# Brain Function Rehabilitation Apparatus (BFRA) effect on cerebral circulation and cerebral function[1)]

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**Abstract：**

**[Objective]** Clinical observation of Brain Function Rehabilitation Apparatus (BFRA) effect on cerebral circulation and cerebral function.

**[Methods]** The patients with cerebrovascular disease in 180 cases, divided into cerebral infarction group and cerebral arteriosclerosis group, vertebrobasilar insufficiency group, 60 cases in each group, according to the visiting sequence is divided into drug treatment group and treatment group, 30 cases in each instrument.The drug therapy group according to the disease treatment of conventional dosage, the treatment group used instruments Brain Function Rehabilitation Apparatus, continuous treatment for 30 days. Transcranial Doppler (TCD) and brain electrical activity mapping (BEAM), which reflect the changes of cerebral blood flow, were used as observation indexes.

**[Results]** In patients with cerebral infarction curative effect of experimental group was significantly better than the control group ($P < 0.01$), and TCD and BEAM in the two groups showed significant difference ($P < 0.05$ or $P < 0.01$); in patients with cerebral arteriosclerosis in the curative effect of experimental group than the control group ($P < 0.05$) Moreover, TCD and BEAM in the two groups showed significant difference ($P < 0.01$) or $< 0.05$); in patients with vertebrobasilar insufficiency, the curative effect of experimental group was significantly better than the control group ($P < 0.05$), and TCD, BEAM in the two groups also showed significant differences for the newspaper ($P < 0.01$).

**[Conclusions]** the application of BFRA can significantly improve the cerebral hemodynamics, increase cerebral blood flow, strengthen the functional activities of the brain, remove brain lesions around tissue edema and swelling, alleviate cerebral vasospasm, improve cerebral blood supply and hypoxia, improve brain tissue and promote The new supersedes the old. ipsilateral to the lesion, or on the side the formation of collateral circulation, activation in the inhibitory state of brain cells, enhance the brain's comprehensive analysis ability and memory function. It can be used for the treatment of cerebral infarction, cerebral arteriosclerosis, vertebrobasilar insufficiency, and brain dysfunction due to enhanced memory.

**Keywords：** Brain Function Rehabilitation Apparatus；DC pulse；Cerebral vascular disease；cerebral infarction；Activated brain cells

Brain dysfunction is one of the most common clinical syndromes, sequelae of stroke, cerebral insufficiency, hardening of the brain and memory of young people , etc., because brain cells are ischemic and anoxic, brain function is impaired.

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At present, the rehabilitation of brain function mainly depends on drug therapy, the drug is injected into the body through the mouth or vein and circulates throughout the body, because the drug can not focus on the brain and has a short duration of efficacy, it takes a long time and has a poor curative effect.

BFRA is a comprehensive instrument for the rehabilitation of brain function combined with Western medicine and traditional Chinese medicine, chemical therapy and physical therapy.

## 1 Clinical data

In this study, 180 patients with cerebrovascular diseases were divided into cerebral infarction group (CAI), cerebral arteriosclerosis group (CAS), vertebral basilar artery insufficiency group (VBI), 60 cases in each group, according to the order of arrival, they were divided into drug treatment group and instrument treatment group, each with 30 cases. All the cases were strictly selected according to the diagnostic points drawn up by the National Conference on cerebrovascular diseases in 1986.Among them, the CAI group male 40 cases, female 20 cases, aged 49 to 68 years old, the average age of 59.7 years; the CAS group male 29 cases, female 31 cases, aged 47 to 66 years old, the average age of 53.2 years; the VBI group male 40 cases, female 20 cases, aged 46 to 68 years old, the average age of 55.9 years.

## 2 Research method

In view of the high positive correlation between brain function and cerebral blood flow, the relationship between brain function and cerebral blood flow can be reflected by changes in brain electrical activity, therefore, in this study, transcranial Doppler (TCD) which reflect cerebral hemodynamic changes and brain electrical activity mapping (BEAM) which reflect brain function changes were selected as observation indexes, clinical manifestations were also used.

### 2.1 Instrument

(1) The TC2 -64B type and TC-2000 type instruments produced by Germany EME company.

(2) The DYD-500 type BEAM instruments produced by Beijing Beike Company.

