



# Effect of Yoga Exercise on Cognitive Ability and Motor Function Recovery in Stroke Patients

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## ABSTRACT

Exercise therapy is widely used in the rehabilitation of stroke patients. Yoga exercise therapy is the typical one, but its specific effect and mechanism of action have not yet been clearly explained. In this context, 58 cases of stroke patients were randomly divided into experimental group and control group. Then, the effect of yoga exercise on the recovery of cognitive ability and motor function of stroke patients was explored by means of clinical controlled experiments. Through the monitoring and comparison of cerebral blood oxygen content, brain feedback-related negativity (FRN) and modified Barthel index (MBI) between the two groups of patients, it was found that yoga exercise therapy actually has a significant effect on improving the cognitive ability and motor function of stroke patients. Besides, from the point of view of the specific mechanism, yoga increases the patient's nerve excitability by increasing blood oxygen content in the brain, while the increase in nerve excitability further enhances the patient's ability to reflect, think, and control the body, so as to ultimately improve their cognitive ability and motor function.

**Key Words:** Yoga Exercise Therapy, Cognitive Ability, Motor Function, Blood Oxygen Content

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## Introduction

Stroke is a general term referring to cerebrovascular circulatory disorders, occlusion, or ruptured diseases caused by different reasons. The main symptoms include cerebral hemorrhage, cerebral infarction, and other cognitive and physical dysfunction (Barden *et al.*, 2005). According to the statistical data, stroke has a high incidence in the middle-aged and elderly population; the mortality, disability, and recurrence rate after onset are also high. It can be considered that the impact of radical stroke on the daily life of patients is impossible to be eliminated by any method (Hlustík and Mayer, 2006). After treated in modern methods, the vast majority of stroke patients still face two major problems, namely cognitive dysfunction and motor dysfunction. Therefore, how to effectively

recover the cognitive function and motor function of stroke patients has become one of the important research topics in the field of rehabilitation medicine, and it is also an inevitable choice for patients and their families to extricate themselves from pain and suffering.

Modern rehabilitation medical research believes that the role of exercise rehabilitation therapy is more significant than that of drug rehabilitation, and the rehabilitation effect of stroke patients with exercise therapy is more significant (Kim *et al.*, 2017). After a period of exercise rehabilitation training, the patient's nerve excitability will be improved and the muscle function will be gradually restored (Tokuno and Eng, 2006). In the better case, stroke patients can even recover most of their self-care ability.

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In this background, this paper selected yoga as a starting point for the specific method of exercise rehabilitation. It explored the effects of yoga on the cognitive ability and motor function of stroke patients at the recovery stage, and further studied the intrinsic mechanism of the role of yoga. Finally, the research conclusion fully affirmed the promoting effect of yoga on cognitive function and motor function recovery in stroke patients, providing the theoretical and practical support for the rehabilitation of stroke patients.

### **Yoga exercise and stroke therapy**

Many studies have shown that martial arts, walking, cycling, yoga, and aerobic exercise have positive effects on the recovery and treatment of patients with stroke. E.g., some scholars have stated that a small number of daily and frequent cycling activities can gradually increase the strength and flexibility of the upper and lower extremities of patients with stroke, and greatly benefit the recovery of limb function (Bohannon, 1986; Roth and Diaz, 1995). In addition, the positive effect of Tai Chi (Shadow boxing) on the recovery of stroke patients has also been recognized by many scholars, because the scholars believe that Tai Chi can strengthen the patient's balance after surgery, which is conducive to exercise the brain function of patients and help them to speed up the recovery process (Arai and Miaki, 2013).

