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ORIGINAL ARTICLE

Retrospective Study

Efficacy of enhanced extracorporeal counterpulsation combined with atorvastatin in the treatment of cognitive impairment after stroke

Yan Duan, Hui-Xia Tang

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Abstract

BACKGROUND

Cerebral apoplexy patients are prone to cognitive impairment, and it is very important to choose appropriate treatment methods to improve their cognitive impairment after stroke.

AIM

To evaluate the effects of enhanced external counterpulsation (EECP) in conjunction with atorvastatin on cognitive function, neurotransmitter levels, and the repair of brain tissue damage in patients with cognitive impairment due to stroke.

METHODS

In this retrospective study, data from 60 patients with poststroke cognitive impairment due to stroke who were treated in our hospital from February 2021 to July 2022 were analyzed and divided into a treatment group (n = 30) and a control group (n = 30) according to the different nursing methods applied. Patients in the treatment group received EECP in addition to atorvastatin, while those in the control group received atorvastatin alone. Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA) and activities of daily living (ADL) scale scores were compared between the two groups. Additionally, the two groups were compared in terms of serum acetylcholine (ACh), acetylcholinesterase (AChE), nitric oxide (NO), endothelin-1 (ET-1), β2-microglobulin (β2-MG), glial fibrillary acidic protein (GFAP), and visinin-like protein 1 (VILIP-1) in the serum. Blood flow measurements from the anterior cerebral artery (ACA), middle cerebral artery (MCA) and posterior cerebral artery (PCA) were compared between the two groups before and after treatment, and the pulsatility index (PI) and resistance index (RI) of each artery were determined.

RESULTS

MMSE, MoCA, and ADL scores all improved in both groups following treatment, with the study group showing more improvement than the control group ($P < 0.05$). After treatment, there were statistically significant increases in both ACh and NO levels, whereas decreases occurred in AChE, ET-1, β2-MG, VILIP-1, and GFAP, levels and the PI and RI of the left-ACA, right-ACA, left-MCA, right-MCA, left-PCA, and right-PCA. The study group showed greater gains in all metrics than the control group ($P < 0.05$).

CONCLUSION

EECP combined with atorvastatin is effective in the treatment of cognitive impairment after stroke and can effectively improve the cognitive function, neurotransmitter levels, and brain tissue damage status of patients.

Key Words: Enhanced extracorporeal counterpulsation; Atorvastatin; Cognitive impairment after stroke; Neurotransmitters; Brain tissue damage status

Core Tip: Enhanced extracorporeal counterpulsation and atorvastatin are widely used in the treatment of stroke patients with cognitive impairment, but the effect of enhanced counterpulsation combined with atorvastatin on cognitive function of stroke patients with cognitive impairment has not been discussed. The objective of this study was to compare the efficacy of enhanced external counterpulsation combined with atorvastatin *vs* atorvastatin alone in the treatment of post-stroke cognitive impairment. Combined therapy is better than atorvastatin therapy alone.

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INTRODUCTION

A patient's quality of life is drastically altered after suffering a stroke, which is an acute cerebrovascular event that can result in brain ischemia, hypoxic damage, and neurological abnormalities as well as sequelae such as language dysfunction, limb malfunction, and cognitive impairment. Cognitive impairment after stroke is caused by degenerative diseases resulting from neural tissue ischemia. Therefore, patients with cognitive impairment following a stroke may achieve some improvement in their clinical symptoms with clinical therapy for nutritional neuropathy, improvement of microcirculation, and hemorheology, along with physical exercise[1,2]. Safe, effective, and noninvasive, enhanced external counterpulsation (EECP) is a mechanical circulatory aid method commonly employed in the treatment of coronary heart disease and angina pectoris. Multiple recent studies have demonstrated the efficacy of EECP in treating ischemic cerebrovascular disease, sleep disturbances, and psychological and psychiatric diseases[3,4]. The mechanism of EECP is to increase both the arterial and venous return of both lower limbs, increase coronary blood flow, and improve the perfusion of the heart, brain, kidneys, and other organs[5]. Statins, which are hydroxymethylglutaryl coenzyme A reductase inhibitors, can significantly boost patients' cognitive performance and postpone disease progression[6] through their anti-inflammatory, antithrombotic, endothelium-protective, and antioxidant properties. The purpose of this research was to examine the effects of EECP in conjunction with atorvastatin on cognitive performance, neurotransmitter levels, and recovery from brain tissue damage in patients with poststroke cognitive impairment. The findings are detailed below.

