

Featured Article

The effect of ivabradine tablets combined with milrinone on arterial blood flow and cTnI in patients with acute myocardial infarction combined with heart failure

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Abstract: Objective: To investigate the effects of ivabradine tablets combined with milrinone on arterial blood flow and cTnI in patients with acute myocardial infarction (AMI) combined with heart failure (HF). **Methods:** A randomised double-blind, placebo-parallel controlled clinical study protocol was adopted to select 78 patients with AMI combined with HF who attended the cardiology care unit of our hospital from January 2022 to January 2024, and randomly divided them into 2 groups of 39 patients each. Both groups were given conventional treatment, with Bmilrinone combined with placebo for oral administration in the control group and milrinone combined with ivabradine hydrochloride tablets for oral administration in the observation group. Compare the clinical efficacy and the occurrence of adverse reactions between the two groups. Compare the arterial blood flow indexes [cardiac index (CI), left ventricular ejection fraction (LVEF), global end-diastolic volume index (GEDVI), systemic vascular resistance index (SVRI), early diastolic/late diastolic LV valvular flow velocity (E/A ratio)], cardiac enzymology indexes [cardiac troponin I (cTnI), troponin T (cTnT)], and cardiac enzymes [cardiac troponin I (cTnI), troponin T (cTnT)] in the 2 groups before and after treatment, lactate dehydrogenase (LDH), creatine kinase isoenzyme (CK-MB)], circulating endocrine hormone levels [renin activity (PRA), angiotensin II (Ang II), aldosterone (Ald)] and quality of life scoring indexes [Seattle Angina Scale (SAQ), Pittsburgh Sleep Quality Index (PSQI)]. **Results:** After treatment, the total clinical effectiveness rate of the observation group (87.18%) was significantly higher than that of the control group (66.67%) ($P < 0.05$). The CI, LVEF, E/A ratio and SAQ scores of the observation group were significantly higher than those of the control group, and the scores of GEDVI, SVRI, cTnI, cTnT, LDH, CK-MB, PRA, Ang II, Ald and PSQI were significantly lower than those of the control group, which were significantly different ($P < 0.05$). There was no significant difference in the comparison of the incidence of adverse reactions between the 2 groups ($P > 0.05$). The incidence of adverse reactions in the 2 groups was not significantly different ($P > 0.05$). **Conclusion:** Ivabradine tablets combined with milrinone in the treatment of AMI combined with HF patients with significant efficacy, can effectively reduce myocardial injury, stabilise arterial haemodynamics, improve the cardiac function of the patients, and does not increase the adverse effects of drugs.

Keywords: acute myocardial infarction; heart failure; ivabradine tablets; milrinone; arterial haemodynamics; cTnI

Acute myocardial infarction (AMI) is a cardiovascular disease caused by acute blockage or lesions of coronary arteries, which reduces cardiac blood flow and induces large-area myocardial functional damage. It is characterized by sudden onset, rapid progression, high mortality, and poor prognosis. Heart failure (HF) is the most common complication in AMI patients. It can accelerate the deterioration of

cardiac pumping function, exacerbate the degree of dyspnea, affect cardiac remodeling, and increase the risk of recurrent myocardial infarction or death. Clinically, the treatment of patients with AMI combined with HF mainly focuses on anticoagulation, cardiotonic, anti-platelet aggregation, and thrombolysis, supplemented by anti-heart failure measures. Ivabradine tablets are a type of specific inhibitor of the cardiac pacemaker current (If). It can selectively inhibit the If current in sinoatrial node cells, reduce heart rate, and improve the balance between cardiac supply and demand, without affecting atrioventricular conduction and ventricular repolarization. Milrinone has both cardiotonic and vasodilatory effects. It can enhance myocardial contractility, relax vascular smooth muscle, and reduce the pre- and after-load of the heart. It is a non-digitalis positive inotropic drug. Existing research rarely mentions the efficacy of the combined use of these two drugs. Based on this, this study aims to investigate the effect of ivabradine tablets combined with milrinone on arterial blood flow and cTnI in patients with AMI combined with HF, so as to provide some theoretical basis for clinical treatment.

