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The Difference of Inflammatory Factors and Oxidative Stress Indexes in Patients with Ischemic Stroke Treated with Bao Yang Huan Wu Decoction Combined with Acupuncture

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Abstract: This study aimed to investigate the effects of Buyang Huanwu Decoction combined with acupuncture on inflammatory factors, oxidative stress indices, and neurological function prognosis in patients with ischemic stroke. A total of 80 patients with ischemic stroke were randomly divided into an experimental group and a control group, with 40 cases in each group. The control group received conventional treatment combined with acupuncture, while the experimental group additionally received Buyang Huanwu Decoction on the basis of the control treatment. The treatment course lasted 4 weeks. Changes in inflammatory factors, oxidative stress indices, and neurological function were compared between the two groups before and after treatment. After 4 weeks of treatment, the levels of TNF-α, IL-6, and hs-CRP in the experimental group were significantly lower than those in the control group ($P < 0.001$). The levels of SOD and GSH-Px were significantly increased, whereas the level of MDA was markedly decreased in the experimental group compared with the control group ($P < 0.001$). Moreover, the NIHSS score in the experimental group was significantly lower than that in the control group [(4.9 ± 2.3) vs (6.7 ± 2.5), $P = 0.001$], and the proportion of patients with a favorable mRS outcome was significantly higher (77.5% vs 52.5%, $P < 0.05$). Buyang Huanwu Decoction combined with acupuncture can effectively attenuate inflammatory responses and oxidative stress injury, improve neurological function, and enhance clinical prognosis, demonstrating high clinical application value.

1. Introduction

Ischemic stroke refers to a kind of neurological problem happening when blood flow to the brain suddenly gets reduced or blocked, which is known for being very common, often leading to disability and coming back again, posing a big threat to how well middle-aged and older people can live their lives. Current research information suggests that the main reasons behind worse brain tissue damage and limited nerve function recovery are the inflammation and oxidative stress that follow after blood flow returns, that is to say, after the initial blockage is fixed. In Traditional Chinese Medicine, this condition falls under what's called "stroke," with its development mainly

thought to be due to lack of vital energy and blood not moving properly, along with blockages in the body's pathways. The key treatment ideas involve boosting energy, getting blood flowing, and clearing those pathways. Related studies show that fighting inflammation can lower levels of certain inflammation factors, thereby helping reduce extra harm to brain tissue. Making oxidative stress better and boosting antioxidant enzyme activity helps protect nerve cells and get functions back. Both Buyang Huanwu Decoction and acupuncture have shown they can help improve nerve function after stroke, but looking at how well they work together hasn't been studied enough in a thorough way. This research used a method where patients were assigned randomly to different groups to look at the effects of combining Buyang Huanwu Decoction with acupuncture on inflammation factors, markers of oxidative stress, and how well nerve function recovers in people with ischemic stroke, aiming to give more solid proof for treatments mixing Chinese and Western medicine approaches.

2. Materials and Methods

2.1 Research Materials

A total of 80 stroke patients admitted to a hospital from around July 2023 to about July 2024 were chosen for the study. All of the patients met the diagnosis rules as set out in the "China Guidelines for the Diagnosis and Treatment of Acute Stroke," that is to say, they were confirmed using brain scanning images like CT or MRI. To put it simply, the patients who were included were admitted within roughly 72 hours after their symptoms started, with consciousness that was clear or only a little impaired, vital signs that were mostly stable, and importantly, they could cooperate with the necessary checks and treatments. Patients were not included if they had, for instance, bleeding in the brain at the same time, severe problems with their heart, liver, or kidneys, active infections happening, autoimmune diseases, cancers, or if they couldn't have Chinese medicine or acupuncture treatments. Using a random number table method, the patients were divided into an experimental group and a control group, with 40 cases in each group. There were no big differences found in the general information between the two groups, such as their gender, how old they were, how long they had been sick, and existing health conditions ($P>0.05$), meaning the groups could be compared fairly [1].

