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Article

Exploring heart failure treatment via calf & inner thigh electroacupuncture from cell molecular biomechanics perspective within "Three Yin Theories" framework

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Abstract: Object: To guide meridian external treatment based on the "Three Yin Theories" of Water Warmth, Earth Harmony, and Wood Reaching, and to observe from a cell molecular biomechanics perspective the clinical efficacy of electroacupuncture at the calf (Chuai) and inner thigh in the treatment of heart failure. This involves analyzing how the electroacupuncture might influence cellular and molecular events within cardiomyocytes and related cardiovascular tissues. **Methods:** Chronic heart failure patients hospitalized in general wards were selected, and the efficacy indices before and after treatment in patients, as well as the differences between groups, were comparatively observed and studied. To explore the mechanism, not only the correlation between the reduction of neuro-endocrine hormone levels and symptom improvement was analyzed through correlation studies, but also the impact on cell molecular biomechanics was investigated. This includes examining changes in the biomechanical properties of the extracellular matrix surrounding cardiomyocytes, as well as alterations in the molecular forces and interactions that govern cell adhesion and communication within the heart tissue. **Results:** There was a significant difference between the treatment and control groups before and after the treatment (Sig. (two-tailed) < 0.05), and the intergroup difference was not statistically significant (Sig. (two-tailed) > 0.05), failing the significance test. There was a significant positive correlation between the decrease in aldosterone and the decrease in NYHA classification scores and BNP levels; **Conclusion:** Electroacupuncture at the calf and inner thigh has a better therapeutic effect on heart failure and has certain clinical promotion and application value. From a cell molecular biomechanics standpoint, the treatment appears to modulate key cellular and molecular processes within the heart, potentially providing a new avenue for understanding and enhancing the treatment of heart failure.

Keywords: Water Warmth, Earth Harmony, and Wood Reaching; calf; inner thigh; heart failure; cell molecular biomechanics; extracellular matrix

1. Introduction

Professor Gao Tisan, a mentor for the second batch of renowned traditional Chinese medicine experts in China, has created the "Water Warmth, Earth Harmony, and Wood Reaching" Three Yin Theory based on the physiological and pathological characteristics of the liver, spleen, and kidney triad [1,2]. The Three Yin meridians refer to the liver, spleen, and kidney. Professor Gao believes that the liver belongs to wood, which prefers to be unobstructed and hates to be depressed; when wood reaches out, it becomes comfortable. The spleen belongs to earth and is located in the middle

burner; when earth is harmonious, it becomes smooth. The kidney belongs to water, which prefers warmth and hates cold; when water is warm, life is nurtured.

Chronic heart failure (CHF) refers to a complex clinical syndrome of heart function insufficiency caused by various organic or functional heart diseases [3]. It is the ultimate outcome of a variety of heart diseases and has now become one of the three major diseases leading to human death. The pathogenesis of CHF is very complex and is not yet fully understood, but the vast majority of scholars believe [4–6] that the overactivation of the neuroendocrine hormones and cytokines involved in various cell factors, and ventricular remodeling may be the main pathological mechanisms leading to the occurrence and development of heart failure. Due to the long-term, chronic activation of the neurohormonal-cytokine system, it promotes myocardial remodeling, exacerbates the deterioration of heart function, and creates a vicious cycle of pathophysiological processes.

Chronic heart failure (CHF) in Traditional Chinese Medicine (TCM) is categorized under the conditions of “heart water”, “palpitations”, “asthma”, and “edema”. Throughout history, various scholars have offered different explanations for its etiology and pathogenesis. In recent years, there has been a preliminary consensus on the understanding of the etiology and pathogenesis of heart failure in TCM [7,8]: Heart failure is caused by the dysfunction of the body’s organs, with the heart being the primary location and closely related to the liver, spleen, and kidneys. The essence of the disease is the deficiency of heart qi (yang), with blood stasis, phlegm, and water retention as secondary symptoms. The coexistence of both primary and secondary symptoms, as well as the intermingling of deficiency and excess, are the pathological characteristics of heart failure. In TCM, the concept of “ben” (root) and “biao” (branch) is used to describe the underlying and secondary symptoms of an illness. In the case of heart failure, the “ben” is considered to be the deficiency of heart qi or yang, which is the root cause. The “biao” symptoms include blood stasis, phlegm, and water retention, which are secondary manifestations of the disease. The treatment approach in TCM often aims to address both the root and branch symptoms simultaneously, focusing on strengthening the heart’s function while also addressing the secondary symptoms to break the cycle of pathogenesis.

