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Nursing Effect of Forbrain® Brain Cognitive Training on Cognitive Dysfunction among Patients with Stroke

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Abstract

In order to observe the rehabilitation effects of Forbrain® brain cognitive training on cognitive dysfunction among patients with stroke. A total of 120 stroke patients with cognitive dysfunction were randomly divided into experimental group 1 (n = 40), experimental group 2 (n=40) and control group (n=40). The control group was given the

routine rehabilitation nursing, the experimental group 1 was given the Forbrain® brain cognitive training based on the routine rehabilitation, and the experimental group 2 was given the non-standard Forbrain® brain cognitive training based on the routine rehabilitation training. The results showed that the scores of visuospatial construction, attention and concentration, memory, abstract thinking, language and total standard score of the experimental group 1 were higher than those of the experimental group 2 and control group ($P < 0.05$). Therefore, Forbrain® brain cognitive training can improve cognitive function of patients with stroke.
Key Words: stroke, cognition disorders, Forbrain® brain cognitive training, Montreal Cognitive Assessment Scale

Stroke is not only the third leading cause of death throughout the world, but also the number one cause of disability in China [1-2]. It has been reported that 75% of stroke survivors have cognitive impairments [3]. Even mild cognitive impairment can affect the patient's quality of life and work [4], imposing a heavy burden on the family and the society [5]. At present, the most commonly used clinical rehabilitation methods are medication, hyperbaric oxygen therapy, computer-assisted cognitive training, electroacupuncture and virtual reality techniques [6-7], all of which have achieve some results.

In this study, Forbrain® brain cognitive training was applied to stroke patients with cognitive dysfunctions to determine effectiveness of this new intervention modality on cognitive functions.

Subjects and Methods

1 Subjects

Between June 2015 and June 2016, 120 hospitalized stroke patients with cognitive dysfunctions were selected from the Rehabilitation Department in Tangshan Gongren Hospital. The sample was composed of 84 males and 36 females between 45-74, with an average age of 57.9±7.0. Among all the participants, there were 89 cases of cerebral infarction and 31 cerebral hemorrhage; as to the location of the lesions, 44 were on the left hemisphere, 55 on the right and 21 on both sides.

The inclusion criteria were: 1. diagnosis of stroke based on the standard established by the 4th Conference of Chinese Cerebrovascular Disease in 1995 [8]and confirmed by CT or MRI results; 2. the course of disease being more than 1 months, stable vital signs and clear consciousness; 3. no moderate or severe encephalatrophy, leukoaraiosis, visual field defect or spatial neglect found through examinations; 4. cognitive dysfunctions shown by a score of MoCA<26 (the original score was added by one point if the subject had less than 12 years of schooling); 5. willingness of the subject and a written version of informed consent.

Exclusion criteria were: 1. history of mental illness or retardation; 2. severe dysfunction of the heart, liver or kidney, malignant tumors or other critical conditions unsuitable for the training; 3. drug or alcohol abuse; 4. severe visual or auditory degradation, aphasia or dysarthria; 5. drop-out or unwillingness to participate

2 Methods

2.1 Grouping

120 stroke patients were randomly divided into experimental group 1, experimental group 2 and control group, 40 cases each.

2.2 Interventions

(1) The control group: conventional rehabilitation training and care.

(2) Experimental group 1: Forbrain® cognitive training in addition to conventional rehabilitation training and care applied in the control group.

The training equipment is composed of a microphone of high sensitivity, a headset with a device facilitating bone conduction and an electronic dynamic filter. Forbrain® cognitive training is developed based on cognitive neuroscience.

A sound in transmission would arrive firstly at the tympanic membrane through the external auditory meatus, and then vibration of the membrane would transmit through the inner ear and transform into nerve impulses, which then travel along the auditory pathway toward auditory cortex. Thus, we can perceive the sound and the process is called air conduction. On the other hand, the vocal cord would vibrate when a sound is made at the throat, and the vibration is mainly transmitted through bone conduction. When a person speaks, the sound is delivered directly to the vestibular-cochlear nerve in the inner ear without passing through the eardrum and the middle ear. The vibrations produced by these sounds are likewise transformed into nerve impulses here, which pass through auditory-related nerves to auditory cortex. Thus, our voice is heard and this process is named bone conduction.