MATERIALS AND METHODS

General information

Data from 60 patients with poststroke cognitive impairment due to stroke who were treated in our hospital from February 2021 to July 2022 were analyzed, and the patients were divided into a treatment group ($n = 30$) and a control group ($n = 30$) according to the different nursing methods applied. There were 21 men and 9 women in the study group, with ages ranging from 49 to 74 (mean = 61.40, SD = 5.59) years; the average duration since stroke onset was 6.30 ± 1.62 mo, and the average duration since cognitive impairment onset was 5.57 ± 1.14 mo. In the control group, the age ranged from 49 to 73 years, with a mean of 60.30 ± 5.84 years. There were 19 men and 11 women in the control group; the mean duration since stroke onset was 6.50 ± 1.28 mo, and the mean duration since the onset of cognitive impairment was 3.75 ± 0.78 mo. Overall, there was little to no difference in these data between the two groups ($P > 0.05$). All protocols in this study were approved by the ethics committee of the Shengjing Hospital of China Medical University and abided by the ethical guidelines of the Declaration of Helsinki. The ethics committee waived the requirement for informed consent.

Diagnostic criteria

All patients were diagnosed with stroke by imaging examination, and color ultrasound examination showed that there was a mural thrombus in the bilateral carotid arteries. The patients were diagnosed with mild cognitive impairment as described in the study of Ismail *et al*[7]: (1) All imaging examinations showed findings in accordance with the diagnostic criteria for stroke; (2) Progressive impairment of cognitive function; (3) Mild memory impairment; (4) Ability to continue daily life; and (5) Cognitive impairment less severe than the threshold for a diagnosis in the Diagnostic and Statistical Manual of Mental Disorders[8]. Reduced capacity to orient oneself, recognize objects, and express oneself in language served as the primary clinical indications.

Inclusion criteria

(1) Imaging findings, physical examination findings, and a thorough review of the patient's medical history all corroborated the diagnosis, which matched all of the criteria laid forth in the Diagnostic Essentials of Various Cerebrovascular Diseases[9]; (2) Absence of any life-threatening organ malfunction; and (3) Voluntary participation in the research.

Exclusion criteria

(1) Neurological disease, such as Alzheimer's disease, Parkinson's disease, or epilepsy; (2) History of brain trauma; (3) Previous stroke or stroke-like event; (4) Existing mental disability before the stroke; and (5) Severe anxiety, depression, or other mental illness.

Methods

Atorvastatin was used in conjunction with EECP to treat patients in the research group (Pfizer Pharmaceutical Co., Ltd., National Drug Approval No.: H20051408). Patients in the control group were given only atorvastatin. Oxygen saturation was tracked using an EECP instrument (a PECP/TM) to measure EECP. The machine was first warmed for approximately 10-15 min. After the patient was positioned in an appropriate posture for treatment, sandpaper was used to smooth the skin around the electrode connection site, and alcohol was used to disinfect the immediate area. The white, red, and black electrodes were fixed under the left clavicle or near the manubrium, the apex of the heart, the upper right abdomen, or the lower right rib. Then, a finger pulse oximeter was placed on a finger of the right hand of the patient, ensuring that the electrode was in a position free from or minimally affected by vibration, the red and white electrodes were not too close, and the electrode position did not affect the inflatable cuff. The standard inflation pressure ranged from 0.025 to 0.045 MPa, with adjustments made during the operation based on the patient's response to the pressure. At the end of treatment, the finger pulse oximeter was removed, the inflatable cuff was unfastened, the electrode leads and electrodes were removed, and the patient was helped in tidying up his or her clothes and leaving the counterpulsation bed. The patient was required to remain under observation for 10 min without any discomfort before leaving. The treatment was performed once a day, 1 h/session, 6 d a week for 6 consecutive weeks, for a total of 36 sessions. Atorvastatin (20 mg) was given once daily for 24 wk.

