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Cardiovascular Reviews

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Study on the Application Value of Amlodipine Combined with Enalapril in the Treatment of Elderly Hypertension

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Abstract: *Objective:* To explore the application value of amlodipine combined with enalapril in the treatment of elderly hypertension. *Methods:* A total of 600 hypertensive patients admitted between May 2020–2023 were recruited and divided into the study group and the control group, with 300 cases in each group, using a double-blind mechanism. The study group was treated with enalapril and amlodipine, while the control group was treated with enalapril. The changes in vascular endothelium, blood pressure performance, pulse pressure level, and drug side effects were compared between the groups. *Results:* Before treatment, the changes in vascular endothelium showed no significant difference between the groups ($P > 0.05$); after treatment, the changes in the study group were significantly better than the control group ($P < 0.05$). Before treatment, the performance of systolic and diastolic blood pressures in the two groups showed no significant difference ($P > 0.05$); after treatment, the performance in the study group was lower than that in the control group ($P < 0.05$). Before treatment, the pulse pressure levels of the two groups showed no significant difference ($P > 0.05$); after treatment, the pulse pressure levels of the study group were significantly better than that of the control group ($P < 0.05$). The side effects of medication in the study group were significantly lower than those in the control group ($P < 0.05$). *Conclusion:* Amlodipine combined with enalapril has a higher curative effect in the treatment of elderly hypertension, which is worthy of promotion.

Keywords: Amlodipine; Enalapril; Elderly hypertension; Treatment

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1. Introduction

Hypertension (high blood pressure, HBP) is a disease caused by abnormal intravascular pressure. It is a chronic disease with a high incidence in the elderly. In recent years, the number of middle-aged hypertensive patients is gradually increasing, and hypertension was found to develop at a younger age over time [1]. Under the influence of hypertension, the elderly are prone to vascular diseases, such as stroke, myocardial infarction, etc., which aggravate physical damage [2]. Hypertension requires long-term medication, and the use of drugs cannot be interrupted, otherwise, the risk of blood vessel rupture and bleeding will increase [3]. The types of

antihypertensive drugs are abundant, and some patients will take combined antihypertensive regimens for hypertension treatment, and the control effect on blood pressure is more significant [4]. Enalapril is a drug for regulating blood pressure, which is suitable for various types of hypertension treatment. After research, it is found that the combined use of enalapril and amlodipine will strengthen the control of blood vessel pressure, reduce the level of systolic and diastolic blood pressures, and maintain the body's normal blood circulation [5]. This study aims to investigate and analyze the application value of amlodipine combined with enalapril in the treatment of elderly hypertension.

2. Materials and methods

2.1. General information

A total of 600 hypertensive patients admitted to the Fourth Affiliated Hospital of Inner Mongolia Medical University from May 2020 to May 2023 were recruited and grouped using a double-blind mechanism. They were divided into a study group and a control group, with 300 cases in each group. The number of males and females in the study group were 155 and 145, respectively; the age was between 55 and 85 years old with an average age of 70.54 ± 1.37 years old; the disease existed for 1 to 7 years with the average time of 4.21 ± 0.68 years. The number of men and women in the control group were 156 and 144, respectively; they aged between 54 and 85 years old with an average age of 70.69 ± 1.42 years old; the disease existed for 1 to 8 years with an average time of 4.59 ± 0.71 years. After comparing the general data, the difference was statistically insignificant ($P > 0.05$).

2.2. Methods

The control group was treated with enalapril: enalapril maleate tablet was given 5 mg once a day for the first time, and the dose was increased from the 2nd day to a maximum of 10 mg/d. The treatment was continued for 12 weeks.

The study group was treated with enalapril and amlodipine: (1) the usage of enalapril was the same as the control group; (2) amlodipine besylate tablet was given 2.5mg once daily, and the dose can be adjusted according to the blood pressure. The treatment was continued for 12 weeks.

2.3. Observation indicators

The observation indicators in this study included:

(1) The changes in vascular endothelium were compared between the groups, including the levels of endothelin-1 (ET-1), prostaglandin F1α (PGF-1α), nitric oxide (NO), and thromboxane B2 (TXB2).

(2) The blood pressure performance was compared between the groups, including systolic and diastolic blood pressure.

(3) The pulse pressure levels were compared between the groups, and comparisons before treatment, 4 weeks after treatment, and 12 weeks after treatment were made.

(4) Side effects of medication were compared between groups, including nausea and vomiting, dizziness, headache, and rash.

2.4. Statistical analysis

SPSS 21.0 statistical software was selected to process and analyze the data, the count data were expressed by the number of cases (n) and percentage (%), the x^2 test was implemented; the measurement data were expressed by the mean ± standard deviation (SD), and the t-test was implemented; $P < 0.05$ was considered statistically significant.

