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Impacts of a lower limb exoskeleton robot on anxious stroke patients

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Abstract. To explore the intervention effect of exoskeleton robot training on anxiety of stroke patients. Methods 24 stroke patients with hemiplegia were randomly divided into experimental group and control group, with 12 cases in each group. Moreover, the robot group took the walking training with UGO 210, a lower limb exoskeleton walking rehabilitation, once per day, 30 minutes per time, a total of 20 times of treatment. Before the trial and at the end of the trial cycle, patients' emotions were assessed using the Self-rating Anxiety scale (SAS), and the efficacy of the two groups was compared. Results: The scores of anxiety scale decreased in both groups ($P < 0.05$), and there was no difference between the two groups ($P < 0.05$). Conclusion: The use of exoskeleton robot can improve the anxiety of stroke patients, but there is no difference compared with the conventional walking training.

1 Introduction

Clinically, stroke is one of the most common cardio-cerebrovascular diseases, with 65/10 of mortality, and 70% of survival patients have different degrees of dyskinesia[1]. A period of time after onset, stroke patients may associated with psychological emotions, such as fear, dependence, and anxiety. Under the pressure of both body and mind, the effect of rehabilitation and the quality of life would be reduced[2,3]. On the one hand, we should do well in terms of patients' physical care and psychological guidance, and pay attention to the early rehabilitation training. With the change of rehabilitation process, the improvement of motor function can help patients rebuild their self-confidence.

Exercise therapy is the main rehabilitation method for them [4]. By squeezing joints, the epidermal receptors and deep tendons are stimulated, and brain cells are stimulated in a benign way, so as to promote the recovery of brain function [5]. Early rehabilitation training is preformed to prepare for later gait training, and most patients still regard the recovery of walking as an important goal of rehabilitation after developing stroke. However, hemiplegia patients often need more accurate and appropriate training urgently, manpower or traditional equipment fail to meet it. At present, the intervention of some auxiliary rehabilitation devices are used clinically, which cannot prevent or correct the abnormal gait of patients, and may miss the best period of walking training for patients. In recent years, as a new high technology, exoskeleton rehabilitation robot has mainly been used in the field of spinal cord injury [6]. It also has the following advantages: providing certain protection for patients to complete the normal activities, having reliable and accurate number measurement, assisting the patients with dyskinesia when performing training [7], reestablishing the flat walking mode, and improving the psychological state after injury. When hemiplegic patients walk with exoskeleton robot, the regular repetitive activities of hip, knee and ankle joints of lower limbs can make muscle and connective tissue contract adaptively, thus reducing muscle tension [8], forming a correct walking mode [9], and indirectly preventing abnormal gait that is caused by the damage of central nervous system. According to the remarkably evidence, based on the principles of motor learning, a high number of task-oriented [10] and repetitive movements can improve muscular strength, and the co-ordination of movement for neurological patients.

We searched the research reports on the application of exoskeleton products that can assist the walking training of hemiplegic patients. Most of the data confirmed that there existed a certain rehabilitation effect in the acute and subacute stages of hemiplegia [11], with clinical implications for the improvement of gait and balance function, as well as the recovery of lower limb motor function in stroke patients. But there was still a lack of sufficient randomized controlled trials, and the conclusion still needs to be studied[12]. Similarly, the domestic literature on the impact of non-weight reducing exoskeleton robot training for hemiplegic patients was retrieved, and the number of articles was temporary [13]. The experimental results revealed that short-term lower

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limb exoskeleton robot training can obviously improve the walking ability of hemiplegic patients during their early stage of stroke. In addition, the wearable exoskeleton robot walking on the real road is different from the fixed training robot. It can simulate a real walking environment and touch the ground feeling, so it can stimulate patients to strengthen their own motion control and make the exoskeleton a good rehabilitation tool [14]. This training method can improve patients' self-confidence, stimulate their interest in rehabilitation training, and rich environmental stimulation can enhance better remodeling of cerebral cortex.