Observational indexes

Clinical data of patients in the two groups were collected, and the Mini-Mental State Examination (MMSE)[10], Montreal Cognitive Assessment (MoCA)[11] and activities of daily living (ADL)[12] scores were compared between the two groups. Serum acetylcholine (ACh), acetylcholinesterase (AChE), nitric oxide (NO), endothelin-1 (ET-1), β2-microglobulin (β2-MG), visinin-like protein-1 (VILIP-1) and glial fibrillary acidic protein (GFAP) levels were compared between the two groups. The blood flow conditions of the bilateral anterior cerebral artery (ACA), middle cerebral artery (MCA) and posterior cerebral artery (PCA) were compared between the two groups before and after treatment. The pulsatility index (PI) and resistance index (RI) of each artery were calculated according to the blood flow velocity of the left and right arteries during the peak systolic period (Vs), end-diastolic blood velocity (Vd) and average blood flow velocity (Vm), with PI = (Vs-VD)/Vm, and RI = (Vs-VD)/Vs.

The MMSE includes five different elements, with a total of 30 items and a total score of 30 points. The better the patient's mental condition, the higher the score. The total possible score on the MoCA is 30 points, and a MoCA score < 26 points indicates that the patient has cognitive impairment. The total possible score on the ADL scale is 100 points, and the higher the score, the better the patient's daily living ability. The abbreviations for the cerebral arteries are left ACA (LACA), right ACA (RACA), left MCA (LMCA), right MCA (RMCA), left PCA (LPCA), and right PCA (RPCA).

Statistical methods

SPSS 20.0 was employed for processing and analyzing the data. The values for the measurements are presented as "mean ± SD". The *t* test for independent samples was used to evaluate differences between the groups. Within-group comparisons of pre- and posttreatment values were performed using the paired *t* test. The χ^2 test was used to make comparisons, with count data being reported as frequencies and category ratios. $P < 0.05$ was considered to indicate a statistically significant difference.

Table 1 Comparison of Mini-Mental State Examination, Montreal Cognitive Assessment and activities of daily living scores between the two groups (mean ± SD, points)

Group	MMSE score		MoCA score		ADL score	
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Study group (n = 30)	20.63 ± 2.94	26.80 ± 2.59[a]	19.50 ± 2.84	26.77 ± 2.08[a]	45.00 ± 4.78	63.70 ± 6.25[a]
Control group (n = 30)	19.73 ± 3.10	24.97 ± 3.29[a]	19.70 ± 1.60	24.70 ± 2.42[a]	45.97 ± 4.62	57.40 ± 4.99[a]
P value	0.253	0.020	0.738	0.001	0.429	< 0.001
t value	1.154	2.400	0.336	3.545	0.797	4.314

[a]P < 0.05, compared with the same group before treatment.
MMSE: Mini-Mental State Examination; MoCA: Montreal Cognitive Assessment; ADL: Activities of daily living.

Table 2 Comparison of cholinergic system component levels between the two groups (mean ± SD, nmol/mL)

Group	ACh		AChE	
	Before treatment	After treatment	Before treatment	After treatment
Study group (n = 30)	10.96 ± 2.84	22.53 ± 2.49[a]	16.53 ± 2.09	8.26 ± 0.89[a]
Control group (n = 30)	10.54 ± 2.99	15.20 ± 1.66[a]	16.92 ± 2.75	12.36 ± 1.17[a]
t value	0.570	13.412	0.616	15.308
P value	0.571	< 0.001	0.540	< 0.001

[a]P < 0.05, compared to the same group before treatment.
Ach: Acetylcholine; AChE: Acetylcholinesterase.

RESULTS

Comparison of MMSE, MoCA, and ADL scores between the two groups

There were no statistically significant differences between the groups in the pretreatment MMSE, MoCA, or ADL scores (P > 0.05). The treatment group showed statistically significant (P < 0.05) improvements in the MMSE, MoCA, and ADL scores after treatment compared to the control group, as shown in Table 1 and Figure 1A.