3. Results

3.1. Comparison of the changes in vascular endothelium between the two groups

Before treatment, the levels of ET-1, PGF-1α, NO, and TXB2 were insignificantly different between the groups ($P > 0.05$). However, after treatment, the levels of ET-1, PGF-1α, NO, and TXB2 in the study group were significantly better than in the control group ($P = 0.0000$). See **Table 1** for details.

Table 1. Comparison of vascular endothelial changes between groups before and after the treatment (mean ± SD)

Group	Number of cases	ET-1 (pmol/L)		PGF-1α (pmol/L)		NO (μmol/L)		TXB2 (pmol/L)	
		Before	After	Before	After	Before	After	Before	After
Study group	300	81.41 ± 10.58	53.41 ± 5.29	58.14 ± 7.61	88.27 ± 8.61	63.58 ± 7.61	86.59 ± 8.51	84.57 ± 10.36	46.58 ± 4.23
Control group	300	81.45 ± 10.63	62.58 ± 6.21	58.75 ± 7.36	71.52 ± 7.51	63.59 ± 7.36	77.12 ± 7.61	84.66 ± 10.56	55.91 ± 5.18
t-value	-	0.0461	19.4698	0.9979	25.3931	0.0163	14.3676	0.1053	24.1638
P value	-	0.9632	0.0000	0.3187	0.0000	0.9870	0.0000	0.9161	0.0000

3.2. Comparison of blood pressure performance between the two groups

Before treatment, the performance of systolic and diastolic blood pressures in the two groups showed insignificant differences ($P > 0.05$). However, after treatment, the blood pressure performance in the study group was significantly lower than that in the control group ($P = 0.0000$). See **Table 2** for details.

Table 2. The comparison of blood pressure between groups before and after the treatment (mean ± SD, mmHg)

Group	Number of cases	Diastolic		Systolic	
		Before	After	Before	After
Study group	300	92.57 ± 5.12	75.64 ± 3.56	170.35 ± 8.12	127.51 ± 5.32
Control group	300	92.68 ± 5.34	81.55 ± 4.36	170.54 ± 8.33	145.28 ± 6.33
t-value	-	0.2575	18.1858	0.2828	37.2229
P value	-	0.7969	0.0000	0.7774	0.0000

3.3. Comparison of the pulse pressure levels between the two groups

Before treatment, the pulse pressure levels of the two groups were insignificant different ($P > 0.05$). After treatment, the pulse pressure level of the study group was significantly better than that of the control group ($P = 0.0000$). See **Table 3** for details.

Table 3. Comparison of pulse pressure levels between groups before treatment, 4 weeks, and 12 weeks after treatment (mean ± SD)

Group	Number of cases	Before treatment	4 weeks after treatment	12 weeks after treatment
Study group	300	75.41 ± 5.12	64.27 ± 5.61	50.41 ± 4.51
Control group	300	75.61 ± 4.33	72.55 ± 6.35	58.67 ± 5.61
t-value	-	0.5166	16.9256	19.8758
P value	-	0.6056	0.0000	0.0000

3.4. Comparison of the side effects between the two groups

Table 4 showed that the side effects of medication in the study group were significantly lower than those in the control group ($P = 0.0140$).

Table 4. The comparison of side effects between groups [*n*, (%)]

Group	Number of cases	Nausea and vomiting	Dizziness headache	Rash	Total incidence
Study group	300	5 (1.67)	4 (1.33)	3 (1.00)	12 (4.00)
Control group	300	7 (2.33)	8 (2.67)	5 (1.67)	20 (6.67)
x^2	-	-	-	-	6.0379
P value	-	-	-	-	0.0140