1. Materials and methods

1.1. General information

A randomized, double-blind, placebo-controlled parallel-group clinical research protocol was adopted. 78 patients with AMI combined with HF who were admitted to the coronary care unit of our hospital from January 2022 to January 2024 were selected as research subjects and randomly divided into two groups, with 39 patients in each group. There were no statistically significant differences in age, gender, body mass index, location of myocardial infarction, and cardiac function classification between the two groups ($P > 0.05$), as shown in **Table 1**.

Inclusion criteria:

- 1) Meet the diagnostic criteria for AMI in the “Diagnosis and Treatment Guidelines for Acute Myocardial Infarction”.
- 2) Meet the diagnostic criteria for HF in the “Chinese Guidelines for the Diagnosis and Treatment of Heart Failure 2024”.
- 3) Age ≥ 18 years old.
- 4) Admitted to the hospital within 6 h after the onset of the disease for treatment.
- 5) Informed consent was obtained from both patients and their families.

Exclusion criteria:

- 1) Patients with acute cerebrovascular diseases or incomplete liver and kidney function.
- 2) Patients with metabolic immune system diseases.
- 3) Patients with malignant tumors.
- 4) Patients with malignant arrhythmia or ventricular fibrillation.
- 5) Patients with allergic constitution.
- 6) Pregnant and lactating women.
- 7) Patients with mental diseases.

This study has been reviewed and approved by the hospital ethics committee.

Table 1.

Group	Age (years)	Gender (male/female)	bodymass index (kg/m ²)	myocardial infarction site (cases)				cardiac function classification (cases)	
				anterior wall	inferior wall	侧壁	右室	III级	IV级
observation group (n = 39)	62.55 ± 2.56	24/15	21.65 ± 1.12	16	11	9	3	27	12
control group (n = 39)	63.11 ± 2.74	26/13	21.75 ± 1.14	15	9	8	7	28	11
t/ χ^2 value	0.933		0.391	1.891				0.062	
P-value	0.354		0.697	0.595				0.804	

1.2. Methods

Both groups received routine anticoagulant and diuretic treatment, and standardized triple therapy with β -blockers, nitrate drugs, and angiotensin-converting enzyme inhibitors/angiotensin receptor blockers (ACEI/ARB). Oxygen inhalation therapy was given to patients with dyspnea.

On this basis, the observation group was administered with 0.75 mg/kg milrinone injection (National Medicine Approval No. H20183452, specification: 20 ml:20 mg, purchased from Qingdao Jinfeng Pharmaceutical Co., Ltd.) +50 mL normal saline via a micro-infusion pump (model: CPE-301, purchased from Zhuhai Fooniya Medical Equipment Co., Ltd.) at a rate of 1 time/day. A 5-day course of treatment was carried out once a month for 3 months. Then, it was combined with ivabradine hydrochloride tablets (National Medicine Approval No. H20213404, specification: 5 mg, purchased from Beijing Bai'ao Pharmaceutical Co., Ltd.) at a dose of 5 mg/time, 2 times/day, taken during breakfast and dinner. A 7-day course of treatment was carried out for 12 courses.

The control group, on the basis of routine treatment, was given 0.75 mg/kg milrinone injection +50 mL normal saline via a micro-infusion pump at a rate of 1 time/day. A 5-day course of treatment was carried out once a month for 3 months. Then, they were given a placebo made of starch orally, 2 times/day, taken during breakfast and dinner. A 7-day course of treatment was carried out for 12 courses.

1.3. Observation indicators

1.3.1. Clinical efficacy

According to the NYHA (New York Heart Association) cardiac function classification [9], the efficacy evaluation criteria were formulated. Marked effect: the cardiac function classification improved by ≥ 2 levels, and clinical symptoms were significantly relieved; effective: the cardiac function classification improved by < 2 levels, and clinical symptoms were slightly relieved; ineffective: the cardiac function classification did not change, and clinical symptoms were not relieved. The total effective rate = the effective rate + the marked – effect rate.