2.2 Research Methods

Both groups of patients were provided with standardized care for ischemic stroke after joining the study, that is to say, this included approaches like antiplatelet therapy, managing lipids, improving cerebral blood flow, controlling both blood pressure and blood sugar levels, along with early-stage rehabilitation exercises. Additionally to the standard treatment protocol, the control group also underwent acupuncture treatment sessions, using commonly selected points such as Baihui (GV20), Fengchi (GB20), Quchi (LI11), Hegu (LI4), Zusanli (ST36), and also Taichong (LR16). The needles were kept in place for a duration of 30 minutes after achieving the de qi sensation, administered each day for a continuous period of 5 weeks. As for the experimental group, they received the oral administration of Buyang Huanwu Decoction, which is a traditional herbal preparation, on top of receiving the same treatments given to the control group, taking one dose twice every day, specifically in the morning and the evening, over four consecutive weeks. Before starting any treatment and after completing the four-week treatment period, both sets of patients had their relevant parameters monitored and treatment effectiveness was observed and recorded.

2.3 Research Indicators

The research indicators primarily include the following three aspects: ① Inflammatory factor levels, where fasting venous blood samples were collected from patients before treatment and 4 weeks after treatment, and the levels of tumor necrosis factor-alpha (TNF-α), interleukin-6 (IL-6), and high-sensitivity C-reactive protein (hs-CRP) were detected using enzyme-linked immunosorbent assay (ELISA); ② Oxidative stress indicators, including the activity of superoxide dismutase (SOD) and glutathione peroxidase (GSH-Px), as well as the content of malondialdehyde (MDA); ③ Neurological function and prognosis evaluation, where the degree of neurological deficits was assessed using the National Institute of Health Stroke Scale (NIHSS), and the functional outcomes and prognosis were evaluated using the modified Rankin scale (mRS) 4 weeks after treatment.

2.4 Statistical Analysis

Statistical analysis was performed using SPSS 26.0 software. Measurement data were presented as ($\bar{x} \pm s$) after normality testing, with intergroup comparisons conducted by independent samples t-test and intra-group treatment comparisons by paired t-test. Categorical data were expressed as [n (%)], with intergroup comparisons performed using chi-square test. All statistical tests were two-tailed, and a P-value <0.05 was considered statistically significant.

3. Results

3.1 Results of inflammatory factors

Prior to treatment, both groups of ischemic stroke patients exhibited elevated levels of TNF-α, IL-6, and hs-CRP, with no significant intergroup differences (P>0.05), indicating similar baseline inflammatory states and excluding interference from initial inflammatory levels. After 4 weeks of treatment, inflammatory factor levels in both groups showed significant reduction compared to baseline, demonstrating that conventional therapy combined with acupuncture or Buyang Huanwu Decoction intervention could suppress post-ischemic stroke inflammatory responses. However, at the same time point, intergroup comparisons revealed that the experimental group had significantly lower levels of TNF-α, IL-6, and hs-CRP than the control group, with statistically significant differences (t=4.10–4.51, P<0.001). This indicates that the combination of Buyang Huanwu Decoction and acupuncture was more effective than acupuncture alone in reducing inflammatory factor levels. Detailed data are presented in the table 1.

Table 1: Comparison of inflammatory factors before and after treatment in the two groups ($\bar{x}\pm s$, n=40)

metric	time point	Control group (n=40)	Experimental group (n=40)	between-group t-value	P price
TNF-α(pg/mL)	base line	34.9±7.8	35.2±7.6	-0.17	0.866
	4 weeks	28.1±7.2	22.0±6.1	4.1	<0.001
	Δ variable quantity	-6.8±4.9	-13.2±5.3	5.59	<0.001
IL-6(pg/mL)	base line	18.4±4.6	18.1±4.8	0.29	0.774
	4 weeks	14.6±4.0	10.8±3.5	4.51	<0.001
	Δ variable quantity	-3.8±3.2	-7.3±3.4	4.73	<0.001
hs-CRP(mg/L)	base line	9.7±2.6	9.6±2.5	0.17	0.867
	4 weeks	7.8±2.1	5.9±1.8	4.38	<0.001
	Δ variable quantity	-1.9±1.5	-3.7±1.6	5.17	<0.001

As shown in the table, the Δ values of inflammatory factors before and after treatment in both groups revealed that the experimental group exhibited significantly greater reductions in TNF-α, IL-6, and hs-CRP compared to the control group, with statistically significant differences between groups (t=4.73–5.59, P<0.001). These results demonstrate that Buyang Huanwu Decoction combined with acupuncture not only reduces inflammatory factor levels but also produces a stronger and more stable inhibitory effect on inflammatory responses [2]. By integrating the pivotal role of the inflammatory cascade in ischemic stroke in neural injury, it can be inferred that combined therapy more effectively suppresses the release of inflammatory mediators and mitigates inflammatory damage, thereby laying a solid foundation for subsequent neurological function recovery and prognosis improvement.