4. Discussion

Hypertension has become a well-known disease, which covers a large scope and is a typical chronic disease of the elderly [6]. Hypertension can reduce the extensibility of the arterial wall, increase the content of some intravascular substances, and lead to changes in blood vessels, mainly manifested by abnormal thickening, contraction, and expansion of blood vessels [7]. Early hypertension does not show physical symptoms. With the continuous increase in blood pressure, symptoms such as dizziness, chest tightness, nausea, and vomiting may appear. At this rate, it has developed into more severe hypertension [8]. Hypertension should be controlled at an early stage, otherwise, it will lead to substantial organ failure, difficulty in maintaining normal circulation, and even death of the patient. Currently, there is no radical measure for the treatment of hypertension, and the long-term application of antihypertensive drugs is the main treatment method [9]. Enalapril is a drug used to control blood pressure. It is an angiotensin-converting enzyme inhibitor. It not only has the effect of controlling blood pressure but also has a certain therapeutic effect on the complications of hypertension [10]. The long-term curative effect of enalapril alone is unsatisfactory, as the patient's body will develop drug resistance to enalapril, and the antihypertensive effect is limited. In order to improve this drawback, a class of antihypertensive drug combination therapy is added on the basis of this drug treatment. The overall curative effect is considerable [11]. Amlodipine is also a drug used to lower blood pressure. It belongs to the dihydropyridine calcium antagonists, and its main function is to control the transport of calcium ions [12]. It can be used as the drug choice of the combined regimen. After amlodipine is taken, the drug's effect lasts for a long time, which is approximately 35 hours. It adjusts the circulation of blood vessels, reduces the pressure of blood flow, relaxes the blood vessels, reduces the influx of calcium ions, and eventually achieves the effect of lowering blood pressure [13]. The combined use of enalapril and amlodipine has a more stable and longer-lasting drug effect, and a lesser impact on other body systems, thereby reducing the incidence of drug side effects [14]. The combined use of these two drugs has a certain synergistic value since amlodipine is selective and allows for high-efficiency drug utilization, leading to a significant control effect of calcium ion influx, a certain maintenance effect on the myocardium, stabilization of blood pressure diseases, and reduction in the impact of the high-pressure state on cardiac load [15]. Complications of hypertension are the key factors leading to the death of patients. Under the combined treatment of enalapril and amlodipine, the occurrence of hypertension complications can be controlled and the damage of hypertension to other organs can be reduced.

The experimental results are as follows: the levels of ET-1, PGF-1α, NO, and TXB2 were insignificantly different between the two groups before treatment ($P > 0.05$), but the levels were significantly better in the study group than the control group ($P < 0.05$); the performance of systolic and diastolic blood pressures in the two

groups before treatment was insignificantly different ($P > 0.05$), but it was lower in the study group than that in the control group after treatment ($P < 0.05$). The pulse pressure levels of the two groups before the treatment were insignificantly different ($P > 0.05$), but it was significantly better in the study group than that in the control group ($P < 0.05$). The side effects of medication in the study group were significantly lower than those in the control group ($P < 0.05$). The combination treatment of amlodipine and enalapril reduces the damage to the vascular endothelium caused by the high-pressure state, and the vascular endothelium has recovered better than before. Both systolic and diastolic blood pressures were significantly reduced, the blood pressure level was relatively stable, and the pulse pressure was reduced. The drug safety performance of the combination therapy is satisfactory, and the occurrence of adverse drug reactions is relatively rare. During treatment, the dosage can be adjusted to meet the drug needs of the patient's condition and strengthen the control of blood pressure.

In conclusion, amlodipine combined with enalapril has an evident curative effect on the treatment of elderly hypertension, and this treatment plan is worthy of widespread promotion and application.

Disclosure statement

The author declares no conflicts of interest.

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Clinical Effect Analysis of Atorvastatin Calcium Combined with Ezetimibe Tablets in the Treatment of Coronary Heart Disease

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Abstract: *Objective:* To explore the effective drug treatment plan for patients with coronary heart disease. *Methods:* A total of 59 patients with coronary heart disease were recruited and divided into the study group (30 cases, treated with atorvastatin calcium combined with ezetimibe tablets) and the control group (29 cases, treated with atorvastatin) after drawing lots, and the therapeutic effects of the two groups were compared. *Results:* After treatment, the blood lipid level, cardiac function, inflammatory factor level, and clinical effective rate of the study group were better than those of the control group ($P < 0.05$); there was no significant difference in the incidence of adverse reactions between the two groups ($P > 0.05$). *Conclusion:* The clinical effect of atorvastatin calcium combined with ezetimibe tablets in the treatment of patients with coronary heart disease is significant, and it has the value of promotion and application.

Keywords: Atorvastatin; Ezetimibe tablets; Coronary heart disease

Online publication: September 21, 2023

1. Introduction

Coronary heart disease is an ischemic heart disease with a relatively high incidence in middle-aged and elderly people. Atherosclerosis occurs inside the coronary tissue of patients, blood circulation is blocked, and myocardial tissue is necrotic under ischemia and hypoxia, which can lead to symptoms such as angina pectoris. With the prolongation of the disease, it can induce arrhythmia, heart failure, and other critical diseases [1]. Drug therapy is the basic treatment plan for coronary heart disease; commonly used drugs include anti-myocardial ischemic drugs, antiplatelet drugs, etc. The latest clinical research shows that dyslipidemia is an important factor in the onset and progression of coronary heart disease, so it is necessary to add lipid-lowering drugs to the drug treatment plan [2]. Atorvastatin is a routine lipid-lowering drug. Some patients with coronary heart disease still have blood lipids beyond the normal range after taking the drug and have adverse reactions such as liver damage. Ezetimibe tablets are a new generation of lipid-lowering drugs, and some studies suggest that this drug can effectively regulate blood lipid levels in patients with coronary heart disease [3]. In this study, 59 patients with coronary heart disease were selected to analyze effective drug treatment options.