1.3.2. Arterial blood flow indicators

The PiCCO Accessories (purchased from PULSION Medical Systems SE, Shanghai Puxun Medical System Co., Ltd.) for thermal dilution catheter package and pressure monitoring were used to detect the levels of cardiac index (CI), left

ventricular ejection fraction (LVEF), global end-diastolic volume index (GEDVI), systemic vascular resistance index (SVRI), and early-to-late diastolic mitral inflow velocity ratio (E/A ratio) in the two groups of patients before and after treatment.

1.3.3. Laboratory indicators

4 mL of fasting venous blood was collected from patients before and after treatment and divided into two equal parts. One part was used to detect the levels of cardiac troponin I (cTnI), cardiac troponin T (cTnT), lactate dehydrogenase (LDH), plasma renin activity (PRA), angiotensin II (Ang II), and aldosterone (Ald) by electrochemiluminescence immunoassay. The other part was used to detect the level of creatine kinase-MB (CK-MB) by a biochemical analyzer.

1.3.4. Quality-of-life score indicators

Before and after treatment: (1) The Seattle Angina Questionnaire (SAQ) [10] was used to assess patients' quality of life. The full score is 75 points, and a higher score indicates a better quality of life. (2) The Pittsburgh Sleep Quality Index (PSQI) was used to evaluate patients' sleep quality. The total score ranges from 0 to 21 points, and a lower score represents better sleep quality.

1.3.5. Incidence of adverse reactions

The occurrence of adverse reactions such as photopsia, bradycardia, hypotension, arrhythmia, and gastrointestinal discomfort in the two groups of patients was recorded and compared.

1.4. Statistical analysis

Data statistical analysis was performed using SPSS 26.0 statistical software. Measurement data such as arterial blood flow indicators, laboratory indicators, and quality-of-life score indicators were expressed as mean $\pm$ standard deviation ($\bar{x} \pm s$), and the *t*-test was used for inter-group comparison. Enumeration data such as clinical efficacy and the incidence of adverse reactions were expressed as number (*n*) and percentage (%), and the chi-square-test was used for inter-group comparison. A *P*-value < 0.05 indicated a significant difference.

2. Results

2.1. Comparison of clinical efficacy between the two groups

After treatment, the total clinical effective rate of the observation group (87.18%) was significantly higher than that of the control group (66.67%) ($P < 0.05$), as shown in **Table 2** and **Figure 1**.

Table 2. Comparison of clinical efficacy between the two groups.

group	marked effect	effective	ineffective	total effective rate
observation group (<i>n</i> = 39)	26 (66.67)	8 (20.51)	5 (12.82)	34 (87.18)
control group (<i>n</i> = 39)	14 (35.90)	12 (30.77)	13 (33.33)	26 (66.67)
χ^2 value				4.622
<i>P</i> -value				0.032

Note: The numbers in parentheses are rates (%).

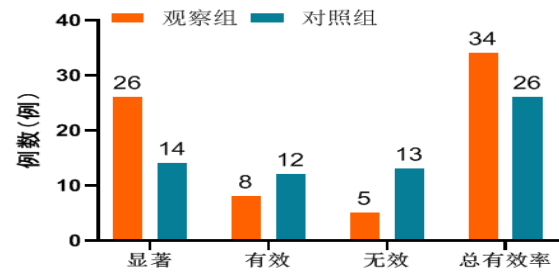


Figure 1. Comparison of clinical efficacy between the two groups.

2.2. Comparison of arterial blood flow indicators between the two groups

After treatment, the levels of CI, LVEF, and E/A ratio in the observation group were significantly higher than those in the control group, while the levels of GEDVI and SVRI were significantly lower than those in the control group, with significant differences ($P < 0.05$), as shown in Table 3 and Figure 2.