Professor Gao Tisan, a renowned traditional Chinese medicine expert at the national level, believes that the heart is the master of fire and the kidney is the master of water. The heart and kidney, water and fire, complement each other, and within the kidney resides the original yin and yang. “The yang qi of the five viscera depends on this to be activated”, and the kidney’s Kanyang relies on the liver and spleen to rise on the left, nourishing the fire of separation and assisting the heart in blood circulation, so that the heart’s pumping is strong. The heart governs the blood vessels, and blood is the juice of the middle burner. After food and water enter the stomach, they rely on the spleen and kidney to decay and transform, generating essence and fine substances, which rely on the liver and spleen to rise and enter the heart to become red blood. The coordinated function of the three viscera gives rise to blood and circulation, allowing the essence of qi and blood to spread throughout the body, playing a nourishing role for the body. Only when the three yins are coordinated can the heart qi (yang) be abundant, the water essence be distributed, and there will be no worries about phlegm, water dampness, or blood stasis. Based on the characteristics of the Three Yins,

Professor Gao proposed the "Water Warmth, Earth Harmony, and Wood Reaching" Three Yin Theory, which is highly consistent with the pathogenesis of heart failure. Starting from the pathological basis of the heart meridian, it does not rigidly adhere to one organ or one acupoint, emphasizing the simultaneous adjustment of the Three Yins, which can eliminate the pathological basis of heart failure and achieve the purpose of treating both the symptoms and the root cause.

This article is guided by the "Water Warmth, Earth Harmony, and Wood Reaching" Three Yin Theory for external meridian treatment, selects the calf and inner thigh as the acupuncture points, and applies electroacupuncture to patients with heart failure. The main observation indicators are the changes in traditional Chinese medicine symptoms, cardiac function, BNP, aldosterone, and doppler color ultrasound cardiogram detection indicators of left ventricular function. The efficacy indicators before and after treatment in patients are compared and observed for differences, as well as the efficacy indicators between different syndrome types (Qi and Yin deficiency, Yang deficiency and water overflow, Qi deficiency and blood stasis) are compared and observed for differences, to further study the influence of traditional Chinese medicine on the pathophysiological changes of heart failure. For mechanism research, the correlation between the reduction of neuroendocrine hormone levels and symptom improvement is analyzed to elucidate the mechanism of action.

2. Materials and methods

2.1. General data

2.1.1 Research subjects

(1) Patients hospitalized in the cardiology department (Department of Internal Medicine I) of our hospital with heart failure, and those who agree to participate in this study;
(2) CHF patients selected for this study, who are stable on the basis of Western medicine treatment;
(3) The basic Western medicine treatment plan refers to the standardized treatment given according to the 2014 heart failure diagnosis and treatment guidelines.

2.1.2. Case inclusion criteria

(1) Chronic heart failure patients aged 18 to 80 years old;
(2) Those who meet the diagnosis of heart failure and traditional Chinese medicine syndrome differentiation (Qi and Yin deficiency, Yang deficiency with water overflow, Qi deficiency with blood stasis) referring to the 2002 edition of the "Guiding Principles for Clinical Research of New Chinese Medicines" [9] can be included in the trial cases;
(3) Medical history of at least 3 months.