But at present, there are few direct researches on the influence of exoskeleton on hemiplegic patients with emotional problems. In this paper, the intervention effect of exoskeleton robot training on stroke patients with anxiety problem was explored.

2 General data

From October 2018 to January 2019, 24 patients with stroke hemiplegia and lower limb motor dysfunction were admitted to the Heilongjiang General Hospital of Agricultural Reclamation. After screening, the patients were randomly divided into two groups with 12 patents in each group, as shown in Table 1. The general data were comparable betw 域 een the two groups with no significant difference, as shown in Table 2. This study was approved by the medical ethics committee of the General Hospital of the State Bureau of Agricultural Reclamation.

3 Inclusion criteria and exclusion criteria

Inclusion criteria: All of them met the diagnostic criteria for stroke established by the 4th National Conference on Cerebrovascular Diseases [15]. The course of disease is 0 to 6 months. After treatment, the vital signs were stable, the condition was stable or improved. The patient was conscious and could follow the instructions, and cooperated well during treatment. Exclusion criteria:. Patients with other neuromuscular and osteoarticular diseases affecting walking ability, combined with severe primary diseases such as cardiovascular, lung, liver, kidney, hematopoietic system and serious cognitive, hearing and vision disorders, who were participating in other clinical studies or were unwilling to participate in the study were excluded.

4 Methods

Both groups took basic rehabilitation training, including trunk control training, hip and knee joint control training, ankle dorsiflexion induction training ， once a day. On this basis, the two groups were given different types of walking training. The patients in the control group were given a 30 minutes routine walking training every day, including balance bar walking training, single leg weight-bearing training, up and down stairs training, etc. The patients in the experimental group were given a 30 minutes walking training every day with UGO 210, a lower limb exoskeleton developed by the Hangzhou RoboCT Technology Development Co., Ltd. Fig.1 shows the patient in experimental group rehabilitation walking training with UGO 210. The patient could be allowed to deviate from the treatment for less than or equal to 2 times during continuous 20 times of training (except Sunday).

Fig1. The patient is training with UGO 210

Table1. Comparison of demographic data between two groups.

Analysis of the group				Population Division	
Groupings	Enroll	Finish	Drop off	FAS	PPS
Robot group	12	12	0	12	12
Control group	12	11	1	12	11
Aggregation	24	23	1	24	23

Table2. Comparison of self-assessment baseline of anxiety.

Stage	Robot group	Control group	Cases	P value
N(Missing)	12	12		
Mean	20.58	21.08		
SD	3.20	6.02		
Min～Max	16.00～25.00	13.00～34.00	0.38(Z value)	0.7061
Median	20.50	20.50		
Shapiro-Wilk(P value)	0.89 (0.1088)	0.88 (0.0892)		

5 Evaluation Method

Each patient was assessed by the same therapist before the start of the trial and at the end of the whole trial cycle. The emotion of the patients was assessed by SAS.

6 Statistical analysis

SAS 9.2 was used for statistical analysis, and comparisons were made between the two groups at each follow-up point. The data were checked for the existence of a normal distribution before the comparative analysis, and comparisons were made before and after training using the independent samples t-test or Mann-Whitney U-test, and within-group comparisons were made using the paired t-test or Wilcoxon rank sum test. The difference was statistically significant ($P < 0.05$).

7 Conclusion

At the beginning of the trial, 12 patients were included in each group, but 1 patient dropped out in the control group at the late stage of treatment. The data of patients with shedding in the control group were analyzed by intentional analysis, that is, the results of the first assessment were used as the results of the last assessment. The two groups of patients before and after treatment anxiety self-scores were tested into a positive distribution, followed by independent samples t-test, p value> 0.05, no statistical difference, see Table 3.

Paired t-test was applied to compare within groups before and after the treatment. Both p values were＜0.05, with statistical difference. The level of anxiety for patients in the two groups decreased after the treatment. The t-test of independent sample was adopted for the comparison between the groups before and after treatment. P values were > 0.05, with no statistical difference, as shown in Table 4.

