Efficacy Study of Levocarnitine Adjuvant Therapy for Complications of Heart Failure

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Abstract: The objective is to investigate the role of standard treatment combined with Levocarnitine (LC) in improving clinical outcomes in patients with complications of heart failure. The authors collected and organized data from 700 patients with complications of heart failure admitted to our cardiology department from January 2015 to February 2020. The patients were divided into a control group and an LC group, with 350 cases in each group. The control group received standard treatment, while the LC group received standard treatment combined with LC. The authors compared left ventricular ejection fraction (LVEF) and brain natriuretic peptide (BNP) levels between the two groups. Results: The LVEF level in the LC group was higher than that in the control group after treatment, with $P<0.05$. The BNP levels were similar between the two groups after treatment, with $P>0.05$. In the LC group, the LVEF level in patients with heart failure and diabetes was higher than that in the control group, and the BNP level was lower than that in the control group, with $P<0.05$. In patients with heart failure and atrial fibrillation in the LC group, the LVEF level was higher than that in the control group ($P<0.05$), and the BNP levels were similar between the two groups ($P>0.05$) after treatment. In patients with heart failure and dilated cardiomyopathy in the LC group, the LVEF level was higher than that in the control group, and the BNP level was lower than that in the control group, with $P<0.05$. Conclusion: LC combined with standard treatment can more significantly improve LVEF and BNP levels in patients with complications of heart failure, especially in the subgroup of heart failure with diabetes.

***Keywords*:** Levocarnitine, heart failure complications, efficacy, left ventricular ejection fraction, brain natriuretic peptide

1. Introduction

Heart failure is a common cardiovascular disease characterized by impaired myocardial function resulting from myocardial damage, leading to dysfunction in cardiac pumping [1]. Statistics show that the prevalence of heart failure in adults ranges from 1% to 2%, reaching up to 10% in individuals aged 70 and above. Currently, there are approximately 8.9 million adult heart failure patients in China [2]. The majority of heart failure patients are elderly individuals, and this demographic often presents with diminished physical resilience and increased susceptibility to other underlying diseases such as diabetes, atrial fibrillation, and dilated cardiomyopathy. The presence of these comorbidities exacerbates myocardial damage, accelerates the progression of heart failure, and poses challenges to treatment, leading to a poorer prognosis [3]. Therefore, actively treating the complications of heart failure is of paramount importance.In order to further investigate the efficacy of Levocarnitine (LC) adjuvant therapy for complications of heart failure, this study conducts a retrospective analysis of the medical records of 700 patients. The study observes changes in left ventricular ejection fraction (LVEF) and brain natriuretic peptide (BNP) levels among patients and presents the findings in this report.

2. Materials and Methods

2.1 General Information

Medical records of 700 patients with complications of heart failure admitted to our cardiology department from January 2015 to February 2020 were collected and organized. The patients were divided into a control group and an LC group, with 350 cases in each group.

Control Group: Male: 201 cases, Female: 149 cases. Age: 51 to 84 years (mean±SD: 63.61±8.35). Body Mass Index (BMI): 19 to 28 kg/m² (mean±SD: 24.26±2.95). Occupations: Farmers: 323 cases, Workers: 16 cases, Retirees: 11 cases.Smoking history: 109 cases (31.14%). Comorbidities: Diabetes: 166 cases, Atrial fibrillation: 155 cases, Dilated cardiomyopathy: 29 cases

LC Group: Male: 166 cases, Female: 184 cases. Age: 53 to 84 years (mean±SD: 63.68±8.31). BMI: 19 to 28 kg/m²

(mean±SD: 24.29±2.93). Occupations: Farmers: 313 cases, Workers: 13 cases, Retirees: 24 cases.Smoking history: 101 cases (28.86%). Comorbidities: Diabetes: 166 cases, Atrial fibrillation: 155 cases, Dilated cardiomyopathy: 29 cases. The basic characteristics of the two groups were comparable (P>0.05).

2.2 Inclusion and Exclusion Criteria

Inclusion Criteria: (1) History of heart failure for more than 1 month, with symptoms such as dyspnea, edema, hepatomegaly, exacerbation of lung rales, or chest X-ray indicating pulmonary congestion or edema. (2) NYHA functional classification of III or IV. (3) Echocardiography showing left ventricular ejection fraction (LVEF) below 50%. (4) Brain natriuretic peptide (BNP) concentration higher than 100 pg/mL.