Lots of scholars have also focused on the role of yoga in promoting the recovery of patients with stroke. The reasons for the scholars' special attention to yoga lie in: firstly, the role of yoga in balancing body functions and promoting metabolism has been widely recognized (Heidi *et al.*, 2002); secondly, many yoga exercises are not dramatic, and it is suitable for many stroke patients to practice in rehabilitation (Eldar, 2000). In the current researches on yoga, scholars believe that yoga training can effectively improve the patient's ability to balance and also enhance mobility. In addition, many scholars believe that the role of yoga is not simply to improve the balance of power, and continuous training can also effectively restore most of the motor function (Purvin, 1996). Others have studied the effect of yoga on nerve excitability of patients. They found that after a period of yoga, the patient's response to external events was more agile and reflected more strongly (Zorowitz, 2010; Meireles *et al.*, 2015). The above research results show that yoga exercise has positive effects on the rehabilitation

of stroke patients, but its specific effects and mechanisms need to be further explored.

### **Methods**

The first two chapters of this paper preliminarily explain the role of yoga. Based on this, this chapter explores the effects of yoga exercise on the recovery of cognitive function and motor function in patients with stroke, and then interprets its mechanism.

### **Experimental subjects**

58 stroke patients from a general hospital in Guangzhou were taken as the experimental subjects in this study. Considering that yoga requires patients to have certain basic movement ability and all patients can be ensured to successfully complete the experiment, only patients with moderate stroke symptoms were selected during the experiment, excluding those with severe stroke (including patients with paralysis and severe cognitive impairment).

Before starting the specific experiment, the selected patients were randomly and evenly divided into experimental group and control group. For the patients in the experimental group, regular rehabilitation therapy was used together with regular yoga training, while the control group only was treated with conventional rehabilitation therapy. Through the statistical analysis of the basic conditions of the patients in the experimental group and the control group, it's showed that there was no significant difference between these two groups of patients ( $P>0.05$ ), which satisfied the basic conditions of the experiment

### **Evaluation indexes**

The purpose of this paper is to study the effect of yoga on the recovery of cognition and motor function in stroke patients and its mechanism. Therefore, the subjects need to be evaluated in terms of the following indexes:

#### **(1) Blood oxygen content index**

Studies have shown that cerebral blood oxygen content in stroke patients is significantly lower than normal (Winter, 1980). The lower blood oxygen content in the brain inhibits brain excitability, which further affects cognitive ability and normal control of the nervous system on the body. Therefore, whether or not to increase blood oxygen content in the brain of patients is one of



the important criteria for evaluating the therapeutic effect of yoga.

**Table 1.** Comparison of Two Groups

	Experimental Group	Control Group	P-value
Age	62.17±4.15	61.29±2.33	0.237
Stature(cm)	167±3.56	166±2.99	0.098
Weight(kg)	71.23±5.78	72.29±4.38	0.112

**1) Nerve excitability index**

Nerve excitability can indirectly reveal the patient’s cognitive ability. In general, the higher the nerve excitability, the stronger the cognitive ability, and the lower the nerve excitability, the weaker the cognitive ability (Nadeau *et al.*, 1997). In clinical studies, the patient’s nerve excitability can be obtained by testing the magnitude and mean of the beta waves  $\beta$  in the brain.

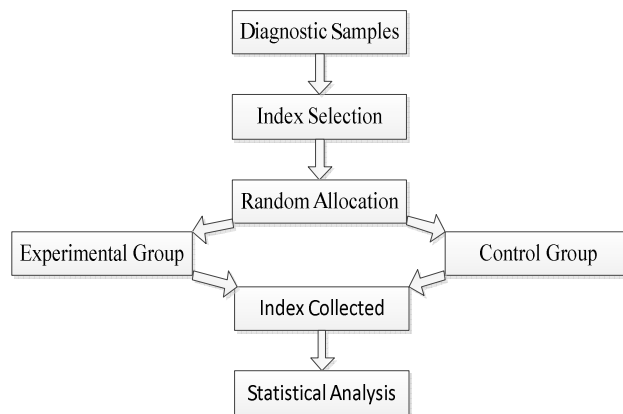
**2) Motor function index**

The function of the motor function index is to judge the patient’s motor function recovery (Siegel *et al.*, 1993; Ogaya *et al.*, 2017). The currently commonly used motor function index is the modified Barthel index (MBI). This index evaluates a series of compound actions that patients need to use in their actual lives, including eating, dressing, bathing, going to the toilet, going up and down stairs etc. The patient’s MBI index is up to 100. It is actually graded as: severe motor impairment and no self-care ability (0-20 points); few self-cares in life and heavy dependence (21-40); partial self-care and moderate dependence (41 -60); Most of them live on their own, relying on lightly (61-80); they live on their own, and can complete all actions without relying on others (81-100).

