehabilitation training intervention were named as the control group, and 46 cases of the implementation of the quadruple-limb linkage trainer combined with rehabilitation training intervention were named as the research group. The patients in the two groups were evaluated for their balance function, gait, quality of life, and get-up-and-walk time, respectively, after implementing the two different modes of intervention. *Results*: Balance function, gait, and quality of life were significantly improved in both groups, and the degree of improvement was significantly higher in the study group than in the control group. The get-up-and-walk time was shortened in both groups, and it was shorter in the study group ($P < 0.05$), which is of research value. *Conclusion*: Through the effective intervention of a limb linkage trainer combined with rehabilitation training, the method can effectively enhance the balance function and walking ability, and then significantly improve the quality of life of Parkinson's disease patients, so it is worth using.

Keywords: Parkinson's disease; Quality of life; Limb linkage trainer

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1. Introduction

Parkinson's disease is a kind of motor system disease, and its typical symptoms include tremors and bradykinesia, which cause serious damage to the patient's ability to take care of themselves, and then have a very negative impact on their overall quality of life. Therefore, the implementation of scientific and effective rehabilitation training for patients is indispensable [1]. Traditional rehabilitation training is mainly through muscle strength and balance training interventions. However, some patients show obvious passivity when participating in rehabilitation training, and their awareness of active training is relatively weak, which undoubtedly affects the realization of the overall training effect to a certain extent [2–3]. The limb linkage trainer

is a highly effective medical aid designed to help patients correct poor body posture and simultaneously improve the coordination and balance of all parts of the body. Therefore, to have a comprehensive understanding of the effects of the combination of rehabilitation training and the quadruple-limb linkage trainer on the rehabilitation process of patients with Parkinson's disease, it was decided to include 92 patients with Parkinson's disease as a research sample in this study. The obtained research results are reported as follows.

2. Data and methods

2.1. General information

For this study, 92 cases of Parkinson's disease patients in the hospital were randomly selected to be analyzed and studied from January 2023 to December 2023. Among the 92 patients, there were 50 males and 42 females, and the duration of the patient's disease was 3–8 years, with an average of 5.22 ± 1.34 years. All 92 patients were divided into two groups, 46 cases implementing rehabilitation training intervention named control group, and 46 cases implementing limb linkage trainer combined with rehabilitation training intervention named research group, age 56–74 years old, mean 65.72 ± 2.16 years old; after implementing two different intervention modes for two groups of patients respectively, age 55–75 years old, mean 65.54 ± 2.71 years old. The study data shows no significant difference at the start of the study ($P > 0.05$).

2.2. Methods

46 new-onset schizophrenia patients in the control group received rehabilitation training intervention, and patients in the research group were intervened with the limb linkage trainer (Xiangyu Medical: XY-SZLD-IA). Both groups were intervened for 8 weeks. Details are as follows.

Rehabilitation training: For muscle strength training, sandbags or self-weighted resistance were used for training, including calf raising and extending, knee extension, deep squatting, and so on, and each training action should be repeated 15–20 times, with moderate intensity, subject to the feeling of fatigue. The patients would rest for 3 minutes after each training, a total duration of 45 minutes, once a day [4–5]. For balance training, sitting or standing center of gravity transfer training, such as tilting forward and backward, left and right, to enhance the center of gravity perception and control. Patients need to separate their feet by a certain distance and perform center-of-gravity shift training to maintain balance. Each training session lasts 15 minutes, twice a day [6]. For gait training, the body should be kept upright when standing, and the eyes should be looking forward. When starting, make sure the heel touches the ground first, followed by the toe. In the process of walking, raise the toes appropriately and slow down the speed of stride. At the same time, the arms should swing back and forth naturally. Train for 20 minutes, 3 times a day [7–8]. For lower limb training, stand with feet apart, the left hand gently holds the wall to maintain stability, while the right hand holds the right heel and slowly stretches backward, maintaining 5–10 seconds, alternately training the lower limbs. Each time 25 minutes, 2 times a day.

Limb linkage trainer: Before the training starts, carefully adjust the angle of the seat, the front and back position, and the distance of the handles to ensure that the patient's limbs and trunk are in a relaxed state. During the training process, make sure that the patient maintains a correct upright posture, with both eyes looking forward, while requiring the patient's waist and back to maintain a moderate distance from the backrest. By actively moving the healthy upper and lower limbs, effectively induce and guide the upper and lower limbs of the affected side to perform the corresponding extension and flexion movements. After the muscle strength of the affected side of the patient is gradually recovered to a certain degree, the patient can be instructed to actively utilize the affected side to perform active movements, and at the same time cooperate with the healthy side of

the movement, and gradually increase the range of motion of the hip, knee, and ankle joints, to improve the strength of the lower limb muscles. During the training period, the training intensity will be adjusted according to the actual condition of the patient. The training is 35 minutes per day, and it is adhered to 6 days per week [9–10].

2.3. Observation indicators

The PDQ-39 questionnaire was used to assess the quality of life of the two groups of patients before and after the intervention, covering several dimensions such as the state of sports emotion, shame, and so on. The score is inversely proportional to the quality of life. The balance function of the two groups of patients before and after the intervention was assessed using the Berg Balance Scale, covering standing, supporting, turning, moving, and so on. The higher the score, the better the balance function. The get-up-and-walk test was used to assess the walking ability of the two groups of patients before and after the intervention, and the time from getting up and walking to touching the backrest again was recorded. The gait analysis system was used to measure and assess the gait condition of the two groups of patients before and after the intervention, covering step frequency, step length, step speed, and so on. The results of the assessment were analyzed comparatively, and presented in the form of tables. The results were compared, analyzed, and presented in table form.