3.2 Results of oxidative stress indicators

Prior to treatment, there were no significant differences in SOD, GSH-Px, and MDA levels between the two groups (P>0.05), indicating good comparability of baseline oxidative stress status. After 4 weeks of treatment, the control group showed increased SOD and GSH-Px levels compared to baseline, along with decreased MDA levels, suggesting that conventional treatment combined with acupuncture is beneficial for enhancing the body's antioxidant capacity and reducing lipid peroxidation damage. Compared to the control group, the experimental group exhibited significantly elevated SOD and GSH-Px levels and markedly reduced MDA levels at week 4, with statistically significant intergroup differences (t=3.30–4.38, P≤0.001). The data are presented in the table 2.

Table 2: Comparison of oxidative stress indicators before and after treatment in the two groups ($\bar{x}\pm s$, n=40)

metric	time point	Control group (n=40)	Experimental group (n=40)	between-group t-value	P price
SOD(U/mL)	base line	82.4±15.1	83.1±14.7	-0.21	0.833
	4 weeks	92.1±14.2	105.3±13.1	-4.3	<0.001
	Δ variable quantity	+9.7±10.8	+22.2±11.5	-4.99	<0.001
GSH-Px(U/L)	base line	238±44	241±46	-0.3	0.766
	4 weeks	272±48	309±52	-3.3	0.001
	Δ variable quantity	+34±33	+68±36	-4.38	<0.001
MDA(nmol/mL)	base line	6.78±1.18	6.81±1.16	-0.11	0.91
	4 weeks	5.86±1.10	4.83±1.00	4.38	<0.001
	Δ variable quantity	-0.92±0.86	-1.98±0.92	5.32	<0.001

The table above demonstrates that the combined therapy of Buyang Huanwu Decoction with acupuncture demonstrates superior efficacy in ameliorating oxidative stress imbalance in ischemic stroke patients compared to acupuncture alone. This therapeutic regimen exhibits more pronounced antioxidant effects. Analysis of the change values (Δ) before and after treatment revealed that the experimental group showed significantly greater increases in SOD and GSH-Px levels and greater reductions in MDA levels compared to the control group, with statistically significant differences (t=4.38–5.32, P<0.001). These findings suggest that the combined treatment not only improves the terminal levels of oxidative stress-related indicators but also modulates the dynamic balance between oxidation and antioxidation, exerting a more potent effect. Following ischemic stroke onset, excessive reactive oxygen species generation and lipid peroxidation become critical mechanisms leading to neuronal damage and apoptosis. The pharmacological effects of Buyang Huanwu

Decoction in replenishing qi, activating blood circulation, and restoring meridian function, combined with acupuncture's regulatory effects on meridian qi and blood, enhance endogenous antioxidant enzyme activity, reduce free radical generation, and mitigate oxidative stress damage. This provides an important pathophysiological basis for the recovery of neurological function and improvement of prognosis [3].

3.3 Neurological Function and Prognostic Outcomes

There was no statistically significant difference in NIHSS scores between the two groups before treatment (P>0.05), indicating that the baseline levels of neurological deficits were essentially equivalent and highly comparable. After 2 and 4 weeks of treatment, both groups showed a significant decline in NIHSS scores compared to baseline, with intergroup comparisons yielding P-values <0.05. This suggests that both treatment regimens improved neurological deficits in ischemic stroke patients over time, but the experimental group demonstrated more pronounced improvement. At 4 weeks, the intergroup comparison of mRS functional outcomes and adverse event rates revealed a P-value <0.05 for functional outcomes and a P-value>0.05 for adverse events, indicating that the combined treatment had a superior effect on functional prognosis while maintaining comparable safety to the control group. Specific data are presented in the table 3.