**Experimental methods**

In view of certain physical dysfunction of patients with moderate stroke, this experiment was carried out gradually at three stages. Each stage lasted 4 weeks, for a total of 12 weeks. The first stage was for yoga movement adaptation. The experimental group was required to be familiar with the breathing pattern of yoga and simple yoga exercise daily. The exercise time was 30 minutes per day. The second stage was the consolidation of the yoga movement. The complexity of the yoga movement was slightly increased, and the patient was required to perform cat stretch and other exercises under the guidance of the professional for 30 minutes/day. The third was the intensive stage, which required

the patient to use the yoga ball and perform more extensive motion training while practicing the exercise of previous stage. The exercise time was 60 minutes/day. Action C in the figure below was trained three times for 15 minutes daily. During the experiment, the patient’s blood oxygen content,  $\beta$  beta waves, and modified Barthel Index (MBI) were recorded and statistically analysed weekly. The specific procedure of the experiment is given as follows.



**Figure 1.** Experimental Procedures

**Results and Discussion**

This chapter demonstrates and interprets the experimental results in terms of three indexes: cerebral blood oxygen content, nerve excitability, and motor function of patients.

**Brain blood oxygen content index**

The index used in the experiment to measure blood oxygen content include the following four types, namely *Hb* (reduced hemoglobin), *HbO2* (oxyhemoglobin), *tHb* (total hemoglobin), and *TSI* (brain oxygen saturation). The following table shows the values and their differences of the four types of indicators recorded before and after the experiment respectively.

From the table above, it can be seen that in terms of *Hb* (reduced hemoglobin), the pre-experimental concentration was 57%, and after 12 weeks of yoga training, the concentration increased by 80%, which was significantly higher than before the experiment ( $P<0.05$ ); for *HbO2* (oxyhemoglobin), the pre-experimental concentration was 66%, and after a period of 12 weeks of yoga training, the concentration increased by 78%, significantly higher than before the experiment ( $P<0.05$ ); in terms of *tHb* (total haemoglobin), the pre-experimental concentration was 60%; after 12 weeks of yoga



training, the concentration increased by 84%, which was significantly higher than before the experiment ( $P < 0.05$ ); for *TSI* (brain tissue oxygen saturation), the pre-experimental concentration was 63%. After 12 weeks of yoga training, the concentration increased by 76%, which was significantly higher than before the experiment ( $P < 0.05$ ).