Comparison of neurotransmitter levels between the two groups

There were no statistically significant differences in the pretreatment ACh or AChE level between the two groups. In both groups, the ACh level increased after therapy, while the AChE level decreased (P < 0.05). There were statistically significant (P < 0.05) improvements in all indices in the experimental group that were not present in the control group, as shown in Table 2 and Figure 1B.

Comparison of vascular endothelial function markers between the two groups

There was no significant change in the ET-1 or NO level between the two groups before treatment (P > 0.05). After therapy, the ET-1 level in both groups decreased, and the NO level increased. The study group showed significantly (P < 0.05) greater improvement than the control group in all areas, as shown in Table 3 and Figure 1C.

Evaluation of serum levels of β2-MG, VILIP-1, and GFAP between the two groups

There were no significant variations in the β2-MG, VILIP-1, or GFAP levels between the two groups prior to therapy (P > 0.05). After treatment, the β2-MG, VILIP-1, and GFAP levels decreased in both groups, with significantly lower levels in the study group (P < 0.05), as shown in Table 4 and Figure 1D.

Comparison of PI values of the cerebral vasculature between the two groups

The PI values of the LACA, RACA, LMCA, RMCA, LPCA, and RPCA were not significantly different between the two groups before treatment (P > 0.05). As expected, therapy resulted in a reduction of pretreatment PI values in all examined vessels (LACA, RACA, LMCA, RMCA, LPCA, and RPCA) in both groups, with the study group showing significantly (P < 0.05) lower PI levels than the control group, as presented in Table 5 and Figure 1E.