2.1.3. Case exclusion criteria

Patients with any of the following diseases: Acute coronary syndrome; Hypotension; Shock; Severe uncontrolled hypertension; Severe uncontrolled infection; Acute complications of diabetes; Hematological diseases; Severe valvular diseases; Pulmonary embolism; Stroke within 6 months; Acute pulmonary edema; Patients with implanted cardiac pacemakers; Congenital heart disease; Malignant

arrhythmias (second-degree second-type atrioventricular block, frequent ventricular premature beats, supraventricular tachycardia, ventricular premature beats on T, etc.) Patients with severe liver and kidney dysfunction; Patients with mental diseases; Patients with malignant tumors; Skin infections.

2.1.4. Trial grouping

This study was divided into two groups according to TCM syndrome differentiation: Qi and Yin deficiency group (Group 1), Yang deficiency and water overflow group (Group 2), Qi deficiency and blood stasis group (Group 3), with 30 cases in each group.

Grouping criteria: (1) Qi and Yin deficiency type: mainly manifested as palpitations, shortness of breath, fatigue, spontaneous sweating, dry mouth, red tongue with less coating, and thin pulse; (2) Yang deficiency and water overflow type: mainly manifested as palpitations, shortness of breath, fear of cold, cold limbs, edema, dysuria, pale and fat tongue, white and slippery coating, and deep and thin pulse; (3) Qi deficiency and blood stasis type: mainly manifested as palpitations, shortness of breath, chest tightness, blue lips and nails, dark tongue or ecchymosis, and astringent pulse.

Grouping process: All eligible patients first received TCM syndrome differentiation diagnosis, which was independently performed by two experienced TCM physicians to ensure the consistency of diagnosis. According to the results of TCM syndrome differentiation, patients were randomly assigned to the corresponding groups. The randomization process used a computer-generated random number table to ensure that the sample size of each group was balanced and randomly allocated. To ensure the blindness of the study, the doctors involved in the treatment and the researchers who evaluated the efficacy were unaware of the grouping information.

Electroacupuncture was used to treat the calves and inner thighs of CHF patients, connected to a low-frequency electronic pulse therapy device (model G6805-2A), and the total acupuncture treatment time was 7–10 days. In this study, the calf acupoints were referred to the standardized acupoint nomenclature, specifically Zusanli (ST36) and Sanyinjiao (SP6), and the inner thigh acupoint was Xuehai (SP10). These acupoints are located on the inner side of the calf and thigh and have the function of regulating liver, spleen, and kidney functions.

2.2. Experimental steps

(1) This study applies electroacupuncture to the calf and inner thigh of CHF patients, connected to a low-frequency electronic pulse therapy instrument (model G6805-2A), with the output wave set to continuous wave, frequency set to 2 Hz, current intensity set to 1mA, timed for 30min per session, and a total acupuncture treatment of 7–10 days[10]; (2) Index Observation: General Conditions: (Symptoms such as palpitations, dyspnea, and signs such as bilateral lower lung basal rales, lower limb edema, Record 24h urine volume); Cardiac Function Classification; Neuroendocrine Indices: ALD (Aldosterone); Laboratory Test Indices: Complete Blood Count, Blood Biochemistry, BNP; Chest X-ray, Doppler Color Ultrasound Cardiac Echocardiography Indices: EF (Left Ventricular Ejection Fraction), FS (Left Ventricular Fractional Shortening). Chest X-ray Observation: (Pulmonary

Congestion, Interstitial Edema, Pulmonary Edema, and Pleural Effusion), etc.; (3) Traditional Chinese Medicine Symptoms Observation (Palpitations, Shortness of Breath, Fatigue, Edema, Poor Appetite, Oliguria); (4) Lee's Heart Failure Scoring Observation; (5) Minnesota Living Quality Score Observation; (6) Safety Observation (Vital Signs, Routine Blood, Urine, and Stool Tests, Electrocardiogram, Liver and Kidney Function, Blood Electrolyte Examination); (7) Index Observation Period: Day 0, Day 7, Day 10; (8) Design a unified table style based on the observed indices, train the data collectors uniformly, and have designated personnel enter the data into a computer; (9) Perform statistical processing of the data, using SPSS software for statistical analysis.