2. Materials and methods

2.1. General information

The study was carried out from May 2021 to December 2022. A total of 59 patients with coronary heart disease were recruited and divided into 30 patients in the study group and 29 patients in the control group after drawing lots. The numerical ratio of males to females in the study group was 18:12, the age was 60.44 ± 4.29 years old, and the disease course was 2.68 ± 0.55 years. The numerical ratio of males to females in the control group was 17:12, the age was 60.53 ± 4.32 years old, and the disease course was 2.62 ± 0.59 years. All patients met the diagnostic criteria for coronary heart disease in the relevant ACC/AHA guidelines, had no other organic lesions or blood system diseases, had no drug allergy, and had no drug treatment before enrollment. The general data of the two groups were comparable ($P > 0.05$).

2.2. Methods

Both groups received basic treatment for coronary heart disease, and antiplatelet and anti-myocardial ischemia drugs were used for intervention. If the patient's condition was in an acute attack stage, the doctor instructed him/her to rest in bed, concurrently inhale oxygen at a low flow rate, and take nitroglycerin sublingually. The patient's blood pressure, heart rate, electrocardiogram, and cardiac function changes were monitored, and any abnormalities were dealt with promptly.

The patients in the control group were treated with atorvastatin calcium at a dose of 10 mg/d. After 4 weeks of continuous medication, the patient's condition was evaluated and the dosage was adjusted. The maximum dosage was 80 mg/d, and the course of treatment was 3 months.

The patients in the study group were treated with ezetimibe tablets according to the protocol of the control group, the dose was 10 mg/d, and the course of treatment was 3 months. During the treatment period, doctors in the two groups provided health guidance to them, informed them about diet, exercise, and other knowledge, guided them to establish a healthy lifestyle, and told them to self-monitor their condition.

2.3. Evaluation criteria

The blood lipid levels, cardiac function, inflammatory factor levels, clinical effective rate, and incidence of adverse reactions were compared between the two groups.

2.4. Statistical methods

SPSS 23.0 software was used to analyze the research data, the measurement data are represented in mean ± standard deviation (SD), and *t*-test was used; count data are represented in %, and x^2 test was used. $P < 0.05$ indicated that there was a statistical level difference.

3. Results

3.1. Comparison of blood lipid levels between the two groups

As shown in **Table 1**, after treatment, the blood lipid levels of the study group were better than those of the control group ($P < 0.05$).

Table 1. Comparison of blood lipid levels between the two groups before and after treatment (mean ± SD, mmol/L)

Group	TC		TG		HDL-C		LDL-C	
	Before	After	Before	After	Before	After	Before	After
Study group (n = 30)	5.93 ± 1.25	4.08 ± 0.77	3.81 ± 0.79	1.72 ± 0.35	0.91 ± 0.13	1.41 ± 0.35	4.02 ± 0.85	2.04 ± 0.23
Control group (n = 29)	5.88 ± 1.29	5.14 ± 1.13	3.77 ± 0.82	2.24 ± 0.61	0.93 ± 0.16	1.08 ± 0.17	4.07 ± 0.79	2.76 ± 0.68
t-value	0.151	4.223	0.191	4.033	0.528	4.581	0.234	5.485
P value	0.880	0.000	0.849	0.000	0.600	0.000	0.816	0.000

Abbreviations: TC, total cholesterol; TG, triglyceride; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.

3.2. Comparison of cardiac function and inflammatory factor levels between the two groups

As shown in **Table 2**, after treatment, the cardiac function and inflammatory factors in the study group were better than those in the control group ($P < 0.05$).

Table 2. Comparison of cardiac function and inflammatory factor levels between the two groups before and after treatment (mean ± SD)

Group	LVEF (%)		hs-CRP (mg/L)		FMD (%)		ET-1 (ng/L)	
	Before	After	Before	After	Before	After	Before	After
Study group (n = 30)	48.92 ± 5.74	55.38 ± 4.72	13.98 ± 2.25	1.48 ± 0.32	6.74 ± 1.12	8.49 ± 1.52	6.12 ± 1.08	4.08 ± 0.55
Control group (n = 29)	48.85 ± 5.79	48.96 ± 2.81	14.03 ± 2.19	2.36 ± 0.77	6.69 ± 1.18	7.03 ± 1.18	6.07 ± 1.13	5.09 ± 0.97
t-value	0.047	6.321	0.086	5.767	0.167	4.111	0.174	4.941
P value	0.963	0.000	0.931	0.000	0.868	0.000	0.863	0.000

Abbreviations: LVEF, left ventricle ejection fraction; hs-CRP, high-sensitivity C-reactive protein; FMD, flow-mediated vasodilatation; ET-1, endothelin-1.