Exclusion Criteria: (1) Concomitant blood disorders, bleeding disorders, acute phase of stroke, history of seizures, moderate to severe anemia, severe hyperthyroidism or hypothyroidism, malignant tumors. (2) Severe liver dysfunction. (3) Severe renal dysfunction undergoing dialysis treatment. (4) Severe heart valve disease, congenital heart disease. (5) Planned coronary artery bypass grafting or cardiac resynchronization therapy.

2.3 Methods

Control Group:Standard treatment was administered according to the Chinese Heart Failure Treatment Guidelines. Patients received standardized heart failure treatment based on specific clinical conditions, including medications such as beta-blockers, ACE inhibitors or ARBs, spironolactone, diuretics, digoxin, sustained-release potassium chloride, and, if necessary, vasodilators such as dopamine, dobutamine, and nitrate medications. Antimicrobial drugs were prescribed if there was an infection. During treatment, patients were advised to rest adequately, follow a low-salt and low-fat diet, restrict fluid intake, and receive oxygen therapy if necessary.

LC Group:The LC group received standard treatment combined with LC treatment. Standard treatment was the same as the control group. Simultaneously, LC (Kangpu Pharmaceutical, National Drug Approval Number H20041747) was administered intravenously at a dose of 2.0g once daily for 14 consecutive days.

2.4 Outcome Measures

(1) Comparison of LVEF and BNP Levels Before and After Treatment in Heart Failure Patients with Complications in Both Groups: LVEF: Evaluated using color Doppler ultrasound with the modified Simpson method.BNP: Blood samples collected in the morning on an empty stomach, measured using enzyme-linked immunosorbent assay.

(2) Comparison of LVEF and BNP Levels Before and After Treatment in Heart Failure Patients with Complications and Diabetes in Both Groups.

(3) Comparison of LVEF and BNP Levels Before and After Treatment in Heart Failure Patients with Complications and Atrial Fibrillation in Both Groups.

(4) Comparison of LVEF and BNP Levels Before and After Treatment in Heart Failure Patients with Complications and Dilated Cardiomyopathy in Both Groups.

2.5 Statistical Methods

Statistical analysis was performed using SPSS 19.0 software. Continuous data were expressed as mean ($\bar{x}$±s), and t-tests were conducted. A significance level of P<0.05 was considered statistically significant.

3. Results

3.1 Comparison of LVEF and BNP Levels Before and After Treatment in Heart Failure Patients with Complications in Both Groups

The LVEF levels in heart failure patients with complications after treatment in the LC group were significantly higher than those in the control group (P<0.05). The post-treatment BNP levels were similar between the two groups (P>0.05). See Table 1.

Table 1. Comparison of LVEF and BNP Levels Before and After Treatment in Heart Failure Patients with Complications in Both Groups ($\bar{x}$±s)

Group	Number	LVEF (%)		BNP (pg/mL)	
		Before	After	Before	After
Control	350	40.11±4.26	45.36±4.61*	17834.36±3881.51	9347.42±1079.62*
LC Group	350	40.06±3.29	49.21±4.86*	17846.21±3857.73	9224.81±1031.57*
t-value	-	0.174	10.752	0.041	1.536
P-value	-	0.431	0.000	0.484	0.062

*Note: Comparison with the pre-treatment values within the group, *P<0.05.

3.2 Comparison of LVEF and BNP Levels Before and After Treatment in Heart Failure Patients with Diabetes Mellitus Complications in Both Groups

After treatment, the LVEF levels in heart failure patients with diabetes mellitus complications were higher in the LC group compared to the control group, and the BNP levels were lower in the LC group than in the control group (both P<0.05). Refer to Table 2.

Table 2. Comparison of LVEF and BNP Levels Before and After Treatment in Heart Failure Patients with Diabetes Mellitus Complications in Both Groups ($\bar{x}$±s)

Group	Number	LVEF (%)		BNP (pg/mL)	
		Before	After	Before	After
Control	166	43.67±5.25	50.78±5.78*	16827.25±3557.37	8366.31±1054.22*
LC Group	166	43.63±5.27	56.13±6.00*	16896.93±3564.60	5014.25±828.69*
t-value	-	0.069	8.274	0.205	32.208
P-value	-	0.472	0.000	0.419	0.000

*Note: Comparison within the group before treatment, *P<0.05.

3.3 Comparison of LVEF and BNP Levels Before and After Treatment in Heart Failure Patients with Atrial Fibrillation Complications in Both Groups

After treatment, the LVEF levels in heart failure patients with atrial fibrillation complications were higher in the LC group compared to the control group (P<0.05), and the BNP levels in both groups after treatment were similar (P>0.05). Refer to Table 3.