**Table 2.** Comparison of Two Groups (Blood Oxygen Levels, Week12)

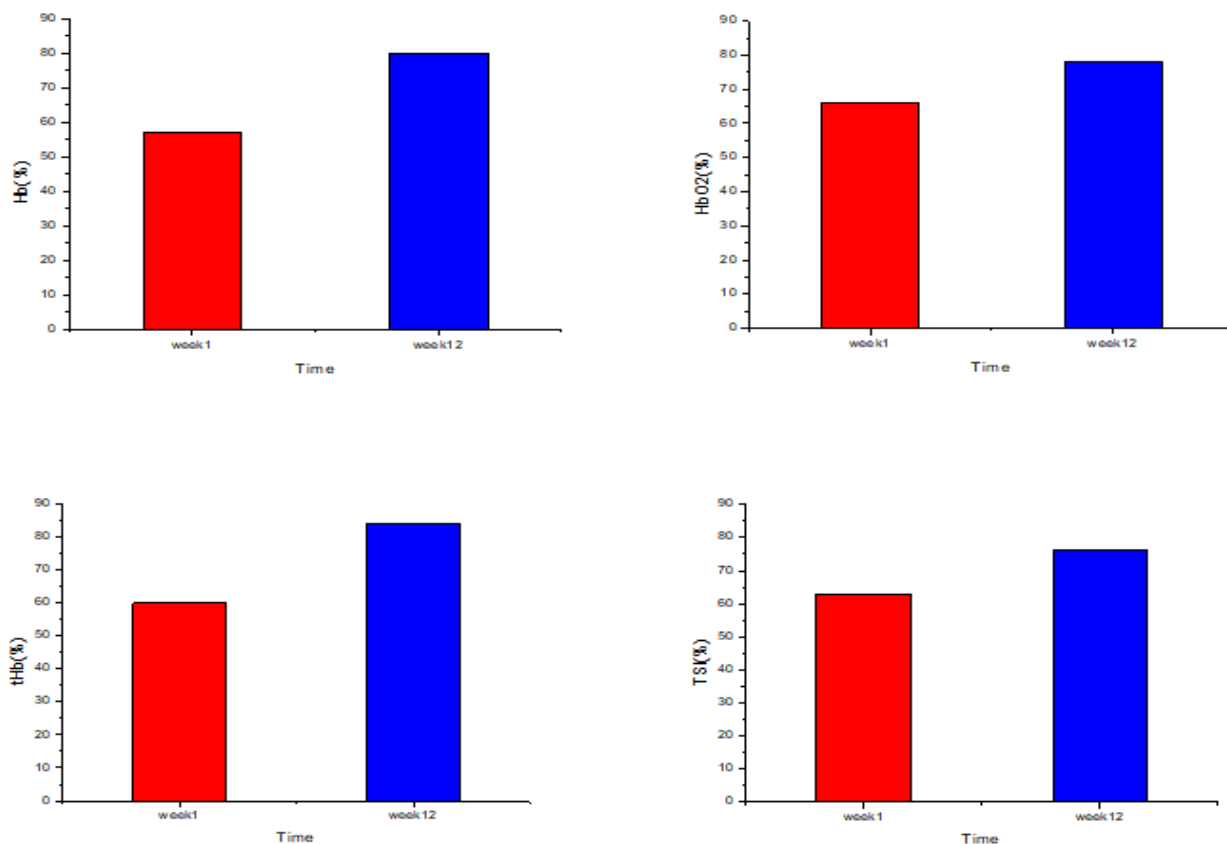
	Hb(%)	HbO <sub>2</sub> (%)	tHb(%)	TSI(%)
Experimental Group	80	78	84	76
Control Group	65	70	68	71
P-Value	0.00	0.02	0.00	0.04

The above experiment shows that after 12 weeks of yoga training, the cerebral blood oxygen content of stroke patients has significantly increased, and blood oxygen contents gradually approach that of normal people. During the experiment, the blood oxygen content of the brain was actually monitored every week, so it's found that the significant increase in blood oxygen content in the brain of the patient basically started in the third week of the experiment, and

there was no significant change in the first two weeks. As mentioned earlier, the lower blood oxygen content in the brain inhibits brain excitability, which further affects cognitive ability and normal control of the nervous system on the body. Therefore, the above results suggest that the patient's nerve excitability should have been significantly improved than before the Yoga training, and cognitive function should also be promoted.

*Cognitive function index*

In this paper, the recovery of cognitive function was inspected by monitoring the brain wave of patients. In the specific experimental process, the simple dialogue with patients was conducted at the end of training every week, while the changes in the patient's brain waves (feedback-related negativity, FRN) was also recorded during the dialogue. It's sure that all patients face the same problems every week, but the problem of different experimental weeks varies.



**Figure 2.** Comparison of Experimental Group before and after the Experiment



Figure 3 shows the observation results of the subjects' FRNs in the experimental and control group in Experiment 1. It can be found that the experimental group's brain wave fluctuates between  $1\mu V$  and  $3\mu V$  with an average fluctuation of 1.97 and a variance of 0.31; while the control group's brain waves fluctuate between  $-0.25\mu V$  and  $0.25\mu V$  with an average fluctuation of 0.04 and the variance of 0.02. Thus, obviously the mean and standard deviation of brain wave fluctuations in the experimental group were significantly higher than those in the control group. The above experiment shows that for the same problem, yoga-trained patients show greater brain activity than those who have not undergone yoga training. This further indicates that the patient's ability to perceive the problem and thinking ability is even higher, i.e., the improvement of cognitive ability.