3.3. Comparing the clinical efficiency of the two groups

As shown in **Table 3**, the clinical effective rate of patients in the study group was higher than that in the control group ($P < 0.05$).

Table 3. Comparison of clinical effective rates between the two groups [n (%)]

Group	Markedly effective	Effective	Ineffective	Total efficiency
Study group (n = 30)	19	9	2	28 (93.3)
Control group (n = 29)	14	7	8	21 (72.4)
x^2 value				4.584
P value				0.032

3.4. Comparing the incidence of adverse reactions between the two groups

As shown in **Table 4**, there was no significant difference in the incidence of adverse reactions between the two groups ($P > 0.05$).

Table 4. Comparison of the incidence of adverse reactions between the two groups [*n* (%)]

Group	Gastrointestinal reaction	Muscle ache	Rash	Incidence of adverse reactions
Study group (*n* = 30)	2	0	1	3 (10.0)
Control group (*n* = 29)	1	1	0	2 (6.9)
x^2 value				0.183
P value				0.668

4. Discussion

Coronary artery tissue is the artery that provides the heart with the blood it needs. For example, the plaque deposited inside the coronary artery can reduce the space for blood flow in the lumen, thereby inducing coronary heart disease. At present, affected by diet, environment, and lifestyle factors, the incidence of coronary heart disease is at a relatively high level. Most patients present with symptoms such as angina pectoris and chest pressure. If early treatment and intervention are not performed, symptoms such as arrhythmia, heart failure, and cardiogenic shock may be induced, and even sudden death may occur [4].

The clinical treatment of coronary heart disease mainly includes conservative drug treatment and surgical treatment. Patients with mild coronary artery stenosis usually use drug therapy, while patients with severe coronary artery stenosis or complete coronary artery occlusion need surgical treatment. With the deepening of pharmaceutical research, the types of drugs suitable for the treatment of coronary heart disease have increased significantly. Commonly used drugs include anti-platelet drugs such as aspirin and anti-myocardial ischemia drugs such as nitroglycerin [5]. Clinical studies have confirmed that hypercholesterolemia is an independent risk factor for the onset and progression of coronary heart disease. If the level of low-density lipoprotein cholesterol (LDL-C) can be effectively controlled, the incidence of adverse cardiovascular events can be reduced. Therefore, it is necessary to add lipid-lowering drugs to the drug treatment plan to improve the therapeutic effect [6]. Atorvastatin calcium is a lipid-lowering drug widely used in clinical practice. The drug composition can highly selectively inhibit 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA), making it unable to induce the synthesis of mevalonate, thereby blocking the cholesterol synthesis pathway, reducing the total amount of cholesterol synthesized by the liver, and effectively controlling the levels of lipoprotein and cholesterol in plasma. Atorvastatin calcium can also act on liver cells to increase the number of LDL receptors on the surface, promote the uptake of LDL, accelerate its catabolism, and block the synthesis of lipoproteins, thereby effectively controlling blood lipid levels. The role of atorvastatin calcium in regulating blood lipids is related to the dosage and sensitivity of the patient's body to the drug. Some patients with coronary heart disease simply increase the dosage of atorvastatin calcium, but the levels of total cholesterol (TC) and LDL-C do not significantly decrease. In addition, excessive dosage can affect liver function and cause adverse reactions such as muscle pain. For this reason, the medication regimen should be adjusted appropriately. Ezetimibe tablets are a new generation of powerful lipid-regulating drugs. The drug ingredients can specifically bind to the brush border receptors of small intestinal villi, block the absorption of cholesterol in the small intestine, prevent cholesterol from being transported to the liver through the small intestine, and then reduce the cholesterol level in the liver, induce the liver to synthesize LDL receptors, promote LDL metabolism, and significantly reduce blood cholesterol and LDL-C levels. The combined application of atorvastatin calcium and ezetimibe tablets can achieve the synergy of different lipid-lowering mechanisms, inhibit the absorption and synthesis of cholesterol at different targets, and gradually restore the blood lipid level of patients to the normal range, and its

curative effect is significantly better than that of single atorvastatin calcium treatment [7].