Table 3. Comparison of LVEF and BNP Levels Before and After Treatment in Heart Failure Patients with Atrial Fibrillation Complications in Both Groups ($\bar{x}$±s)

Group	Number	LVEF (%)		BNP (pg/mL)	
		Before	After	Before	After
Control	155	43.52±4.73	51.09±5.00*	16731.83±3246.49	8683.64±1163.42*
LC Group	155	43.48±4.78	55.24±5.42*	17021.45±3215.82	8646.93±1179.80*
t-value	-	0.074	7.007	0.789	0.276
P-value	-	0.471	0.000	0.215	0.391

*Note: Comparison within the group before treatment, *P<0.05.

3.4 Comparison of LVEF and BNP Levels Before and After Treatment in Heart Failure Patients with Dilated Cardiomyopathy Complications in Both Groups

After treatment, the LVEF levels in heart failure patients with dilated cardiomyopathy complications were higher in the LC group compared to the control group, and the BNP levels in the LC group were lower than the control group (P<0.05). Refer to Table 4.

Table 4. Comparison of LVEF and BNP Levels Before and After Treatment in Heart Failure Patients with Dilated Cardiomyopathy Complications in Both Groups ($\bar{x}$±s)

Group	Number	LVEF (%)		BNP (pg/mL)	
		Before	After	Before	After
Control	29	33.65±4.21	35.11±4.35*	19414.25±3783.13	12944.25±3793.32*
LC Group	29	33.49±4.25	38.32±4.48*	19482.10±3790.45	10683.68±3616.44*
t-value	-	0.144	2.768	0.068	2.323
P-value	-	0.443	0.004	0.473	0.012

*Note: Comparison within the group before treatment, *P<0.05.

4. Discussion

Heart failure is a common disease, particularly affecting the elderly, and its incidence has been on the rise in recent years. The factors influencing heart failure are diverse, including impaired ventricular pump function, cardiac damage or overload, ventricular remodeling, insufficient organ perfusion, increased blood volume, infections, arrhythmias, and

emotional stress, all of which can trigger disease onset [4]. This condition can lead to varying degrees of symptoms such as dyspnea, dizziness, palpitations, fatigue, and, if not effectively treated, can cause heart functional damage, resulting in complications like pulmonary edema, generalized edema, and even multi-organ dysfunction, posing a threat to life [5]. Heart failure patients often have complications such as diabetes, atrial fibrillation, and dilated cardiomyopathy, which can worsen the condition, increase the difficulty of treatment, and should be diagnosed and treated early.

Standard treatment methods can improve patients' heart function to some extent, but the overall efficacy is generally moderate. L-carnitine (LC) is an endogenous substance that mammals can synthesize on their own, primarily in the liver and kidneys [6]. LC plays a crucial role in fatty acid transport and oxidative energy supply, and its uptake and synthesis are significant for maintaining normal fatty acid metabolism and energy in the body [7]. In cases of myocardial cell hypoxia and ischemia, LC levels in cardiac tissue significantly decrease, leading to fatty acid oxidation reactions and subsequent fatty acid accumulation, causing substantial energy loss and reduced myocardial energy metabolic capacity. Supplementing with LC can help the heart store sufficient free LC, aiding in the elimination of metabolic byproducts, promoting heart cell energy metabolism, and facilitating myocardial function recovery. LC also has protective effects, such as shielding the heart from toxic damage, regulating ion channel activity, exerting antioxidant and anti-inflammatory effects, and promoting myocardial cell energy metabolism, ultimately shortening myocardial recovery time, alleviating heart failure symptoms, and improving the exercise endurance and quality of life of patients with heart failure complications [8].

This study demonstrates that the LVEF levels in patients treated with LC in addition to standard treatment were higher than those in the control group, indicating that combined standard treatment with LC can significantly improve LVEF levels in patients. Regarding BNP levels, heart failure patients with diabetes and dilated cardiomyopathy in the LC group had lower BNP levels after treatment compared to the control group, while there were no significant differences in BNP levels between the LC group and the control group in heart failure patients with atrial fibrillation. These results suggest that combined treatment can bring about a certain degree of improvement in BNP levels, especially in heart failure patients with diabetes, where the improvement is most noticeable. Therefore, it is believed that combination therapy has a more significant effect on improving heart function in patients with heart failure complications.

In conclusion, combined LC and standard treatment can more effectively improve LVEF and BNP levels in patients with heart failure complications, particularly showing remarkable efficacy in the subgroup of patients with heart failure and diabetes.

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