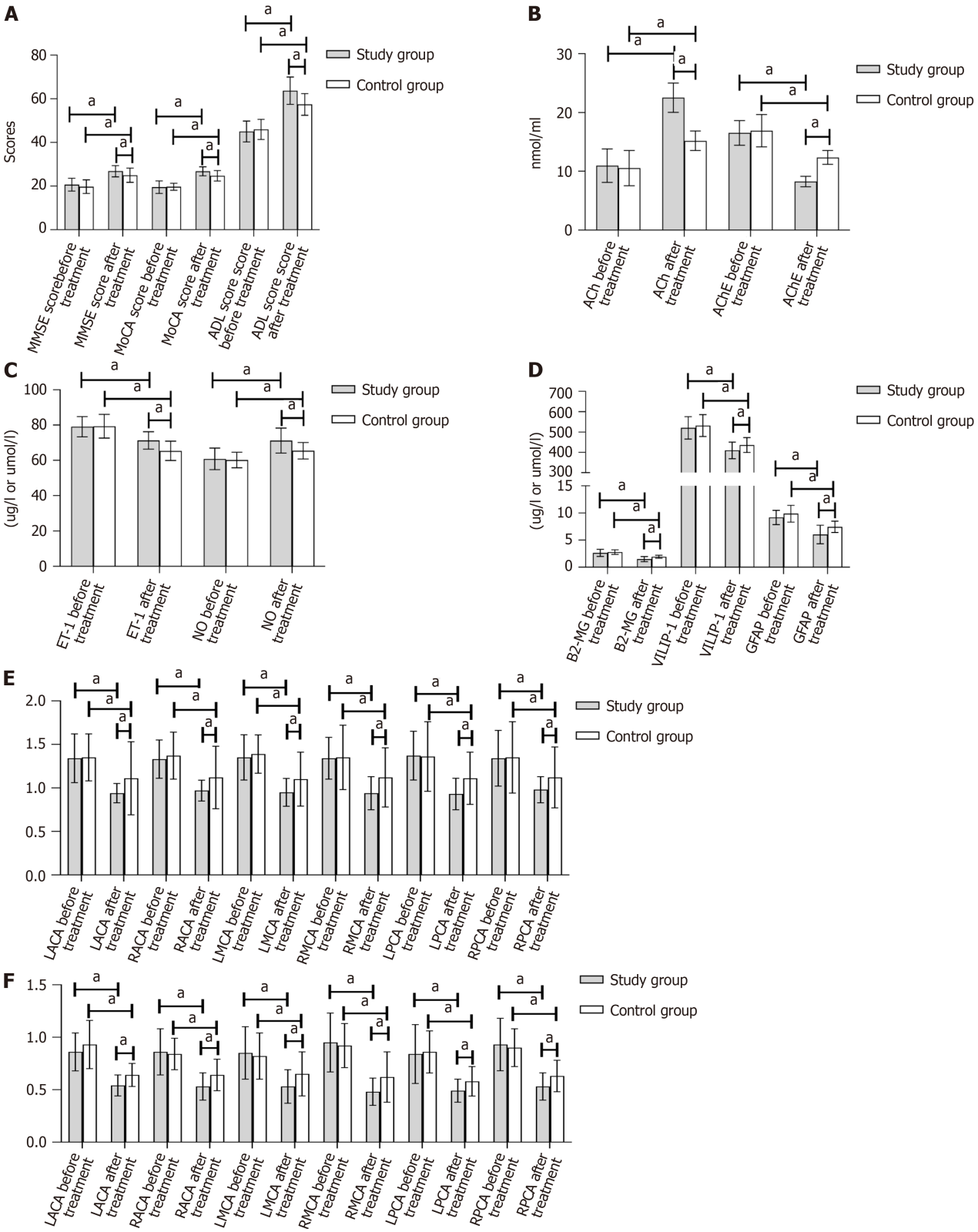

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Figure 1 Comparison of the level of each observation index between the two groups. A: Comparison of neurotransmitter levels between the two groups; B: Comparison of neurotransmitter levels between the two groups; C: Comparison of vascular endothelial function markers between the two groups; D: Evaluation of serum levels of β2-microglobulin, visinin-like protein 1, and glial fibrillary acidic protein between the two groups; E: Comparison of pulsatility index values of the cerebral vasculature between the two groups; F: Analyzing the difference in resistance index values of the cerebral vessels between the two groups. MMSE: Mini-Mental State Examination; MoCA: Montreal Cognitive Assessment; ADL: Activities of daily living; Ach: Acetylcholine; AChE: Acetylcholinesterase; NO: Nitric oxide; ET-1: Endothelin-1; β2-MG: β2-microglobulin; GFAP: Glial fibrillary acidic protein; VILIP-1: Visinin-like protein 1; LACA: Left-anterior cerebral artery; RACA: Right-anterior cerebral artery; LMCA: Left-middle cerebral artery; RMCA: Right-middle cerebral artery; LPCA: Left-posterior cerebral artery; RPCA: Right-posterior cerebral artery. $^{a}P < 0.05$.

Table 3 Comparison of vascular endothelial function markers between the two groups (mean ± SD, d)

Group	ET-1 (μg/L)		NO (μmol/L)	
	Before treatment	After treatment	Before treatment	After treatment
Study group (n = 30)	79.02 ± 5.77	71.29 ± 4.90[a]	60.81 ± 6.13	71.19 ± 7.08[a]
Control group (n = 30)	79.32 ± 6.70	65.40 ± 5.45[a]	60.19 ± 4.40	65.45 ± 4.64[a]
P value	0.854	< 0.001	0.655	0.001
t value	0.185	4.400	0.450	3.709

[a]P < 0.05, compared to the same group before treatment.
NO: Nitric oxide; ET-1: Endothelin-1.

Table 4 Comparison of serum β2-microglobulin, glial fibrillary acidic protein, and visinin-like protein 1 concentrations between the two groups (mean ± SD)

Group	B2-MG (mg/L)		VILIP-1 (ng/L)		GFAP (mg/L)	
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Study group (n = 30)	2.64 ± 0.65	1.49 ± 0.48[a]	520.59 ± 55.39	409.67 ± 40.77[a]	9.17 ± 1.32	6.04 ± 1.70[a]
Control group (n = 30)	2.79 ± 0.42	1.93 ± 0.28[a]	531.47 ± 54.03	435.83 ± 37.09[a]	9.87 ± 1.56	7.44 ± 1.06[a]
P value	0.294	< 0.001	0.444	0.012	0.064	< 0.001
t value	1.061	4.339	0.771	2.599	1.888	3.817

[a]P < 0.05 compared to the same group before treatment.
β2-MG: β2-microglobulin; GFAP: Glial fibrillary acidic protein; VILIP-1: Visinin-like protein 1.