The results of this study showed that after treatment, the blood lipid indexes of the patients in the study group were better than those in the control group. Dyslipidemia is a high-risk factor in the onset and progression of coronary heart disease. Excessive levels of LDL-C can lead to aggravation of atherosclerosis, and excessive levels of TG can lead to increased mortality of patients. Therefore, appropriate lipid-lowering treatments should be adopted. Atorvastatin calcium is the basic medicine for preventing and treating coronary heart disease. After taking the medicine, it can block the synthesis of HMG-CoA in the liver, reduce the total amount of cholesterol synthesis, and then reduce the levels of lipoprotein and cholesterol in the blood. Atorvastatin calcium can also act on liver cells, induce the synthesis of LDL-C receptors on the cell surface, accelerate the metabolism of LDL-C, and then control the progression of atherosclerosis. Clinical studies suggest that cholesterol is excreted together with bile after metabolism in the human body, and part of the metabolized cholesterol can be absorbed by the small intestine. Treatment with atorvastatin calcium alone cannot inhibit cholesterol absorption. Some patients still have abnormal blood lipid levels after stopping the drug. For this reason, other lipid-lowering drugs need to be used to block the cholesterol absorption pathway. Ezetimibe tablets belong to a new generation of lipid-lowering drugs, which can bind to Niemann-Pick C1-like intracellular cholesterol transporter 1 (NPC1L1) in the epithelial tissue of the upper small intestine after medication to block the reabsorption of cholesterol in the small intestine, thereby reducing the cholesterol content in the liver and blood. The combined intervention of atorvastatin calcium and ezetimibe tablets can inhibit cholesterol synthesis and reabsorption through different channels, and then effectively regulate blood lipid levels, and its curative effect is significantly better than a single atorvastatin calcium treatment intervention [8]. The data of this study confirmed that the cardiac function and inflammatory factor levels of patients in the study group were improved after treatment. The reason for this result is that atorvastatin calcium has the effect of anti-infection and improving coronary vascular endothelial function, combined with ezetimibe treatment can effectively regulate blood lipid levels, control atherosclerotic plaque, reduce inflammatory response, repair damaged coronary vascular endothelial function, inhibit inflammatory response, and gradually improve cardiac function level [9]. The results of this study showed that the clinical effective rate of patients in the study group was higher than that in the control group. Lipid-lowering drugs are indispensable in drug treatment programs for patients with coronary heart disease. Simple atorvastatin calcium can only inhibit cholesterol synthesis, but cannot block the pathway of cholesterol reabsorption. Some patients have no significant improvement in blood lipid levels after taking the drug, and the lipid-lowering effect has not been significantly improved after increasing the dosage of the drug and may induce a variety of adverse reactions. Ezetimibe tablets can make up for the deficiency of atorvastatin calcium. After medication, it can bind to the relevant sites in the small intestine to block the absorption of cholesterol, which can help improve the lipid-lowering effect, so that patients can obtain satisfactory curative effects. The results of this study showed that there was no significant difference in the incidence of adverse reactions between the two groups. The main function of atorvastatin and ezetimibe tablets is lipid-lowering, the drug is absorbed and metabolized rapidly and has no accumulation in the human body, and there is no serious adverse reaction after the combined drug [10]. This study believes that the combined application of atorvastatin calcium and ezetimibe tablets in the treatment of patients with coronary heart disease can achieve good clinical effects, and this treatment plan has high clinical promotion value. In the process of drug treatment intervention, physicians need to conduct comprehensive and meticulous health management of patients, inform patients to pay attention to quitting smoking and alcohol in daily life, limit cholesterol intake, control primary diseases, guide patients to complete cardiac rehabilitation exercises, focus on improving patients' dietary problems, guide patients to maintain an optimistic state of mind, learn to self-control emotions, and guide patients to self-monitor the changes in their

condition. The treatment of coronary heart disease has long-term characteristics. For this reason, patients must strictly follow the doctor's prescription for medication. Doctors also need to dynamically evaluate the patient's condition and adjust the treatment plan early to speed up the patient's recovery process.

In summary, it can be seen that the clinical effect of atorvastatin calcium combined with ezetimibe tablets in the treatment of patients with coronary heart disease is significant, and it has the value of promotion and application. The number of samples of coronary heart disease patients included in this study is relatively small, and no comparative analysis of the same type of data has been carried out. The mechanism of atorvastatin calcium combined with ezetimibe tablets still needs to be analyzed and studied.

Disclosure statement

The author declares no conflicts of interest.

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Comparison of Efficacy and Safety Between Video-Assisted Thoracoscopic Surgery and Traditional Thoracotomy in the Treatment of Esophageal Cancer

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Abstract: *Objective:* To compare the therapeutic effect of video-assisted thoracoscopic surgery and traditional thoracotomy in patients with esophageal cancer. *Methods:* 60 patients with esophageal cancer who were treated from February 2022 to February 2023 were randomly divided into groups. Video-assisted thoracoscopic surgery was included in group A, and thoracotomy was included in group B. The curative effects of esophageal cancer surgery were compared. *Results:* All surgical indexes in group A were better than those in group B ($P < 0.05$); interleukin-6 (IL-6), C-reactive protein (CRP), and tumor necrosis factor-α (TNF-α) levels in group A were lower than those in group B ($P < 0.05$); the postoperative SF-36 score in group A was higher than that in group B ($P < 0.05$); the postoperative complication rate in group A was lower than that in group B ($P < 0.05$). *Conclusion:* Video-assisted thoracoscopic treatment for patients with esophageal cancer can reduce postoperative inflammatory response and reduce surgical trauma, which is safe and efficient.