### 2.2 Method

(1) Control group　According to the routine treatment of each treatment, continuous treatment for 30 days.

(2) Experience group　The BFRA was used 1 times a day for 20 minutes, 30 times for 1 courses.

All cases underwent 1 TCD and BEAM examinations before and after treatment, and compared the changes before and after treatment.

## 3 Results and analysis

### 3.1 Cerebral infarction group

A comparison of the efficacy, hemodynamics, and neurophysiological properties of the two therapies in patients with cerebral infarction is given in table 1~3.

Table 1　Comparison of the efficacy of the two therapies

| | Total number of cases | Recovery | Effective | To become better | Invalid | Efficiency (%) |
|---|---|---|---|---|---|---|
| Control group | 30 | 0 | 3 | 17 | 10 | 66.67 |
| Experience group | 30 | 0 | 5 | 21 | 4 | 86.67 |
| P | | | | | | ＜0.01 |

Table 2 Comparison of mean flow velocity (Vm) of two therapies for estimation of cerebral blood flow (ECBF)

| | Total number of cases | Before treatment | | After treatment | | Increase rate | | P | |
|---|---|---|---|---|---|---|---|---|---|
| | | Vm | ECBF | Vm | ECBF | Vm | ECBF | Vm | ECBF |
| Control group | 30 | 19.3±8.7 | 150±42 | 21.1±7.7 | 173±48 | 9.3 | 15.8 | ＞0.05 | ＞0.05 |
| Experience group | 30 | 21.5±7.7 | 134±41 | 26.6±6.5 | 201±40 | 23.9 | 50.6 | ＜0.01 | ＜0.01 |
| Increase rate | | | | 25.9 | 16.1 | | | | |
| P | | ＞0.05 | ＞0.05 | ＜0.01 | ＜0.05 | | | | |

Note: Vm=cm/s，ECBF=m1/mim，Increase rate=%

Table 3 Comparison of slow wave power spectra of two therapies (%)

| | Total number of cases | Before treatment | After treatment | Reduction rate | P |
|---|---|---|---|---|---|
| Control group | 30 | 44.3±3.6 | 43.2±5.8 | 2.6 | ＞0.05 |
| Experience group | 30 | 43.9±5.4 | 40.7±7.0 | 7.9 | ＜0.05 |
| Reduction rate | | | 6.1 | | |
| P | | ＞0.05 | ＜0.05 | | |

From table 1~3, the effect of the experimental group was better than that of the control group ($P < 0.01$), and the difference of TCD and BEAM between the two groups was significant ($P < 0.05$ or 0.01).

### 3.2 Cerebral arteriosclerosis group

A comparison of the efficacy, hemodynamics, and neurophysiological properties of the two therapies in patients with cerebral arteriosclerosis is given in table 4~6.

Table 4 Comparison of the efficacy of the two therapies

| | Total number of cases | Recovery | Effective | To become better | Invalid | Efficiency (%) |
|---|---|---|---|---|---|---|
| Control group | 30 | 0 | 1 | 19 | 10 | 66.66 |
| Experience group | 30 | 0 | 3 | 22 | 5 | 83.33 |
| P | | | | | | ＜0.05 |

Table 5 Comparison of average flow velocity, estimation of cerebral blood flow of the two therapies

| | Total number of cases | Before treatment | | After treatment | | Increase rate | | P | |
|---|---|---|---|---|---|---|---|---|---|
| | | Vm | ECBF | Vm | ECBF | Vm | ECBF | Vm | ECBF |
| Control group | 30 | 29.8±4.9 | 164±71 | 31.0±5.8 | 186±88 | 4.0 | 13.4 | ＞0.05 | ＞0.05 |
| Experience group | 30 | 29.6±6.5 | 182±84 | 35.0±6.5 | 228±78 | 18.3 | 25.3 | ＜0.05 | ＜0.05 |
| Increase rate | | | | 12.9 | 22.6 | | | | |
| P | | ＞0.05 | ＞0.05 | ＜0.01 | ＜0.01 | | | | |

Table 6 Comparison of slow wave power spectra of two therapies (%)

| | Total number of cases | Before treatment | After treatment | Reduction rate | P |
|---|---|---|---|---|---|
| Control group | 30 | 43.2±3.9 | 42.9±7.4 | 0.8 | ＞0.05 |
| Experience group | 30 | 42.2±4.1 | 40.4±3.7 | 4.5 | ＜0.05 |
| Reduction rate | | | 6.1 | | |
| P | | ＞0.05 | ＜0.05 | | |

As shown in table 4~6, the efficacy of the experimental group was superior to that of the control group ($P < 0.05$) in patients with cerebral arteriosclerosis, moreover, TCD and BEAM showed significant difference between the two groups ($P < 0.01$ or $< 0.05$).