Table3. Comparison of demographic data between two groups.

Admission to the group			Population Division		
Grouping	Cases	Complete	missing	FAS	PPS
Robot group	12	12	0	12	12
Control group	12	11	1	12	11

Table4. Paired test of rating results before and after treatment and comparison of differences between the two groups.

Comparison before and after treatment in group				Comparison before and after treatment between groups	
Grouping	Cases	Statistic(S)	p value	Cases (Z)	p value
Robot group	12	-27.5	0.0020	0.81	0.4191
Control group	11	-14.5	0.0469		

8 Discuss

In the process of stroke rehabilitation, patients will gradually develop anxiety due to a combination of factors, such as the condition and the environment, and the most common ones are anxiety (PSA), depression (PSD), and post-stroke comorbid anxiety and depression (PSCAD) [16], and these mood disorders often affect the progress of recovery and the quality of life of patients. As a common psychological problem that most patients will encounter, health care professionals and family members can promote the formation of healthy behaviors through effective nursing interventions after discovering abnormalities [17], or use psychological guidance, group communication, and corrective behavior [18] to achieve the purpose of mitigating the impact of negative emotions. While exercise rehabilitation and psychological intervention are complementary relationships [19], patients will be rehabilitated in a more positive frame of mind after making some progress in physical exercise [20]. In this study, the differences in the condition and age of the two groups of patients were small, and after four weeks of training, the anxiety scale scores of both groups decreased compared to the enrollment, indicating that exercise rehabilitation is able to improve the psychological state of the patients; perhaps due to the small sample size of the trial, the patient participation did not reach the expected effect, so statistically comparing the effect of the application of the two groups shows that there is no difference in the improvement of patients' anxiety .

The two groups in this study, in addition to different gait training programs, both also performed basic motor rehabilitation at the same time. With reference to most of the literature [21], exoskeletal robotic training is more of an adjunct than a substitute in stroke rehabilitation. Basic rehabilitation is designed to help patients improve mobility and endurance in all joints before going down so that better rehabilitation results can be achieved when practicing walking. In the experiment conducted by Rustem mustafaoglu et al. [22], the patients were randomly divided into three groups. They received routine rehabilitation training and robot assisted training (RAGT), conventional rehabilitation training and robot assisted training respectively. The results gave information that combined training could improve the activities of life (ADLs) and quality of life (QoL) of patients, compared with the other two groups. In an experiment that was carried out to explore the effect of RAGT on balance and lower limb function of survivors of off infratentorial stroke [23], it was clear that RAGT could improve standing balance function and lower limb motor function for patients with infratentorial stroke more effectively, compared with routine rehabilitation training in the same period of time.

In addition to ensuring the consistency and continuity of training, exoskeleton robotic training also has the visualization function of background training records to help therapists evaluate patients, which is a promising new rehabilitation method with a wide range of applications. For example, there have been some studies that used exoskeleton and virtual reality to intervene in patients' rehabilitation training [24], which showed that the exoskeleton can improve motor skills in upper limb functional retraining, but its effectiveness in gait training needs sufficient evidence. Other institutions have integrated exoskeletal devices with functional electrical stimulation [25], enabling them to leverage the advantages of both rehabilitation techniques and provide more treatment options for clinical patients. With the advances in exoskeleton technology, it is possible that exoskeleton robotic therapy will become the standard treatment for stroke rehabilitation in the future [26], which could greatly reduce the shortage of rehabilitation therapists, break the traditional one-to-one model, and improve the efficiency of rehabilitation for hemiplegic patients.

The rehabilitation of stroke patients is a multifaceted and continuous treatment process, and intervention methods need to be adjusted according to the different physical and psychological conditions of each patient. At the same time, the patient's family should also actively cooperate with the therapist to create a relaxed and pleasant rehabilitation environment, reduce psychological stress and increase confidence. However, how to optimally apply exoskeletal robotic training changes needs further in-depth discussion.

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