Keywords: Esophageal cancer; Traditional surgery; Video-assisted thoracoscopy; Curative effect; Safety

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1. Introduction

Esophageal cancer is a common clinical malignant tumor with a high mortality rate, and its typical feature is lymph node metastasis. After the occurrence of esophageal cancer, the patient's survival period is about 10 months, and the 5-year survival period after surgery is about 20%. The sooner surgery is performed, the longer the survival is. In addition, surgical treatment for patients with esophageal cancer can completely remove the cancer focus and help patients restore the function of the digestive system. Conventional thoracotomy is relatively common in the treatment of esophageal cancer, but various complications are prone to occur after the operation, and the prognosis of most patients is poor. As minimally invasive techniques continue to mature, video-assisted thoracoscopic techniques are gradually being used in the treatment of esophageal cancer, which can reduce surgical injuries and bleeding and has been widely used in thoracic surgery [1]. In this paper, 60 patients with esophageal cancer were recruited to explore the effect of video-assisted thoracoscopic treatment.

2. Materials and methods

2.1. General information

A total of 60 patients with esophageal cancer who were treated from February 2022 to February 2023 were recruited and randomly divided into groups A and B. The data of patients with esophageal cancer in group A were not different from those in group B (P>0.05), as shown in **Table 1**.

Table 1. Data analysis of esophageal cancer

Group	No.	Gender		Age (years)		Tumor stage (%)			Tumor location		
		Male	Female	Interval	Average	I	II	III	Upper section	Middle section	Lower paragraph
Group A	30	17	13	54–79	66.28 ± 2.19	2	19	9	4	21	5
Group B	30	19	11	54–80	66.31 ± 2.21	3	19	8	5	19	6
x^2 / t	-	0.2778		0.0528		0.0577			0.0584		
P	-	0.5981		0.9581		0.9362			0.9782		

2.2. Inclusion and exclusion standards

The inclusion criteria included: (1) patients with pathological and imaging results suggesting esophageal cancer; (2) patients who choose surgical treatment; (3) patients with informed consent; and (4) patients undergoing angiographic examination, showing that the diameter of the lesion is less than 5 cm.

The exclusion criteria included: (1) patients with abnormal liver, kidney, and cardiopulmonary function; (2) patients with a history of chest surgery; (3) patients with blood system lesions; and (4) patients with other malignant tumors.

2.3. Treatment methods

Group A video-assisted thoracoscopic treatment: the operation was completed under video-assisted thoracoscopic surgery, and the patient was assisted in the left lateral position before the operation; With general anesthesia, and the double-lumen tracheal intubation was performed, with an opening in the 6th or 7th intercostal space, and the length of the incision was controlled at about 1.0–1.5 cm, which was put in the endoscope; 2 main operation holes were determined and opened at the 5 intercostals in the right armpit, the incision length was controlled at about 1.5–2.0 cm, the 5 intercostals at the right midaxillary line were opened and the incision length was controlled at 1.0–1.5 cm, followed by completion of the thoracoscopic surgery through the aforementioned main operation hole; a secondary operation hole was determined and opened at the 9th rib between the posterior axillary line and the scapular line, and the length of the incision was controlled at 2.0–3.0 cm. With the assistance of video-assisted thoracoscopic surgery, the thoracic esophagus, azygos vein, and mediastinal lymph nodes were dissected. If relevant conditions were met, a drainage tube was indwelled. Afterward, the good limbs were placed, and the lateral position was changed to a supine position. An incision was made with a length of 1.5 cm. At the same time, small incisions in the four quadrants were made to thoroughly clean the lymph nodes in the stomach. After the completion, the stomach is freed to maintain a tubular shape. After suturing, the tube-like stomach is lifted to the neck, and gastroesophageal anastomosis is carried out.

Group B thoracotomy treatment: the operation method is thoracotomy with three incisions radical operation, the patient was instructed to lie on the left side, the incision position was at the 6th intercostal space

on the right side, the incision length was controlled at 20–25 cm, and then the incision was made in the supine position. The location was in the middle of the abdomen, the length was controlled at 18–20 cm, the operation after the opening was the same as that of group A, and finally, the neck anastomosis was carried out.