### 3.3 Vertebral basilar artery insufficiency group

The efficacy, hemodynamics, and neurophysiological comparison of the two therapies in patients with vertebrobasilar insufficiency are shown in table 7~9.

Table 7 Comparison of the efficacy of the two therapies

| | Total number of cases | Recovery | Effective | To become better | Invalid | Efficiency (%) |
|---|---|---|---|---|---|---|
| Control group | 30 | 10 | 12 | 4 | 4 | 86.67 |
| Experience group | 30 | 12 | 13 | 3 | 2 | 93.33 |
| P | | | | | | ＜0.05 |

Table 8 Comparison of average flow velocity, estimation of cerebral blood flow of the two therapies

| | Total number of cases | Before treatment | | After treatment | | Increase rate | | P | |
|---|---|---|---|---|---|---|---|---|---|
| | | Vm | ECBF | Vm | ECBF | Vm | ECBF | Vm | ECBF |
| Control group | 30 | 17.1±2.3 | 8.6±2.9 | 18.0±2.9 | 9.2±2.8 | 5.3 | 7.0 | ＞0.05 | ＞0.05 |
| Experience group | 30 | 17.0±2.7 | 9.5±3.1 | 21.8±3.1 | 13.6±4.7 | 28.3 | 43.2 | ＜0.01 | ＜0.01 |
| Increase rate | | | | 21.1 | 47.8 | | | | |
| P | | ＞0.05 | ＞0.05 | ＜0.01 | ＜0.01 | | | | |

Table 9 Comparison of slow wave power spectra of two therapies (%)

| | Total number of cases | Before treatment | After treatment | Reduction rate | P |
|---|---|---|---|---|---|
| Control group | 30 | 46.6±3.8 | 45.8±6.8 | 1.7 | ＞0.05 |
| Experience group | 30 | 46.1±4.6 | 42.8±6.2 | 7.8 | ＜0.01 |
| Reduction rate | | | 7.2 | | |
| P | | ＞0.05 | ＜0.01 | | |

As shown in table 7~9, in patients with vertebrobasilar insufficiency, the efficacy of the experimental group was superior to that of the control group ($P < 0.05$) ,moreover, TCD and BEAM showed significant difference between the two groups ($P < 0.01$).

## 4 Discuss

### 4.1 Basic treatment of rehabilitation brain function of Brain Function Rehabilitation Apparatus

The BFRA is a comprehensive therapeutic apparatus which integrates the direct current medicine ion introduction therapy, the low frequency pulse electrotherapy, the electric acupuncture treatment, the Chinese medicine treatment and the simulation brain electricity physiological wave in an organic whole. It can remove the edema and swelling of brain tissue around the lesion, alleviate cerebral vasospasm, improve cerebral blood supply and hypoxia, increase the metabolism of brain tissue, promote the formation of collateral circulation of the ipsilateral or contralateral of the lesion, activate brain cells that are in inhibitory state, mobilize the potential energy of the brain, enhance the brain's ability to integrate analysis and memory.

### 4.2 The relationship between brain function and cerebral blood flow [1-4]

Under normal physiological conditions, there is a close relationship between the functional state of the