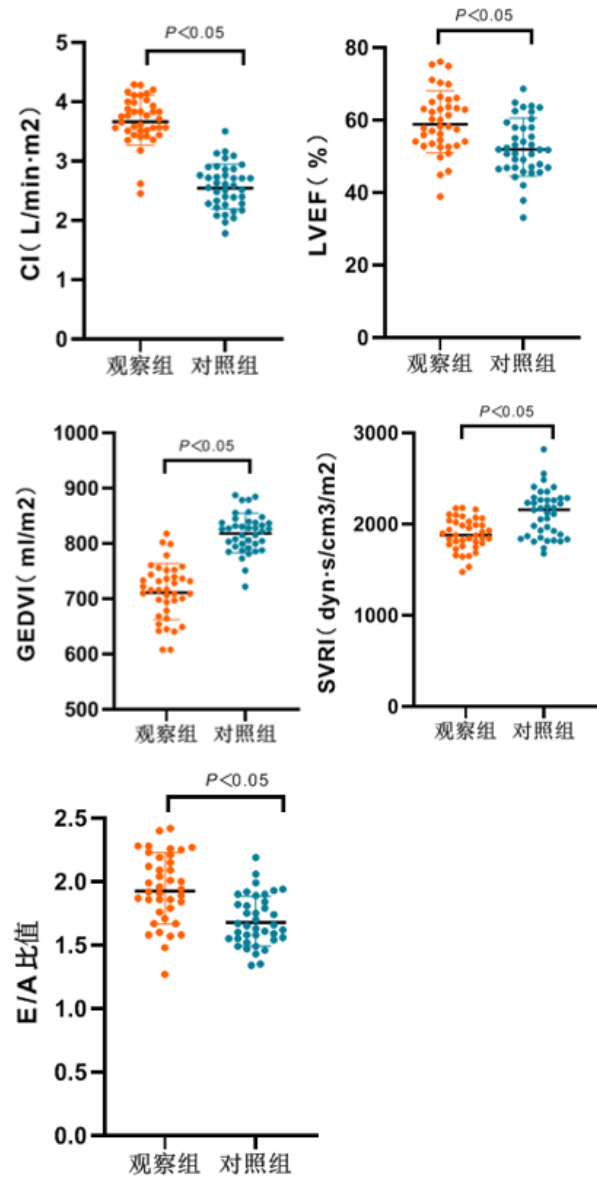


Figure 2.

Table 3. Comparison of arterial blood flow indicators between the two groups.

group	CI (L/min·m ²)		LVEF (%)		GEDVI (ml/m ²)	
	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment
observation group (n = 39)	1.75 ± 0.32	3.69 ± 0.39*	44.76 ± 7.43	59.46 ± 8.42*	1128.89 ± 51.46	712.98 ± 50.05*
control group (n = 39)	1.79 ± 0.35	2.57 ± 0.38*	45.23 ± 7.16	52.51 ± 7.82*	1131.17 ± 56.89	819.06 ± 35.32*
t value	0.527	12.845	0.284	3.777	0.186	10.814
P-value	0.600	0.000	0.777	0.000	0.853	0.000

group	SVRI (dyn·s/cm ³ /m ²)		E/A 比值	
	before treatment	after treatment	before treatment	after treatment
observation group (n = 39)	2537.29 ± 276.49	1888.75 ± 174.01*	0.80 ± 0.12	1.95 ± 0.27*
control group (n = 39)	2529.37 ± 262.63	2116.21 ± 255.48*	0.79 ± 0.11	1.69 ± 0.20*
t value	0.130	4.595	0.384	4.832
P value	0.897	0.000	0.702	0.000

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2.3. Comparison of myocardial enzyme indexes between the two groups

After treatment, the levels of cTnI, cTnT, LDH, and CK-MB in the observation group were significantly lower than those in the control group, with significant differences ($P < 0.05$), as shown in **Table 4**.