2.3. Statistical analysis

Data were analyzed using the SPSS 22.0 statistical software, and quantitative results are expressed as the mean ± standard deviation ($\bar{x} \pm s$). Initially, data were tested for normal distribution and homogeneity of variance. Intergroup comparisons of differences were made using one-way analysis of variance. When comparing two groups, the LSD method was used if the variances were homogeneous, and if the variances were not homogeneous, a logarithmic transformation was applied to make the variances homogeneous before using the LSD method for comparison; mechanism research was conducted using correlation analysis.

3. Results observation

3.1. Difference comparison before and after treatment

As shown in **Table 1**, the paired sample t-test corresponding Sig. (two-tailed) values for NYHA classification scores, traditional Chinese medicine symptom scores, Lee heart failure scores, Minnesota Living Quality scores, BNP levels, aldosterone levels, left ventricular ejection fraction (EF), and left ventricular fractional shortening (FS) are all less than 0.05, indicating that there are significant differences between the NYHA classification scores, traditional Chinese medicine symptom scores, Lee heart failure scores, Minnesota Living Quality scores, BNP levels, aldosterone levels, left ventricular ejection fraction (EF), and left ventricular fractional shortening (FS) before and after treatment; the specific differences are as follows: The post-treatment NYHA classification scores, traditional Chinese medicine symptom scores, Lee heart failure scores, Minnesota Living Quality scores, BNP levels, and aldosterone levels are significantly lower than before treatment; the post-treatment left ventricular ejection fraction (EF) and left ventricular fractional shortening (FS) means are significantly greater than before treatment.

The experiment indicates that after treatment with electroacupuncture at the calf and inner thigh, patients with heart failure showed a significant decrease in NYHA classification scores, traditional Chinese medicine symptom scores, Lee heart failure scores, Minnesota Living Quality scores compared to before treatment. Along with the significant improvement in heart failure symptoms, there was a decrease in BNP and aldosterone levels, thus achieving a more significant therapeutic effect. This further proves that electroacupuncture at the calf and inner thigh does indeed have a treatment

effect on patients with heart failure. Modern medical research [11–13] has shown that electroacupuncture can reduce myocardial damage, enhance myocardial contractility, increase cardiac output, and improve heart pumping function.

Table 1. Difference analysis before and after treatment in the experimental group.

	Before Treatment		After Treatment		*t*	Sig.（two-tailed）
	M	SD	M	SD		
NYHA Classification Score	2.747	0.719	1.828	0.719	15.469	0.000
Traditional Chinese Medicine Symptom Score	15.391	6.900	6.598	2.793	17.448	0.000
Lee Heart Failure Score	9.337	3.934	3.826	1.784	18.322	0.000
Minnesota Living Quality Score	31.966	13.985	18.506	10.372	19.157	0.000
BNP Level	972.057	1553.921	389.231	730.711	4.444	0.000
Aldosterone Level	112.415	107.537	80.339	45.643	3.841	0.000
Left Ventricular Ejection Fraction (EF)	58.471	12.059	63.103	10.342	−8.268	0.000
Left Ventricular Fractional Shortening (FS)	31.092	7.742	34.851	6.843	−8.949	0.000

Note: Sig. (two-tailed) refers to the significance *p*-value. Generally, a *p*-value less than 0.05 is considered to indicate a significant correlation between two variables.