brain and the supply of blood to the brain, Ingvar(1967) and others measured local cerebral blood flow changes during psychological activity using the 133Xe clearance method, They found that when the mental activities, cortical blood flow increased by an average of 8%, some cortical areas, such as the diabetic gyrus, increased markedly. Olesen (1971) using the 133Xe clearance method showed that when the hands were moving vigorously, the regional cerebral blood flow in the contralateral cortex increased by an average of 54%, in other non projective areas, an average increase of 11%, As the amount of activity increases, the area of blood flow increases along the central sulcus. Ingvar&Risberg (1973~1975)have studied cerebral blood flow changes when psychological activities, such as problem solving, memory, reading, talking and reasoning, it would cause the expansion of regional brain activity, which can increase the local cerebral blood flow in several areas, the average increase of 15%. The blood flow in the precentral region was increased more than in the central posterior aspect when the sensory impulse was increased; In addition, electrical stimulation of the contralateral thumb can cause moderate increases in regional cerebral blood flow in the motor area, the precentral region is more evident than the precentral posterior, when the intensity of stimulation was increased to slight pain, the increase of cerebral blood flow was more obvious, especially in the whole motor area and frontal region. Therefore, the state of cerebral hemodynamics reflects the functional activity of the brain to some extent.

This study showed that the brain function improved significantly when the mean flow velocity of the basal cerebral artery and the estimated cerebral blood flow increased.

### 4.3 Brain electrical activity is an objective reflection of brain function[1-4]

Experiments have shown that the relationship between brain function and cerebral blood flow can be represented by brain electrical activity, and the electrical activity of the brain is highly positively correlated with regional cerebral blood flow. When epileptic seizures occur, the brain shows epileptic discharges, and the regional cerebral blood flow increases greatly. On the contrary, in various coma States, the EEG shows slow waves, and the regional cerebral blood flow decreases obviously. When inhaled CO2, pial artery expansion, EEG slow wave, frequency speed reduction; and when hyperventilation induced vasoconstriction, EEG slow wave increase quickly, reduce the activities of. The two cases are highly correlated.

This study demonstrated that the slow wave power spectrum values of EEG maps decrease accordingly when the blood flow increases.

## 5 Epilogue

This study shows that: the application of the BFRA in the treatment of certain cerebrovascular disease can significantly improve the cerebral hemodynamics, increase cerebral blood flow, strengthen the functional activities of the brain, can be used for the treatment of cerebral infarction, cerebral arteriosclerosis, vertebrobasilar insufficiency as well as strengthening induced brain memory function.

Because this instrument can obviously improve the cerebral circulation, so for the following diseases can not be used or used under the guidance of a doctor: intracranial hypertension, severe hypertension, glaucoma, critically ill patients, bleeding tendency, mental illness, children under the age of 10.

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**Author contribution:**

Mingde Jiao: Brain Rehabilitation Instrument clinical trial program principal designer, Clinical report " The effection of Brain Rehabilitation Instrument (BRI) in the treatment of cerebral circulation and the function " writer.

Danfeng Xu, Lanying Li, Bo Yu: Brain Rehabilitation Instrument(BRI) clinical trials;

Zuodong Sun: Brain Rehabilitation Instrument clinical trial program design participants, Inventor of Brain Rehabilitation Instrument(BRI) .

1) Brain Rehabilitation Instrument（ZL95210432.6 、96246672.7） commissioned a total of two clinical company for clinical trials,This is a clinical report issued by The Second Affiliated Hospital of Harbin Medical University in November 10, 1995 (the original copy can be found in Aobo medical website),The data of " Effect of Aobo Celebral Rehabilitation Medical Apparatus treatment on cerebral circulation and cerebral function " published in "medical care appliances" in 1998 comes from the clinical report.This clinical report was approved by Heilongjiang medical administration, at the same time, the clinical report" The effection of Brain Rehabilitation Instrument (BRI) in the treatment of cerebral circulation and the function " (the original copy can be found in Aobo medical website)issued by the First Hospital of Harbin was also approved by Heilongjiang medical administration，They are the clinical basis for the certification of Brain Rehabilitation Instrument registration,Medical device registration number: HeiYiXieZhunZi(95)No.227014.

In addition to transcranial electrical stimulation, Brain Rehabilitation Instrument has drug penetration and drug iontophoresis, later, a large number of clinical trials found that the real treatment was "electrical stimulation.",therefore, in the product upgrading, only the transcranial electrical stimulation was reserved.The name of the Brain Rehabilitation Instrument has undergone many changes, respectively named Aobo Brain Rehabilitation Instrument, Aobo Cerebral Rehabilitation Medical Apparatus, until now the tDCS Brain Function Rehabilitation Instrument.