The cognitive training with Forbrian® aims at harmonize bone conduction and air conduction during the process of auditory information. By employing the auditory feedback and enhancing perception of auditory information, the patient is trained to speak in a more accurate fashion. In this way, the auditory-speech feedback [9] will be optimized and cognitive function restored.

Operation: Turn on Forbrain®. When the blue light is on, instruct the patient to wear the device. The patient can select his favorite material, be it stories, essays, novels, magazines and newspapers, and ask the patient to read out loud. During the process, instruct the patient to adjust his pronunciation and stress timely according to the sound perceived through bone conduction, in order to optimize the effects of the training. For those who are illiterate or with literacy problems, their family members can initiate conversations with them for the purpose of training.

Training Schedule: start keeping time when the patient starts reading. 20 minutes per session, 5 sessions a week, 10 weeks in total.

(3) Experimental Group 2: Non-standard Forbrain® cognitive training in addition to conventional rehabilitation training and care applied in the control group. The non-standard Forbrain® cognitive training involves wearing of a device of identical appearance with that used in experimental group 1. However, the device does not have the dynamic vocal processing technology or electronic dynamic filter. It only transmits the sound through bone conduction and has no effect in improving “speech-auditory feedback”. The operation of the device and train schedule is the same as experimental group 1.

2.3 Assessment

All three groups of patients were assessed using the MoCA scale before and after the 10-week intervention by trained researchers. The MoCA scale was designed by Nasreddine [10] based on clinical experience and reference to Mini-mental State Examination (MMSE). It was translated into Chinese in 2007 by Wang Wei and his team [11]. The scale includes 11 indexes covering 8 cognitive aspects: concentration, executive function, memory, language, visuospatial construction, abstract thinking, calculation and orientation.

The total score is 30 and 26 is set as the baseline for normal cognition.

A score less than 26 is indicative of impaired cognitive function and 1 point would be added to the score if the subject received less than 12 years of education [10].

2.4 Statistical analysis

Statistical software SPSS17.0 was used to show the difference before and after the experiment. t test was conducted for comparison within the same group, variance analysis for inter-group comparison, and x^2 test for enumeration data

3 Results

3.1 Comparison among 3 groups at baseline

Before the experiment, the difference among these three groups in demographic information, course of disease, nature of disease, sides of lesions and total score of MoCA was not statistically significant (P > 0.05), suggesting all groups are inter-comparable. See Table 1.

Table 1 Comparison among Groups at baseline [n(%)]

	Experimental Group 1 (n=40)	Experimental Group 2 (n=40)	Control Group (n=40)	Statistical Data	*P*
Age/Year					
45 ～54	15(37. 5)	15(37.5)	17(42.5)	0. 375[a]	0. 984
55 ～60	17(42.5)	18(45. 0)	16(40.0)		
>60	8(20.0)	7(17.5）	7(17. 5)		
Sex					
Male	27(67.5)	28(70. 0)	29(72. 5)	0. 238[a]	0. 888
Female	13(32.5)	12(30.0)	11(27.5)		
Educational Background					
None	13(32.5)	13(32.5)	14(35. 0)	0.425[a]	0. 981
Primary or Junior High School	17(42. 5)	15(37. 5)	17(42. 5)		
Senior High School and Above	10(25.0)	11(27.5)	9(22.5)		
Time since Onset /Month					
1～	17(42. 5)	19(47. 5)	15(37. 5)	0. 837[a]	0. 933：
2～	14(35.0)	13(32. 5)	15(37. 5)		
>3	9(22.5)	8(20.0)	10(25.0)		
Nature of Disease					
Cerebral Infarction	29(72.5)	30(75. 0)	30(75. 0)	0. 086[a]	0. 958
Cerebral Hemorrhage	11(27.5)	10(25.0)	10(25.0)		
Sides of Lesions					
Left	14(35.0)	15(37. 5)	15(37. 5)	0.489[a]	0.975
Right	19(47.5)	17(12. 5)	19(47. 5)		
Bilateral	7(17. 5)	8(20. 0)	6(15. 0)		
MoCA Score	15. 80± 2.24	16. 38±2. 70	16. 30±2.73	0. 594[b]	0.554

Note: a: value of x^2 ;b: value of *F*;

3.2 MoCA scores after intervention

After the 10-week intervention, the scores of visuospatial construction, attention and concentration, language, abstract thinking, memory and the total score in experiment group 1 were significantly higher than those in experiment group 2 and control group ($P < 0.05$), meaning that intervention used in the experimental group 1 was more effective that those used in the other two groups. See Table 2.