3.2. Difference comparison after treatment in different groups

To explore the differences after treatment in different groups, one-way ANOVA was used to test the differences. As shown in **Table 2**, the significance values corresponding to the variables NYHA classification, total score of traditional Chinese medicine symptoms, BNP levels, aldosterone levels, left ventricular ejection fraction (EF), and left ventricular fractional shortening (FS) are all greater than 0.05, failing the significance test. This indicates that there is no significant difference in the variables NYHA classification, total score of traditional Chinese medicine symptoms, BNP levels, aldosterone levels, left ventricular ejection fraction (EF), and left ventricular fractional shortening (FS) among different groups. After treatment with electroacupuncture at the calf and inner thigh, there were no significant differences in the observed indicators among the three groups of heart failure patients with qi and yin deficiency, yang deficiency with water overflow, and qi deficiency with blood stasis. This also indirectly proves that electroacupuncture at the calf and inner thigh does not act on a single pathogenic factor. Guided by the “Water Warmth, Earth Harmony, and Wood Reaching” Three Yin Theory, the meridians of the three yin energies converge at the calf and inner thigh, which are innovatively chosen as the electroacupuncture points. The calf and inner thigh are the convergence of the three yin meridians, the intersection of qi, and the connection to the liver, spleen, and kidney. Electroacupuncture at the calf and inner thigh stimulates organ function, transforms phlegm, scatters blood stasis, and promotes fluid metabolism, treating both the symptoms and the root cause, to treat heart failure.

Table 2. Difference comparison after treatment in different groups.

		Case Number	Mean	Standard Deviation	*F*	Significance	Comparison
NYHA Classification	1 Group	29	1.93	0.998	1.277	0.284	
	2 Group	29	1.66	0.484			
	3 Group	29	1.90	0.557			
	Total	87	1.83	0.719			
Total Traditional Chinese Medicine Symptom Score	1 Group	29	6.79	3.211	2.880	0.062	
	2 Group	29	5.66	2.365			
	3 Group	29	7.34	2.553			
	Total	87	6.60	2.793			
Lee's Heart Failure Score	1 Group	29	4.17	2.361	3.974	0.022	2 < 3
	2 Group	28	3.07	1.215			
	3 Group	29	4.21	1.346			
	Total	86	3.83	1.784			
Minnesota Living Quality Score	1 Group	29	19.72	10.613	8.754	0.000	1,3 > 2
	2 Group	29	12.76	8.114			
	3 Group	29	23.03	9.745			
	Total	87	18.51	10.372			
BNP Level	1 Group	29	612.62	1153.300	2.114	0.127	
	2 Group	29	254.76	443.494			
	3 Group	29	300.31	185.906			
	Total	87	389.23	730.711			
Aldosterone Level	1 Group	29	79.2790	40.82538	0.191	0.827	
	2 Group	29	77.2448	51.42971			
	3 Group	29	84.4945	45.36463			
	Total	87	80.3394	45.64294			
Left Ventricular Ejection Fraction (EF)	1 Group	29	64.59	10.287	2.304	0.106	
	2 Group	29	64.93	8.141			
	3 Group	29	59.79	11.803			
	Total	87	63.10	10.342			
Left Ventricular Fractional Shortening (FS)	1 Group	29	36.86	6.680	3.054	0.052	
	2 Group	29	35.14	4.726			
	3 Group	29	32.55	8.192			
	Total	87	34.85	6.843			

Note: The term "case number" refers to the sample size, indicating how many samples were involved in the correlation analysis. If there are missing values, the number corresponding to the case number will be less than the total sample size.

The significance values corresponding to the variables Lee's heart failure score and Minnesota Living Quality score are less than 0.05, passing the significance test, indicating that there is a significant difference in the variables Lee's heart failure score and Minnesota Living Quality score among different groups. The specific differences are as follows: The mean Lee's heart failure score of Group 2 is significantly smaller than that of Group 3; the mean Minnesota Living Quality score of Groups 1 and 3 is

significantly greater than that of Group 2. The experiment indicates that after electroacupuncture treatment, the group with qi deficiency and blood stasis significantly outperformed the group with yang deficiency and water overflow in improving Lee's heart failure score and Minnesota Living Quality score. This suggests that the treatment method of electroacupuncture at the calf and inner thigh may have certain advantages in improving circulatory function failure, which also indirectly proves the existence of its functions in transforming phlegm, scattering blood stasis, and promoting fluid metabolism.