Table 4. Comparison of myocardial enzyme indexes between the two groups.

group	cTnI (μg/mL)		cTnT (μg/L)	
	before treatment	after treatment	before treatment	after treatment
observation group (n = 39)	114.92 ± 28.25	29.51 ± 7.38*	0.53 ± 0.13	0.15 ± 0.02*
control group (n = 39)	118.26 ± 25.30	39.64 ± 8.57*	0.50 ± 0.11	0.17 ± 0.03*
t value	0.550	5.594	1.100	3.464
P value	0.584	0.000	0.275	0.001

group	LDH (U/L)		CK-MB (U/L)	
	before treatment	after treatment	Before treatment	after treatment
observation group (n = 39)	396.51 ± 63.39	267.19 ± 42.38*	98.62 ± 18.79	38.12 ± 9.44*
control group (n = 39)	402.58 ± 72.63	299.61 ± 47.57*	97.65 ± 19.72	49.73 ± 9.87*
t value	0.393	3.178	0.222	5.309
P value	0.695	0.002	0.825	0.000

Compared with before treatment, ^{*}P < 0.05.

2.4. Comparison of circulating endocrine hormone levels between the two groups

After treatment, the levels of PRA, Ang II, and Ald in the observation group were significantly lower than those in the control group, with significant differences ($P < 0.05$), as shown in **Table 5**.

Table 5. Comparison of circulating endocrine hormone levels between the two groups.

group	PRA (pg/ (mL·h))		AngII (pg/mL)		Ald (pg/mL)	
	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment
observation group (n = 39)	7.67 ± 0.79	5.14 ± 0.65*	86.75 ± 9.03	43.32 ± 4.78*	192.34 ± 18.35	127.54 ± 15.64*
control group (n = 39)	7.71 ± 0.80	6.67 ± 0.72*	85.98 ± 8.78	63.43 ± 6.76*	191.67 ± 18.78	162.86 ± 15.85*
t value	0.222	9.850	0.382	15.169	0.159	9.906
P value	0.825	0.000	0.704	0.000	0.874	0.000

Compared with before treatment, ^{*}P < 0.05.

2.5. Comparison of quality-of-life score indicators between the two groups

After treatment, the SAQ score of the observation group was significantly higher than that of the control group, and the PSQI score was significantly lower than that of the control group, with significant differences ($P < 0.05$), as shown in Table 6.

Table 6. Comparison of quality-of-life score indicators between the two groups.

group	SAQ (分)		PSQI (分)	
	before treatment	after treatment	before treatment	after treatment
observation group (n = 39)	31.49 ± 6.93	71.79 ± 7.53*	11.84 ± 1.12	7.16 ± 0.75*
control group (n = 39)	33.21 ± 7.24	55.58 ± 6.19*	12.03 ± 1.24	9.98 ± 1.12*
t value	1.072	10.385	0.710	13.065
P value	0.287	0.000	0.480	0.000

Compared with before treatment, ^{*}P < 0.05.

2.6. Comparison of the incidence of adverse reactions between the two groups

After treatment, there was no significant difference in the incidence of adverse reactions between the two groups ($P > 0.05$), as shown in Table 7.

Table 7. Comparison of adverse reaction occurrence between the two groups.

group	photopsia	bradycardia	hypotension	arrhythmia	gastrointestinal discomfort	total
observation group (n = 39)	1 (2.56)	0 (0.00)	1 (2.56)	1 (2.56)	1 (2.56)	4 (10.26)
control group (n = 39)	0 (0.00)	2 (5.13)	2 (5.13)	0 (0.00)	1 (2.56)	5 (12.82)
χ^2 value						0.126
P value						0.723

3. Discussion

Emotional agitation, hypertension, straining during defecation, overexertion, etc. are all risk factors for inducing acute myocardial infarction (AMI) [11]. When AMI occurs, the coronary artery is locally blocked, blood flow is obstructed, and myocardial cells suffer from acute ischemia and necrosis. This impairs the systolic and diastolic functions of the heart, triggering ventricular remodeling [12]. Moreover, the larger the infarct area, the worse the heart's pumping ability. The

cardiac output cannot meet the metabolic needs of tissues, and the incidence of heart failure is higher [13]. Conventional treatments such as cardiotonic, diuretic, and vasodilator therapies can relieve clinical symptoms, but for the low physiological function and metabolic capacity of the body,