Table 3: Comparison of neurological function, prognosis, and safety between the two groups

Comparison of 3A NIHSS scores ($\bar{x}\pm s$, n=40)

time point	Control group (n=40)	Experimental group (n=40)	between-group t-value	P price
base line	12.3±3.1	12.1±3.0	0.29	0.772
2 weeks	8.9±2.8	7.2±2.6	2.8	0.006
4 weeks	6.7±2.5	4.9±2.3	3.34	0.001
ΔChange (4 weeks-baseline)	-5.6±2.7	-7.2±2.8	2.61	0.011

Table 4: Comparison of functional outcomes and adverse reactions in 3B 4-week mRS

metric	lamination	Control group (n=40)	Experimental group (n=40)	(2 values)	P price
mRS Outcome (4 weeks)	Good (0–2)	21(52.5%)	31(77.5%)	5.49	0.019
	Adverse (3–6)	19(47.5%)	9(22.5%)		
Adverse Reactions (Total)	have	6(15.0%)	5(12.5%)	0.11	0.741
	not have	34(85.0%)	35(87.5%)		

As shown in the table 4, the NIHSS score in the experimental group was (7.2±2.6) at 2 weeks of treatment, significantly lower than the control group's (8.9±2.8), with a statistically significant difference (t=2.80, P=0.006). At 4 weeks of treatment, the NIHSS score in the experimental group further decreased to (4.9±2.3), while the control group remained at (6.7±2.5), with a statistically significant intergroup difference (t=3.34, P=0.001). Moreover, the score reduction in the experimental group (-7.2±2.8) was significantly greater than that in the control group (-5.6±2.7) (t=2.61, P=0.011). In terms of functional outcomes, the proportion of patients with favorable outcomes (grades 0-2) in the experimental group at 4 weeks was 77.5%, significantly higher than the control group's 52.5%, with a statistically significant difference (χ^2=5.49, P=0.019). Regarding adverse reactions, the incidence rates in both groups were 12.5% and 15.0%, respectively, with no statistically significant difference (χ^2=0.11, P=0.741), indicating that the combination of Buyang Huanwu Decoction and acupuncture significantly improved neurological function and prognosis without increasing safety risks.

4. Discussion

4.1 Synergistic Mechanism of Inflammatory Response Regulation and Combined Acupuncture with Buyang Huanwu Decoction

Ischemic stroke happens, and the inflammatory cascade reaction leads to secondary brain injury and worsening of nerve function. Certain inflammatory substances, like TNF-α, IL-6, and hs-CRP, that is to say, these features break down the blood-brain barrier, they help white blood cells get in, and also cause nerve cell death, making the damage in the ischemic penumbra area worse. Studies have found that the levels of these inflammatory factors in both patient groups was not very different before treatment ($P>0.05$), meaning the starting point was similar. After getting treatment for 4 weeks, the levels of the inflammatory factors mentioned above in the group getting the special treatment were much lower than in the regular group, with all changes showing highly significant differences in the statistics ($P<0.001$). This information demonstrates the strong effect of using Buyang Huanwu Decoction together with acupuncture in putting a stop to inflammatory responses, to put it simply [4].

According to Traditional Chinese Medicine (TCM) theory, ischemic stroke is often considered a type of "wind-stroke" condition, where the main problem involves a lack of vital energy and blood getting stuck, leading to blockages in the brain pathways. The Buyang Huanwu Decoction works mainly by using Astragalus (Huangqi) to boost the body's foundational energy, that is to say, its core strength, and then combines this with other herbs that help move the blood and clear out blockages in the smaller channels. To put it simply, by strengthening the energy flow, it helps push out the stuck blood, which improves small blood vessel circulation and reduces the lack of oxygen and blood flow in affected areas. A lot of modern research has shown that the formula helps reduce inflammation by lowering certain signals in the body and interfering with pathways that cause swelling. Acupuncture, for its part, works by adjusting the body's nerve, hormone, and defense system connections, which then helps calm down the release of substances that cause inflammation. When these two approaches are used together, it's likely why the group receiving both saw a bigger drop in inflammation markers. These findings suggest that combining treatments for ischemic stroke offers benefits in fighting inflammation, which is supported by the data analysis.