2.4. Statistics and methods

All research data were analyzed by the SPSS 23.0 system. The count data were expressed by (Mean ± SD, %), and the differences between the two groups were compared by t and x^2 tests. If $P < 0.05$, it indicates that the experiment has significant value.

3. Results

3.1. Comparison of the quality of life before and after the intervention of the two groups

The result analysis showed that the quality of life of patients in the research group is better than that of the control group, and its effect is better, with $P < 0.05$, see **Table 1**.

Table 1. Comparison of PDQ-39 scores between the two groups of patients (Mean ± SD)

Group	Number of cases	Pre-intervention	Post-intervention
Control subjects	46	73.23 ± 3.43	49.42 ± 2.71
Research group	46	72.87 ± 3.23	42.03 ± 2.35
P-value		$P > 0.05$	$P < 0.05$

3.2. Comparison of balance function and get-up-and-go time before and after intervention in the two groups

After analyzing the results, it showed that the balance function of the patients in the research group was better than that of the control group, the get-up-and-walk time was shorter than that of the control group, and its effect was better, with $P < 0.05$ (**Table 2**).

Table 2. Comparison of BBS score and get-up-and-walk time between the two groups of patients (Mean ± SD)

Group	Number of cases	BBS rating		Getting up-walking time	
		Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Control subjects	46	20.45 ± 2.69	33.98 ± 3.12	23.73 ± 2.51	20.32 ± 1.71
Research group	46	20.34 ± 2.73	40.26 ± 3.73	23.67 ± 2.53	17.37 ± 1.35
P-value		$P > 0.05$	$P < 0.05$	$P > 0.05$	$P < 0.05$

3.3. Comparison of gait before and after intervention in two groups

The result analysis showed that the step frequency, step speed, and step length of the patients in the research group were higher than those in the control group, and their effects were better, with $P < 0.05$ (**Table 3**).

Table 3. Comparison of gait frequency, gait speed, and gait length between the two groups of patients (Mean ± SD)

Group	Number of cases	Step frequency (step-min^{-1})		Step speed (cm-s^{-1})		Step length/cm	
		Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Control subjects	46	88.32 ± 4.43	93.23 ± 5.11	60.32 ± 3.78	64.98 ± 3.99	26.32 ± 3.01	29.98 ± 4.17
Research group	46	88.23 ± 4.45	97.02 ± 5.34	60.36 ± 3.87	70.23 ± 4.12	26.39 ± 3.12	35.09 ± 4.25
P-value		$P > 0.05$	$P < 0.05$	$P > 0.05$	$P < 0.05$	$P > 0.05$	$P < 0.05$

4. Discussion

Parkinson's disease is a neurodegenerative disease, that will lead to symptoms such as muscle ankylosis and balance and posture disorders, and these symptoms will have a serious adverse effect on the daily life and mobility of patients. Currently, clinical intervention and relief are mainly provided through traditional rehabilitation training methods, such as muscle strength training and balance training. However, due to a variety of factors, the training effect of some patients fails to achieve the expected ideal state [11–12]. Therefore, more effective treatment methods must be sought to improve the quality of life of patients with Parkinson's disease. The limb linkage trainer can effectively strengthen the synergistic function of the limbs and improve motor function and has been widely used in many clinical fields and achieved remarkable results [13].

Through the movement of the healthy side of the limb, the limb of the affected side is driven to carry out joint training. This synergistic training method not only helps to enhance muscle tone and strength but also improves the coordination and motor ability of the patient's limbs. When the patient's feet are placed on the pedal of the trainer, the diversified sensory information such as touch and pressure transmitted by the plantar skin can effectively relieve the spasm of the affected muscles and further improve the motor function of the affected limb. At the same time, the combination of muscle strength, balance training, and other rehabilitation training measures can accurately stimulate the patient's sensory system, thereby strengthening muscle strength and improving balance and coordination. The four-limb linkage trainer utilizes advanced scientific principles, and through the healthy side of the upper and lower limbs to drive the affected side of the movement, which helps to improve the synergistic control of the multi-group muscle groups and joints. This training method can effectively improve the patient's trunk control ability and help him or her successfully complete the standard

gait cycle. Through continuous training, the patient's walking ability will be significantly improved. After the systematic training of the limb linkage trainer, the patient's trunk stability has been significantly improved, and at the same time, his lumbar and back muscle strength has been strengthened accordingly. This enables the patients to complete basic movements such as transferring and walking more smoothly, and then improve their quality of life. At the same time, key walking movements such as lower limb stirrups and upper limb flexion and extension are successfully simulated during the training process, which in turn gradually strengthens the walking function of the patients, effectively prolonging the time they spend from sitting up to standing up and then to walking [14].

In summary, for Parkinson's disease patients, the intervention mode of combining the limb linkage trainer and rehabilitation training demonstrated significant clinical application effects. This model not only significantly improves the balance and walking ability of the patients but also comprehensively improves the overall quality of life of the patients, which is worthy of clinical promotion and application.

Disclosure statement

The authors declare no conflict of interest.

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