This slows down the rate of diastolic depolarization of sinoatrial node cells, thereby reducing the frequency of rhythmic electrical impulses in the sinoatrial node and regulating and slowing down the heart rate. This mode of inhibition does not interfere with myocardial contraction, atrioventricular conduction, nor does it affect ventricular repolarization [14]. Milrinone, on the other hand, can inhibit the activity of phosphodiesterase, reducing the degradation of cyclic adenosine monophosphate (cAMP), increasing the concentration of cAMP in myocardial cells, opening calcium channels, allowing a large amount of calcium ions to flow into myocardial cells, enhancing myocardial contractility and pumping function [6]. When the two are used in combination, ivabradine tablets can counteract the increase in heart rate caused by milrinone, maintaining the heart rate within the normal range. This enhances the myocardial pumping ability while preventing an increase in myocardial oxygen consumption due to a higher heart rate. Therefore, the combination of ivabradine tablets and milrinone can exert a synergistic effect, helping to enhance the drug efficacy and improve the disease prognosis.

In patients with AMI complicated by HF, the myocardial contractility weakens, and the enlargement of the cardiac cavity leads to slow blood flow within the cavity, blood stasis, and the formation of vortices. Coupled with their own hypercoagulable state, thrombi are extremely likely to form within the cardiac cavity. The detachment of thrombi can lead to serious complications such as systemic embolism and stroke [15]. LVEF, CI, and E/A ratio are important hemodynamic indicators for evaluating cardiac systolic function, pumping function, and left ventricular diastolic function respectively [16]. GEDVI refers to the total amount of blood in the four chambers at the end of diastole. It can accurately reflect the pre-load state of the heart and provide a theoretical basis for judging the volume of fluid replacement. SVRI can directly reflect the peripheral vascular resistance and is a monitoring indicator for adjusting vasoactive drugs as needed [17]. The results of this study showed that the levels of CI, LVEF, and E/A ratio in the observation group were significantly higher than those in the control group, while GEDVI and SVRI were significantly lower than those in the control group. This indicates that the combination of ivabradine tablets and milrinone for patients with AMI complicated by HF can improve vascular endothelial function and relieve the pre- and after-load of the heart. This may be because the cAMP level in vascular smooth muscle cells is increased by milrinone, causing the smooth muscle to relax, reducing the resistance of pulmonary and peripheral blood vessels, alleviating the pre- and after-load of the heart, and enhancing the cardiac output [18]. Moreover, the heart-rate-slowng effect of ivabradine tablets helps to optimize the balance of cardiac output [12]. Therefore, the combined use of the two drugs can further improve the arterial hemodynamics of patients, reduce myocardial oxygen consumption, increase cardiac perfusion, and relieve discomfort symptoms such as dyspnea, edema, and fatigue.

Myocardial infarction causes damage to myocardial cells. The integrity and permeability of the myocardial cell membrane at the infarcted site are damaged,

releasing substances such as cTnI, cTnT, LDH, and CK-MB into the peripheral blood [19]. cTnI, cTnT, LDH, and CK-MB are all important biological indicators reflecting myocardial function, and cTnI has significantly higher specificity and sensitivity in diagnosing myocardial injury than other indicators [20]. In this study, the levels of cTnI, cTnT, LDH, and CK-MB in the observation group were significantly lower than those in the control group, suggesting that the combination of ivabradine tablets and milrinone in the treatment of patients with AMI complicated by HF can promote myocardial contraction, improve the myocardial ischemia-hypoxia state, and reduce the degree of myocardial injury. The reason for this is analyzed as follows: The diuretic effect of milrinone helps to reduce the burden on the heart. Its vasodilatory and positive inotropic effects can enhance cardiac contractility, improve the myocardial ischemia-hypoxia state, and enhance pulmonary circulation and gas exchange [18]. Ivabradine tablets can regulate glucose and fatty acid metabolism, regulate the serum fibrinolytic system, and improve plaque stability. It can control the heart rate, prolong the diastole, improve the compliance of the ventricular diastole, promote blood reflux, improve myocardial function, and curb cardiac structural changes and myocardial remodeling. The combined use of the two drugs helps to reduce the risk of disease deterioration and protect cardiac function [14].