Analyzing the difference in RI values of the cerebral vessels between the two groups

The RI values of the LACA, RACA, LMCA, RMCA, LPCA, and RPCA were similar in the two groups before treatment (P > 0.05). Treatment resulted in a substantial (P < 0.05) reduction in the RI values of the LACA, RACA, LMCA, RMCA, LPCA, and RPCA in both groups, as shown in Table 6 and Figure 1F.

DISCUSSION

The degree of cognitive impairment in stroke patients is strongly correlated with their prognosis, and elderly individuals are especially prone to cognitive impairment as a sequela of cerebral infarction. Therefore, it is crucial to find efficient ways to reduce stroke patients' cognitive impairment. According to relevant studies, atorvastatin serves antioxidant and antithrombotic functions and protects vascular endothelial function. It can play a direct role in protecting nerves, reducing the abundance of macrophages in atherosclerotic plaques, enhancing the integrity of fibrous plaque caps, inhibiting vascular inflammation, protecting the vascular endothelium, and inhibiting cognitive impairment after a stroke caused by vascular factors. EECP is a safe and cost-effective treatment that is mainly suitable for the treatment of coronary heart disease and angina pectoris. Numerous investigations conducted recently have demonstrated that EECP significantly affects ischemic cerebrovascular disorders and heart failure[13,14]. According to a prior study, EECP can reduce the clinical symptoms of coronary artery disease by enhancing vascular endothelial function[15]. EECP is an important means of cardiovascular auxiliary circulation that can simultaneously increase the arterial and venous return of both lower limbs and improve coronary blood flow. Patients' diastolic blood pressure and cardiac output as well as blood perfusion to the heart, brain, kidneys, and other organs can all be improved by wrapping balloon sleeves around the thighs, calves, and buttocks and then inflating and deflating the balloons using an air supply system. EECP has been shown to enhance arterial blood flow, increase blood perfusion in brain tissue, improve brain cell metabolism, and facilitate neurological function recovery[16]. Numerous clinical trials have demonstrated that EECP is able to successfully increase blood flow to ischemic areas, restore nerve cell activity, and facilitate the opening of collateral circulation in the ischemic penumbra[17,18].

This research compared the effects of EECP combined with atorvastatin to those of atorvastatin alone between two groups. The results indicated that after therapy, the MMSE, MoCA, and ADL scores in the study group improved more than those in the control group (P < 0.05). These findings demonstrate that the combined application of EECP and atorvastatin might be more effective than atorvastatin alone in enhancing patients' cognitive function and daily living abilities and that such enhancements could serve as direct indicators of the efficacy of therapy. The endothelium lining

Table 5 Comparison of pulsatility index values of cerebral vessels between the two groups (mean ± SD)

Group	LACA		RACA		LMCA		RMCA		LPCA		RPCA	
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Study group (n = 30)	1.34 ± 0.28	0.94 ± 0.11[a]	1.33 ± 0.22	0.97 ± 0.12[a]	1.35 ± 0.26	0.95 ± 0.16[a]	1.34 ± 0.24	0.94 ± 0.19[a]	1.37 ± 0.28	0.93 ± 0.18[a]	1.34 ± 0.32	0.98 ± 0.15[a]
Control group (n = 30)	1.35 ± 0.27	1.11 ± 0.42[a]	1.37 ± 0.27	1.12 ± 0.36[a]	1.39 ± 0.22	1.10 ± 0.31[a]	1.35 ± 0.37	1.12 ± 0.34[a]	1.36 ± 0.40	1.11 ± 0.30[a]	1.35 ± 0.41	1.12 ± 0.35[a]
P value	0.832	0.040	0.536	0.049	0.490	0.024	0.905	0.013	0.857	0.007	0.983	0.047
t value	0.213	2.139	0.622	2.043	0.695	2.339	0.120	2.589	0.180	2.805	0.021	2.052

[a]P < 0.05 compared to the same group before treatment.

LACA: Left-anterior cerebral artery; RACA: Right-anterior cerebral artery; LMCA: Left-middle cerebral artery; RMCA: Right-middle cerebral artery; LPCA: Left-posterior cerebral artery; RPCA: Right-posterior cerebral artery.