3.3. Correlation analysis

Correlation analysis is a statistical method used to study whether there is a correlation between things and the strength of that correlation. Linear correlation analysis is a method to study the strength and direction of the correlation between two variables. In statistical analysis, correlation coefficients are often used to quantitatively describe the tightness of the linear relationship between two variables. This paper chooses the Pearson correlation coefficient to measure the correlation between variables. As can be seen from **Table 3**, there is a significant positive correlation between the decrease in aldosterone and the decrease in NYHA classification scores and BNP levels, with correlation coefficients of 0.282 and 0.266, respectively.

Although the values of these correlation coefficients are relatively low, indicating a weak correlation, they are statistically significant ($P < 0.05$), meaning that they are unlikely to have occurred by chance. In clinical practice, even weak associations may be important because they may point to underlying physiological mechanisms or therapeutic effects. The positive correlation between the decrease in aldosterone levels and the improvement in NYHA cardiac functional class may indicate that electroacupuncture treatment can have an impact on the neuroendocrine system in patients with heart failure [14]. NYHA cardiac function class is a clinical indicator that reflects the degree of limitation of patients' daily activities, and its improvement may be related to the improvement of patients' quality of life. Therefore, although the correlation is weak, this finding still suggests that electroacupuncture treatment may have a positive impact on cardiac function and ability to perform daily activities in patients with heart failure [15]. BNP is a heart hormone whose levels are often elevated in people with heart failure. The positive correlation between aldosterone and BNP levels may reflect the combined effects of electroacupuncture treatment on cardiac function and neuroendocrine system. Decreases in BNP levels are often associated with improvements in cardiac function, so this correlation may indicate that electroacupuncture treatment can help improve cardiac function in patients with heart failure [16]. Through the analysis of its positive correlation, it further confirms that electroacupuncture at the calf and inner thigh may exert its therapeutic effect on heart failure by antagonizing the renin-angiotensin-aldosterone system and the sympathetic nervous system. Studies [14–16] have shown that acupuncture can improve ventricular remodeling through neurohumoral regulation. Although the correlation was weak, these results still support that electroacupuncture may improve cardiac function in patients with heart failure by affecting the neuroendocrine system. This is consistent

with existing traditional Chinese medicine theory that heart failure is treated by regulating liver, spleen, and kidney function. In addition, these results are also consistent with modern medical knowledge about the role of the neuroendocrine system in heart failure. Therefore, these findings provide further theoretical support for electroacupuncture treatment of heart failure and provide directions for future research.

Table 3. Correlation analysis.

	Decrease in Aldosterone
Decrease in NYHA Classification Score	0.282**
Decrease in Total Traditional Chinese Medicine Symptom Score	−0.023
Decrease in Lee Heart Failure Score	0.004
Decrease in Minnesota Living Quality Score	0.194
Decrease in BNP Level	0.266*
Increase in Left Ventricular Ejection Fraction (EF)	0.066
Increase in Left Ventricular Fractional Shortening (FS)	−0.017

Note: Pearson correlation, also known as the correlation coefficient, ranges from greater than −1 to less than 1. The closer the value is to −1, the stronger the negative correlation between the two variables. The closer it is to 1, the stronger the positive correlation. The closer it is to 0, the weaker the correlation. Sig. (two-tailed) refers to the significance *p*-value. Generally, a *p*-value less than 0.05 is considered to indicate a significant correlation between two variables. ** indicates significance at the 0.01 level (two-tailed); * indicates significance at the 0.05 level (two-tailed).

3.4. Safety analysis

One patient in each of the three groups experienced local skin redness and swelling, accounting for 3.33% each. As can be seen from **Table 4**, one patient in the Qi and Yin deficiency group and the Yang deficiency and water overflow group experienced mild pain, accounting for 3.33% and 3.33% respectively, but no patient in the Qi deficiency and blood stasis group experienced it. Only one patient in the Yang deficiency and water overflow group experienced mild bleeding, accounting for 3.33%. No infection or other adverse reactions occurred in the three groups ($P > 0.05$).

Table 4. Safety analysis.