Table 2: MoCA socres of 3 groups after intervention ($\bar{x} \pm s$)

MoCA	experimental group 1 (n=40)	experimental group 2	control group	*F*	*P*
visuospatial construction	0. 53±0. 51[ab]	0.20 ±0.41	0.15±0.36	9.035	0.000
Executive function	0. 30±0. 46	0.25 ± 0.44	0.25±0.44	0.167	0.847
Attention and concentration	0, 40±0.50[ab]	0.08 ± 0.27	0.05±0.22	12.499	0.000
Language	0. 60±0. 59[ab]	0.28 ± 0.45	0.10±0.30	11.967	0.000
Calculation	0. 13 ± 0.46	0.1 ± 0.44	0.08±0.35	0.141	0.869
Abstract thinking	0. 33 ±0.47[ab]	0.13 ± 0.34	0.13±0.34	3.561	0.032
Memory	0. 58 ± 0.59[ab]	0.08 ±0.27	0.08±0.27	20.181	0.000
Orientation	0. 10 ±0. 30	0.05±0.22	0.05±0.22	0.527	0.592
Total	2. 95 ±1.09[ab]	1.15±0.89	0.88±0.91	54.350	0.000

Note: a: $p<0.05$ when experimental group 1 is compared with control group; b: $p<0.05$ when experimental group 1 is compared with experimental group 2

3.3 MoCA scores of experimental group 1 before and after intervention

After the 10-week intervention, the scores of attention and concentration, visuospatial construction , executive skills, language, abstract thinking, memory, orientation and the total score in experiment group 1 were significantly higher than the corresponding data collected before the experiment ($p<0.05$). See Table 3.

Table 3: MoCA scores of experimental group 1 before and after intervention ($\bar{x} \pm s$)

MoCA	Before (n=40)	After (n = 40)	*t*	*P*
Visuospatial construction	1. 53±0. 55	2. 05±0. 50	- 6.565	0. 000
Executive function	2. 00 ±0. 45	2. 30±0. 52	-4. 088	0. 000
Attention and	1. 75±0. 44	2. 15 ± 0. 36	-5. 099	0. 000
Language	1. 43±0. 50	2. 03±0. 48	-6. 426	0. 000
Calculation	1. 53 ±0. 93	1. 65±0+ 95	-1. 706	0. 096
Abstract thinking	1. 18±0. 55	1. 50±0. 51	-4. 333	0. 000
Memory	1. 60± 0. 74	2. 18±0. 59	-6. 119	0. 000
Orientation	4. 05±0. 39	4. 15±0. 43	-2. 082	0. 044
Total	15. 80±2. 24	18. 75±2. 05	-17. 198	0. 000

3.4 MoCA scores of experimental group 2 before and after intervention

The result showed that there was major improvement in the aspect of visuospatial construction, executive skills, language, abstract thinking and the total score of MoCA in experimental group 2 after intervention ($p < 0.05$). See Table 4.

Table 4: MoCA scores of experimental group 2 before and after intervention ($\bar{x} \pm s$)

MoCA	Before (n=40)	After (n = 40)	*t*	*P*
Visuospatial construction	1. 60±0.59	1. 80 ± 0. 46	-3. 122	0. 003
Executive function	1.98±0. 58	2. 23±0. 48	-3. 606	0. 001
Attention and	1. 83±0. 39	1. 90±0. 44	-1. 778	0. 830
Language	1. 58±0.50	1. 85±0.53	-3. 846	0. 000
Calculation	1.68±1. 00	1. 78±1.03	-1. 433	0. 160
Abstract thinking	1. 20±0. 46	1. 33±0. 47	-2. 360	0. 023
Memory	1. 83±0. 59	1. 90 ± 0. 55	-1. 778	0. 083
Orientation	3. 98±0. 36	4.03 ± 0.28	-1. 433	0. 160
Total	16. 38±2. 69	17. 53 ± 2. 41	-8. 145	0. 000

3.5 MoCA scores of the control group before and after intervention

The control group also showed improvement in visuospatial construction, executive skills, language, abstract thinking, and the overall condition ($p < 0.05$). See Table 5.