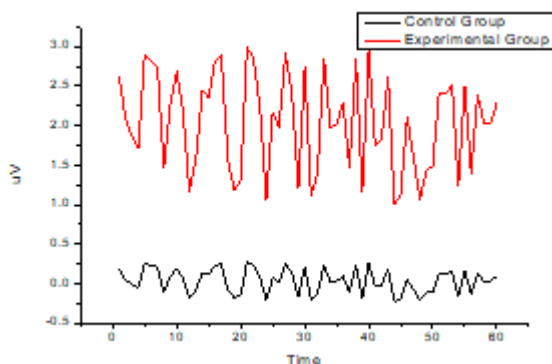


Figure 3. Comparison of Experimental Group (FRN)

Besides, when recording the brain wave of the patient, it's found that the significant difference of the brain waves between the experimental group and the control group basically appeared in the fourth and fifth week of the experiment, all lagging behind the time when the significant increase in blood oxygen content in the brain of the patient. This result in fact shows that the increase in blood oxygen content does increase the patient's nerve excitability, while the increase in nerve excitability enhances the patient's brain activity and improves cognitive ability. Therefore, the increase of blood oxygen content in the brain is the prerequisite for the improvement of patients' cognitive ability.

#### Motor function index

Figure 4 shows the recorded results of the modified Barthel index (MBI) during the

experiment. The scores of the two groups in the experiment were recorded each week, so as to calculate and compare the average scores. The data analysis results showed that: First, the average scores of both groups of patients increased with time; second, the mean score of the modified Barthel index in the experimental group was significantly higher than the average score of the control group at the 7th week of the experiment, and the average scores of the two groups before the week were not significantly different. Third, at the end of the experiment, the average score of the experimental group was 69 points, which was significantly higher than the average score of the control group (50 points) ( $P < 0.05$ ). This shows that after a period of yoga training, stroke patients' living ability and motor function have been greatly improved, and the degree of this improvement is more obvious than those who did not take the yoga training.

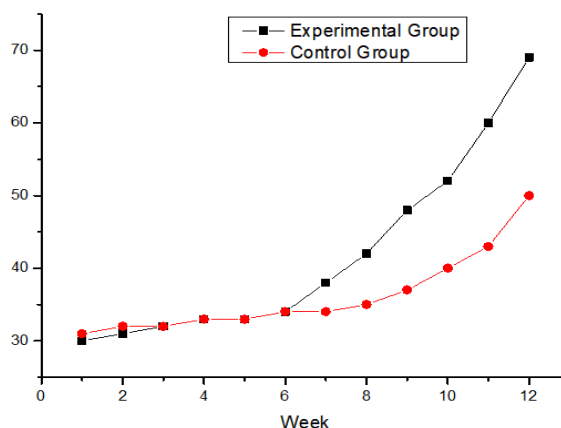


Figure 4. Comparison of experimental group (MBI)

#### Conclusions

The cognitive function and motor dysfunction that stroke patients are faced with after surgery have always been one of the key research topics in the field of rehabilitation medicine. This paper incorporates yoga exercises into the rehabilitation environment of patients with stroke and focuses on exploring the role of yoga exercise therapy in the recovery of cognitive function and motor function in stroke patients. The main findings of this paper are as follows:

- (1) Yoga exercise therapy can significantly improve the cognitive ability of patients with stroke and promote the recovery of motor function.
- (2) Yoga exercise therapy can improve the cognitive ability of patients with stroke, mainly by





increasing blood oxygen content in the brain of patients. The main mechanism of this process is that the increase of blood oxygen content in the brain will promote the increase of nerve excitability, and the increase of nerve excitability will ultimately improve the patient's cognitive ability by improving the patient's response and thinking ability.

(3) Increased blood oxygen content in the brain leads to increased nerve excitability. It can also increase the ability of the nervous system to control the limb tissue, which is manifested in improvement of living ability and significant recovery of motor function.

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