Table 6 Comparison of the resistance index values of the cerebral vessels in the two groups (mean ± SD)

Group	LACA		RACA		LMCA		RMCA		LPCA		RPCA	
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Study group (n = 30)	0.86 ± 0.18	0.54 ± 0.10[a]	0.86 ± 0.22	0.53 ± 0.13[a]	0.85 ± 0.25	0.53 ± 0.16[a]	0.95 ± 0.28	0.48 ± 0.13[a]	0.84 ± 0.28	0.49 ± 0.11[a]	0.93 ± 0.25	0.53 ± 0.13[a]
Control group (n = 30)	0.93 ± 0.23	0.64 ± 0.11[a]	0.84 ± 0.15	0.64 ± 0.15[a]	0.82 ± 0.22	0.65 ± 0.21[a]	0.92 ± 0.21	0.62 ± 0.24[a]	0.86 ± 0.20	0.58 ± 0.14[a]	0.90 ± 0.18	0.63 ± 0.15[a]
P value	0.225	0.001	0.729	0.004	0.720	0.014	0.582	0.007	0.701	0.006	0.566	0.008
t value	1.226	3.661	0.349	3.033	0.360	2.547	0.553	2.847	0.386	2.864	0.578	2.750

[a]P < 0.05 compared to the same group before treatment.

LACA: Left-anterior cerebral artery; RACA: Right-anterior cerebral artery; LMCA: Left-middle cerebral artery; RMCA: Right-middle cerebral artery; LPCA: Left-posterior cerebral artery; RPCA: Right-posterior cerebral artery.

the blood vessels is vulnerable to oxidative damage, which can be caused by atherosclerosis. Atorvastatin is a commonly used lipid-lowering drug that stabilizes atherosclerotic plaques. EECP can play a role in increasing cerebral blood flow and perfusion and improving neural function, such that the combined application of these two treatments is more effective. Previous studies have also shown that EECP combined with conventional drugs can be used to treat poststroke cognitive impairment more effectively than the same drugs alone[19]. Learning and memory are two physiological processes that benefit greatly from the functioning of the central cholinergic system. AChE catalyzes the decomposition reaction that produces ACh, which binds to ACh receptors. Degeneration of cholinergic neurons is common in patients with cognitive impairment after stroke[20]. ACh can participate in neuronal activity and regulate synaptic plasticity. In this investigation, the improvement in ACh and AChE levels following therapy was larger in the study group than in the control group (P < 0.05). The treatment of cognitive impairment following a stroke, which may be connected to the management of AChE and ACh levels, is said to benefit significantly from the combination of EECP and atorvastatin. The vascular endothelium serves both barrier and endocrine functions. Dysfunction of vascular endothelial cells can lead to damage to the blood-brain barrier, causing toxic substances to accumulate around nerve cells; triggering inflammatory reactions; damaging brain white matter, neuronal axons and synapses; and leading to cognitive impairment. Vascular endothelial damage, atherosclerosis, brain tissue damage, increased ET-1 expression, and decreased NO expression result in spasms of small cerebral vessels and damage to the nerve fiber network. It has been reported that the serum ET-1 and NO levels in patients with dementia are closely related to endothelial dysfunction of small cerebral vessels and can be used as a marker of endothelial dysfunction[21]. Patients with cognitive impairment following stroke showed significant improvement in ET-1 and NO levels in the treatment group compared to the control group, suggesting that combination therapy can increase the degree of vascular endothelial function more effectively than pharmacotherapy alone. Atorvastatin's lipid-lowering action, ability to mitigate atherosclerosis and protective effect on vascular endothelial function are all well documented. EECP has been shown to ameliorate cognitive impairment by normalizing systolic and diastolic vascular function, controlling vascular tension, and boosting endothelial function in blood vessels. Thus, when

applied in combination, they could play synergistic roles, resulting in an enhanced therapeutic effect.