Table 5: MoCA scores of the control group before and after intervention ($\bar{x} \pm s$)

MoCA	Before (n=40)	After (n = 40)	*t*	*P*
Visuospatial construction	1. 63±0. 59	1. 78±0. 53	-2. 623	0. 012
Executive function	2. 03±0. 58	2. 28 ±0. 45	-3. 606	0. 001
Attention and	1. 80±0. 41	1. 85 ± 0. 36	-1. 433	0. 160
Language	1. 60±0. 50	1. 70±0. 46	-2. 082	0. 044
Calculation	1. 83±1. 04	1. 90 ±1. 01	-1.356	0. 183
Abstract thinking	1. 13 ± 0.56	1. 25±0. 44	-2. 36	0. 023
Memory	1. 63±0. 59	1.70±0. 56	-1. 778	0. 083
Orientation	3. 90±0. 44	3. 95±0. 39	-1.433	0. 160
Total	16. 30±2. 73	17. 18 ± 2.37	-6.074	0. 000

4 Discussion

Cognitive function is the capability of the human brain to perceive and comprehend ideas, including mainly attention, learning ability, memory and thinking [12]. One commonly-seen cause of cognitive dysfunction is brain damage resulted from cerebral ischemia and hypoxia combined with neurodegeneration and vascular damage in cases of stroke [13]. Researches shows that simulation induced by early rehabilitation training is conducive to the establishment of new neural pathways, and eventually new neural network can be established to promote cognitive rehabilitation [14].

The result of this study show that the total score of MoCA, the scores of visuospatial construction, executive skills, language and abstract thinking of the control group increased after the experiment ($P <0.05$), meaning that conventional rehabilitation and care are effective in improving cognitive functions of stroke patients, in line with existing references[15].

The results of the study also showed that, after a ten-week intervention, the scores of attention and concentration, visuospatial construction, executive skills, language, abstract thinking, memory, orientation and the total score in experiment group 1 were significantly higher than those before the experiment ($P<0.01$). In addition, the scores of visuospatial construction, attention and concentration, memory, language, abstract thinking, and the total score in experiment group 1 were significantly higher than those in experiment group 2 and control group ($P <0.05$); the difference between experimental group 2 and control group after intervention was not statistically significant ($P> 0.05$). In such light, it can be concluded that cognitive training provided by Forbrain® is effective in improving cognitive functions of stroke patients.

Its mechanism might be: (1) The brain of patients would be stimulated and blood flow in the affected area increased during repeated reading, and thus memory is trained, in line with the result of another research [16]. (2) The temporal lobe, inferior frontal gyri and primary motor cortex are associated with language ability, as reported [17]. Forbrain® cognitive training required patients to read aloud, and their voice is collected by microphones. During such a process, patients' perception of the sound is enhanced and at the same time, the corresponding regions of the brain such as the temporal lobe and primary motor cortex are stimulated to contribute to better language and executive skills. (3) Attention is the prerequisite of cognitive processes [18]. During the cognitive training, dynamic filter installed on the device can block the noise from the surrounding environment, highlighting the perception of the user's own voice. In this way, the part of the cerebral cortex in charge of attention would be efficiently activated and trained. Moreover, by trying to identify difference in his own voice, a patient's attention and memory is improved. (4) It has also been reported that regular and systematic auditory training can delay the aging process and improve the cognitive functions of the elderly [16]. During standard Forbrain®

training, patients were asked to read repeatedly and regularly, and such repetitive training would bring about repeated stimulation. Consequently, nerve cells would recover from the damage, marginal zones would compensate for the loss, and new neural pathways would establish, improving cognitive function in stroke patients, especially the capability to store and recall memories [18-19].

In conclusion, Forbrain® brain cognitive training can effectively improve the cognitive functions of stroke patients. It is simple to apply and guarantee high patient compliance, serving as a great intervention modality for rehabilitation of cognitive function. However, limitations on time and sample size necessitate further researches with larger sample size and refined grouping techniques.

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