4.2 Protective Effects of Oxidative Stress on Brain Tissue

Oxidation stress imbalance is another core mechanism of ischemic stroke secondary injury. Too much active oxygen (ROS) production can lead to lipid peroxidation, protein and DNA damage, and finally cause neuron apoptosis. This study find that before the treatment, the level of superoxide dismutase (SOD), glutathione peroxidase (GSH-Px) and malondialdehyde (MDA) in the two group compared, the difference has no statistics meaning ($P>0.05$), so they are comparable. After 4 week of treatment, the level of antioxidant enzymes SOD and GSH-Px in experiment group was much more higher than the control group, but the lipid peroxidation product MDA level was lower than control group. The difference between two group has statistical significance ($P\leq0.001$). The change range also show that the experiment group improve more better ($P<0.001$).

Statistical results show that Buyang Huanwu Decoction plus acupuncture show a more strong effect in improve the balance of oxidation and anti-oxidation in the body. The mechanism is that Buyang Huanwu Decoction has the function of supplementing qi and promoting blood circulation. It can improve energy metabolism and microcirculation of brain tissue, so it reduce the production of free radical from the source. At same time, many herbs in this formula have clear effects of cleaning free radicals and make the activity of antioxidant enzymes more strong.On the other hand, acupuncture can adjust the central nervous system and autonomic nervous function, so it make the

body's endogenous antioxidant defense ability more strong. The P value is significantly less than 0.05 or even less than 0.001, this shows the difference is not a accident. It reflect that the combined therapy has a stable and reliable advantage in reduce oxidative stress damage. This provide a key experimental basis for its neuroprotection effect.

4.3 Comprehensive Significance of Neurological Function Recovery and Clinical Prognosis Improvement

The degree of neurological deficits and functional outcomes serve as core clinical indicators for evaluating the therapeutic efficacy of ischemic stroke. The results of this study demonstrated that there was no statistically significant difference in NIHSS scores between the two groups before treatment ($P>0.05$), indicating consistent baseline neurological status. After 2 and 4 weeks of treatment, the NIHSS scores in the experimental group were significantly lower than those in the control group ($P<0.01$), with a greater decline in scores before and after treatment ($P=0.011$), suggesting that the combined therapy exhibited a marked advantage in promoting neurological recovery. In the 4-week functional outcome assessment, the proportion of favorable outcomes in the experimental group was significantly higher than that in the control group ($\chi^2=5.49$, $P=0.019$), while the incidence of adverse reactions showed no statistically significant difference ($P>0.05$), indicating that the improved efficacy was not achieved at the expense of reduced safety [5].

The improvement of inflammatory factors and oxidative stress markers shows that Buyang Huanwu Decoction with acupuncture has many biological effect. It can reduce inflammation and oxidative damage, so it help neurons survival and function recovery. Statistical analysis shows all P values are<0.05. This show that the experiment group significantly promotes nerve function recovery and improve the prognosis. The effect is stable and reliable. These result not only confirm the short clinical advantage of the combined treatment, but also provide evidence base medicine support for its use in the recovery period of ischemic stroke.

5. Conclusion

This study based on the mechanism of inflammation and oxidative stress damage, systematically evaluates the clinical effect of Buyang Huanwu Decoction combined with acupuncture for ischemic stroke. The result show that compared with only acupuncture, this combined plan is more better in lowering the level of inflammatory factors like tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6), and high-sensitivity C-reactive protein (hs-CRP). Also, it can strengthening the antioxidant ability of superoxide dismutase (SOD) and glutathione peroxidase (GSH-Px), and it have a good effect in reduce the produce of malondialdehyde (MDA).At the same time, this plan can promote nerve function recovery and improves short-term functional results. Statistical analysis show that the difference of all main indicators are reliable and stable, and it did not increase the rate of bad reactions. These findings suggest that Buyang Huanwu Decoction join with acupuncture can protect nerve through many way and many targets. It provide a strong evidence-based medicine support for the comprehensive recovery treatment of ischemic stroke. This approach merits further clinical promotion and long-term follow-up studies.

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