The reduction in cardiac output leads to insufficient renal perfusion. Renin is stimulated to enter the blood, catalyzing the conversion of angiotensin to AngII, and activating the renin-angiotensin-aldosterone system (RASS) to secrete Ald. PRA can directly reflect the functional state of renin and can also assist in judging the activation degree of the RASS system [21]. In this study, the levels of PRA, AngII, and Ald in the observation group were significantly lower than those in the control group, suggesting that the combination of ivabradine tablets and milrinone in the treatment of patients with AMI complicated by HF can effectively inhibit the production of circulating endocrine hormones and prevent myocardial cell necrosis [21]. This is related to the regulatory effects of ivabradine tablets and milrinone on heart rate and myocardium, as well as their role in delaying myocardial remodeling. In addition, the SAQ score of the observation group was significantly higher than that of the control group, and the PSQI score was significantly lower than that of the control group. This indicates that the combination of ivabradine tablets and milrinone can improve the sleep quality and quality of life of patients with AMI complicated by HF. It is considered that this is because ivabradine tablets have the function of controlling heart rate and reducing the burden on the heart [5], and milrinone has the function of optimizing blood circulation and assisting cardiac contraction [6]. The combined use of the two drugs can exert a synergistic effect, improve the cardiac function of patients with AMI complicated by HF, relieve their discomfort symptoms, and help improve their sleep quality and quality of life. In addition, there was no significant difference in the incidence of adverse reactions between the observation group and the control group, indicating that the combined use of drugs did not increase the incidence of adverse reactions. However, vital signs still need to be closely monitored during the combined use.

In conclusion, the combination of ivabradine tablets and milrinone in the treatment of patients with AMI complicated by HF can effectively reduce myocardial injury, stabilize arterial hemodynamics, improve cardiac function, and has significant

curative effects without increasing adverse drug reactions. However, the sample size included in this study was small, and the research time was insufficient, making it impossible to conduct long-term dynamic monitoring of the drug efficacy. The results may be biased. In the follow-up, the sample size will be expanded, the research time will be extended, and a more in-depth and detailed study of the combined treatment mechanism of the two drugs will be carried out, in the hope of providing a solid theoretical basis for the clinical treatment of patients with AIM complicated by HF.