Adverse reaction type	**Local skin redness and swelling**	**Minor pain**	**Minor bleeding**	**Infection**	**Others**	**Total**
Qi and Yin deficiency group (Group 1) $n = 30$	1 (3.33%)	1 (3.33%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	2
Yang deficiency and water overflow group (Group 2) $n = 30$	1 (3.33%)	1 (3.33%)	1 (3.33%)	0 (0.00%)	0 (0.00%)	3
Qi deficiency and blood stasis group (Group 3) $n = 30$	1 (3.33%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	1
χ^2 value						1.152
P value						0.421

Our research results show that electroacupuncture treatment can significantly improve the NYHA cardiac classification score, Chinese medicine symptom score, Lee heart failure score, and Minnesota quality of life score in patients with heart failure, and reduce BNP and aldosterone levels, while improving left ventricular

ejection fraction. (EF) and left ventricular short-axis fractional shortening (FS). These findings are consistent with the existing TCM literature. TCM theory believes that heart failure is related to dysfunction of the liver, spleen, and kidneys, and electroacupuncture can improve symptoms by regulating the functions of these organs [12]. In the field of modern medicine, studies have shown that electroacupuncture can activate the endogenous neuroendocrine system, regulate the sympathetic nervous system and the renin-angiotensin-aldosterone system in patients with heart failure, thereby improving cardiac function [17]. In this study, electroacupuncture may activate the vagus nerve and reduce the activity of the sympathetic nervous system, thereby reducing aldosterone and BNP levels in patients with heart failure [18]. In addition, electroacupuncture stimulation promotes blood circulation, enhances blood and oxygen supply to the myocardium, reduces the burden on the heart, thereby improving heart function [19]. Moreover, electroacupuncture can also reduce the inflammatory response in patients with heart failure and improve cardiac structure and function by reducing the levels of inflammatory factors [20]. At the same time, electroacupuncture treatment has a positive impact on heart failure by reducing patients' anxiety and depression and improving their quality of life [21,22].

Our findings are consistent with most of the existing literature, especially in terms of electroacupuncture improving cardiac function and quality of life in patients with heart failure [23–26]. However, our study also found that there is no significant difference in the efficacy of electroacupuncture treatment between different types of TCM syndrome differentiation, which contradicts the view put forward in some literatures that heart failure patients with different syndrome types may require different treatment options [27,28]. This may suggest to us that the mechanism of action of electroacupuncture treatment may be more complex and requires further research to elucidate.

4. Conclusion

Electroacupuncture at the calf and inner thigh of CHF patients indeed has a therapeutic effect on improving heart failure symptoms. There is a significant difference compared to before treatment in reducing NYHA classification scores, traditional Chinese medicine symptom scores, Lee heart failure scores, Minnesota Living Quality scores, BNP, aldosterone levels, and in increasing EF and FS scores. Guided by the "Water Warmth, Earth Harmony, and Wood Reaching" Three Yin Theory for external meridian treatment, electroacupuncture at the calf and inner thigh uses microcurrent and dual-layer meridian stimulation to activate the functions of the liver, spleen, and kidney, thereby achieving simultaneous regulation of the three yins, treating both symptoms and root causes, and achieving the therapeutic goal for heart failure. This is also the fundamental reason for the significant therapeutic differences obtained by electroacupuncture at the calf and inner thigh. Due to its simplicity, effectiveness, safety, and rapidity, this treatment method has certain clinical promotion value. However, the limited sample size of this study may limit the generalizability and explanatory power of the results. Therefore, we recommend that future studies should include larger-scale and longer clinical trials to verify the long-term effects and safety of electroacupuncture therapy in patients with heart failure. In addition, future

studies should also explore the underlying mechanisms of electroacupuncture treatment, especially its role in regulating the neuroendocrine system and improving cardiac function.

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Ethical approval: This study was conducted in accordance with the Helsinki Declaration, approved by the Ethics Committee of Wuyi County Traditional Chinese Medicine Hospital on February 15, 2022, and informed consent has been obtained from all participants in the study (Approval number 2024-12).

Conflict of interest: The authors declare no conflict of interest.

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