All nucleated cells contain β2-MG, which might increase the risk of an inflammatory response and subsequent brain injury. With a negative effect on cognition, β2-MG has been linked to a host of serious health problems[22]. According to relevant studies, serum β2-MG levels are high in patients with cognitive impairment after stroke[23]. It has been shown that the expression level of VILIP-1, a small-molecule cytosolic protein typically dispersed in nerve cells, is positively linked with the presence of brain damage[24]. Serum levels of GFAP, an intermediate filament protein found in glial cells, are significantly elevated in those who have had a stroke and are experiencing cognitive impairment[25]. The fact that the levels of β2-MG, VILIP-1, and GFAP improved more in the study group than in the control group suggests that the combination therapy may promote the healing of damaged brain tissue in patients, which merits additional investigation into the specific mechanism of action. Patients with poststroke cognitive impairment who received combination therapy showed greater improvements in the PI and RI values of the LACA, RACA, LMCA, RMCA, LPCA, and RPCA than those who received atorvastatin therapy alone. This is because of the synergistic impact of atorvastatin's lipid-lowering and antithrombotic effects and the capacity of EECP to increase cerebral blood flow perfusion.

CONCLUSION

In conclusion, EECP combined with atorvastatin can effectively improve cognitive function, daily living ability, vascular endothelial function, neural function, and cerebral blood flow in patients with poststroke cognitive dysfunction, indicating the clinical value of this combination. A limitation of this study is that it was a retrospective study, and the number of cases that could be included in the observation was small, which may have led to bias in the results. In the future, a prospective multicenter study with a larger sample should be conducted to further verify the results of this study.

ARTICLE HIGHLIGHTS

Research background

The research background is the discussion on the treatment of patients with cognitive dysfunction after stroke. The current research status is that atorvastatin is widely used to treat cognitive impairment after stroke, and the research significance is to provide a new treatment plan for cognitive impairment after stroke and improve clinical efficacy.

Research motivation

With the treatment of stroke patients with cognitive dysfunction as the research topic, more effective treatment plans need to be explored to improve the prognosis of stroke patients with cognitive dysfunction. The significance of this study is to affirm the better treatment of cerebral stroke patients with cognitive dysfunction, and promote the innovation of clinical treatment of cerebral stroke cognitive endometrial methods.

Research objectives

The objective of this study was to compare the therapeutic effect of different treatment methods and to observe the advantages of enhanced external counterpulsation (EECP) combined with atorvastatin over atorvastatin alone. In this study, enhanced *in vitro* rebuttal combined with atorvastatin was effective in the treatment of cognitive dysfunction in stroke patients, including cognitive function, ability of daily living, vascular endothelial function, nerve function and cerebral blood flow, confirming that the combined treatment has good clinical effects and providing a new reference for the treatment of cognitive dysfunction in stroke patients in the future.

Research methods

The clinical data of the patients were analyzed retrospectively and grouped according to different treatment methods. Then, independent sample *t* test, paired sample *t* test and χ^2 test were used to statistically analyze the general data of the two groups, including mental state, cognitive function, daily living ability score, neurotransmitter level, vascular endothelial function index level, cognitive-related index and cerebral blood flow index before and after treatment. The feature of retrospective study is to explore the cause through the results, and it is easier to obtain the case data.

Research results

EECP combined with atorvastatin can significantly improve cognitive function, mental state, ability of daily living, vascular endothelial function, nerve function and cerebral blood flow in the treatment of stroke patients with cognitive dysfunction, which provides a new treatment method for the treatment of stroke patients with cognitive dysfunction and requires further prospective exploration. To further verify the effectiveness of this treatment method.

Research conclusions

Vascular endothelial dysfunction can lead to impairment of the blood-brain barrier, leading to cognitive dysfunction. Therefore, attention should be paid to the effect of treatment on vascular endothelial function. Based on the better treatment effect of EECP combined with atorvastatin, the more effective treatment scheme should be selected in clinic.

Research perspectives

Biological indicators can effectively reflect the severity of the patient's disease, and the effect of treatment regimen on the level of novel biomarkers in patients with post-stroke cognitive dysfunction needs to be further explored.

FOOTNOTES

Author contributions: Duan Y initiated the project, designed the experiment and conducted clinical data collection; Tang HX performed postoperative follow-up and recorded data, conducted a number of collation and statistical analysis, and wrote the original manuscript; both authors reviewed and approved the paper; and all authors have read and approved the final manuscript.

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