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

References

1. Saleh M, Ambrose JA. Understanding myocardial infarction. *F1000Research*. 2018; 7: 1378. doi: 10.12688/f1000research.15096.1
2. Kapur NK, Thayer KL, Zweck E. Cardiogenic Shock in the Setting of Acute Myocardial Infarction. *Methodist DeBakey Cardiovascular Journal*. 2020; 16(1): 16. doi: 10.14797/mdcj-16-1-16
3. Chen Q, Su L, Liu C, et al. PRKAR1A and SDCBP Serve as Potential Predictors of Heart Failure Following Acute Myocardial Infarction. *Frontiers in Immunology*. 2022; 13. doi: 10.3389/fimmu.2022.878876
4. Li D, Li K, Yu D. Clinical study on ivabradine tablets combined with tolvaptan tablets in the treatment of patients with acute myocardial infarction complicated with heart failure. *The Chinese Journal of Clinical Pharmacology*. 2023; 39(7): 928-931.
5. Liang J, Xu Y, Liu J. Clinical study on ivabradine in the treatment of elderly patients with hypertension complicated with heart failure. *The Chinese Journal of Clinical Pharmacology*. 2024; 40(20): 2920-2923.
6. Song J, Du X, Shi J, et al. Effect of Qiliqiangxin Capsule combined with milrinone on arterial blood flow and cardiac function in patients with myocardial infarction complicated with heart failure. *Shaanxi Journal of Traditional Chinese Medicine*. 2020; 41(4): 493-495.
7. Cardiovascular Disease Branch of Chinese Medical Association, Editorial Board of Chinese Journal of Cardiology, Editorial Board of Chinese Circulation Journal. Guidelines for the diagnosis and treatment of acute myocardial infarction. *Chinese Journal of Cardiology*. 2001; 29(12): 710-725.
8. Cardiovascular Disease Branch of Chinese Medical Association, Cardiovascular Medicine Specialists Branch of Chinese Medical Doctor Association, Heart Failure Professional Committee of Chinese Medical Doctor Association, et al. Guidelines for the diagnosis and treatment of heart failure in China 2024. *Chinese Journal of Cardiology*. 2024; 52(3): 235-275.
9. He X, Liu Y, Yang N. Analysis of related factors affecting the occurrence of atrial fibrillation in patients with coronary atherosclerosis. *Guizhou Medical Journal*. 2020; 44(12): 1899-1900.
10. Shi L, Su L, Zhao L, et al. Randomized controlled study on the effect of Baduanjin on cardiopulmonary function of patients with acute myocardial infarction. *Chinese Journal of Integrated Traditional and Western Medicine*. 2023; 43(8): 922-929.
11. Li J, Dong X, Xie X, et al. Exploring the effect of self-made traditional Chinese medicine prescription based on the method of tonifying the kidney and promoting blood circulation on the improvement of cardiac function in the treatment of chronic heart failure after acute myocardial infarction. *Medical Journal of West China*. 2024; 36(8): 1196-1201.
12. Wen X, Zeng X, Su R. Application of ivabradine tablets combined with levosimendan in patients with acute myocardial infarction complicated with heart failure. *The Practical Journal of Medicine & Pharmacy*. 2024; 40(2): 242-247.
13. Ma L, Gao H, Yang N, et al. Clinical characteristics and risk factors of acute myocardial infarction complicated with heart failure. *Chinese Journal of Evidence—Based Cardiovascular Medicine*. 2024; 16(11): 1388-1390.
14. Xia L, Jiang R, Bu L, et al. Clinical efficacy of ivabradine combined with milrinone in the treatment of elderly patients with heart failure. *Journal of Clinical and Experimental Medicine*. 2024; 23(14): 1486-1489.
15. Yang X, Guan Y, Wang Y, et al. Study on the effect of novel oral anticoagulants on the regression of mural thrombus in patients with heart failure and ventricular aneurysm after acute myocardial infarction. *Journal of Cardiovascular and Pulmonary Diseases*. 2024; 43(4): 331-335,342.
16. Peng Q, Yang Q, Hu G, et al. Observation on the value of aerobic exercise in improving cardiac function, vascular endothelial function and quality of life in patients with acute myocardial infarction accompanied by heart failure. *Chinese*

- Journal of Emergency Resuscitation and Disaster Medicine. 2023; 18(3): 298-301.
17. Dong N, Xing C, Cheng G. Application of levosimendan in patients with acute myocardial infarction complicated with heart failure. *China Medical Herald*. 2024; 21(14): 58-60,69.
 18. Liu Z, Xu F, Lu Y. Effect of milrinone combined with non - invasive ventilator on blood gas, myocardial damage and recent adverse events in elderly patients with cor pulmonale and acute heart failure. *Journal of Chinese Health Care and Medicine*. 2024; 26(4): 460-463.
 19. He K, Xin H. Relationship among serum 3-NT, cTnT, cardiac function and left ventricular remodeling in STEMI patients after interventional therapy. *Acta Academiae Medicinae Sciences Circum-South*. 2024; 52(5): 768-771.
 20. Yu Y, Liao Y, Wei X, et al. Clinical study on PCI combined with intra-aortic balloon counterpulsation in the treatment of elderly patients with acute myocardial infarction complicated with heart failure. *Chinese Journal of Integrative Medicine on Cardio-Cerebrovascular Disease*. 2024; 22(11): 2000-2004.
 21. Shao Y. Clinical study on freeze-dried recombinant human brain natriuretic peptide combined with furosemide in the treatment of elderly patients with acute myocardial infarction complicated with heart failure. *Chinese Journal of Integrative Medicine on Cardio-Cerebrovascular Disease*. 2019; 17(16): 2480-2483.