2.4. Observation indicators

The observation indicators of this study are as follows:

(1) Surgical indicators: record incision length, operation time, hospitalization time, chest drainage volume, number of dissected lymph nodes, and blood loss during operation.
(2) Inflammatory indicators: detect the levels of interleukin-6 (IL-6), C-reactive protein (CRP), tumor necrosis factor α (TNF-α), and other indicators.
(3) Quality of life: The quality of life of patients with esophageal cancer was evaluated by SF-36, with a score of 0–100.
(4) Adverse reactions: Anastomotic leakage, recurrent laryngeal nerve injury, tracheal injury, and cardiopulmonary complications were recorded.

2.5. Statistical research

Esophageal cancer data were processed with SPSS 21.0, % records (x^2 test) count data of esophageal cancer patients, mean ± standard deviation (SD) records (*t*-test) measurement data of esophageal cancer patients. There is a statistical difference if $P < 0.05$.

3. Results

3.1. Surgical indicators for esophageal cancer

Table 2 showed that the surgical indicators of patients with esophageal cancer in group A were better than those in group B ($P < 0.05$).

Table 2. Comparison of surgical indicators for esophageal cancer (mean ± SD)

Group	Incision length (cm)	Operation time (min)	Length of hospital stay (d)	Chest drainage volume (ml)	Number of lymph nodes dissected (pieces)	Intraoperative blood loss (mL)
Group A ($n = 30$)	5.58 ± 1.25	261.25 ± 1.88	11.84 ± 1.25	425.15 ± 25.25	11.01 ± 0.58	187.25 ± 8.19
Group B ($n = 30$)	16.11 ± 1.39	339.42 ± 1.99	19.48 ± 1.36	548.36 ± 31.44	12.84 ± 0.64	333.61 ± 9.43
t	30.8525	156.3974	22.6539	16.7356	11.6049	64.1829
P	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

3.2. Inflammatory factor indicators

After the operation, the levels of IL-6, CRP, and TNF-α in patients with esophageal cancer in group A were lower than those in group B ($P < 0.05$), as shown in **Table 3**.

Table 3. Analysis table of inflammatory factor levels before and after the operation (mean ± SD)

Group	IL-6 (ng/L)		CRP (mg/L)		TNF-α (ng/L)	
	Before	After	Before	After	Before	After
Group A (n = 30)	8.31 ± 0.42	71.86 ± 11.25	5.01 ± 0.89	6.29 ± 1.32	20.07 ± 3.25	36.11 ± 4.15
Group B (n = 30)	8.29 ± 0.44	100.14 ± 15.43	5.03 ± 0.91	8.25 ± 1.39	20.05 ± 3.27	47.85 ± 6.21
t	0.1801	8.1115	0.0861	5.6004	0.0238	8.6092
P	0.8577	0.0000	0.9317	0.0000	0.9811	0.0000

3.3. Quality of life indicators

Table 4 showed that the SF-36 scores of patients with esophageal cancer in group A were higher than those in group B after the operation ($P < 0.05$).

Table 4. SF-36 score analysis of patients with esophageal cancer before and after the operation (mean ± SD)

Group	Physical health (points)		Mental health (points)		Physiological functions (points)		Social functions (points)	
	Before	After	Before	After	Before	After	Before	After
Group A (n = 30)	61.28 ± 2.15	83.25 ± 3.58	62.49 ± 2.36	84.11 ± 3.61	63.25 ± 2.42	81.42 ± 3.41	61.52 ± 2.21	81.59 ± 3.52
Group B (n = 30)	61.31 ± 2.17	72.43 ± 2.79	62.51 ± 2.41	73.16 ± 3.43	63.27 ± 2.39	72.84 ± 3.25	61.49 ± 2.15	62.36 ± 3.43
t	0.0538	13.0572	0.0325	12.0441	0.0322	9.9762	0.0533	21.4306
P	0.9573	0.0000	0.9742	0.0000	0.9744	0.0000	0.9577	0.0000

3.4. Complications

The surgical complication rate in group A was lower than that in group B ($P < 0.05$), as shown in **Table 5**.

Table 5. Analysis table of complications in two groups [n (%)]

Group	Anastomotic fistula	Recurrent laryngeal nerve injury	Tracheal injury	Cardiopulmonary complications	Incidence rate
Group A (n = 30)	0	0	0	1	3.33
Group B (n = 30)	1	1	1	3	20.00
x^2	-	-	-	-	4.0431
P	-	-	-	-	0.0444

4. Discussion

In the early stage of esophageal cancer, patients may experience symptoms such as dysphagia, tight throat, and dry throat. In the early stage of esophageal cancer, patients may experience symptoms such as dysphagia, tight throat, and dry throat. During daily eating, foreign body sensations and swallowing blockage may occur, and some patients may also have abdominal pain [2]. With the progression of esophageal cancer, the diameter of

the tumor continues to expand, and the patient has the problem of being unable to swallow dry and hard food. In the middle and advanced stages, the symptoms of dysphagia are progressively aggravated, and there is no remission period of dysphagia during the onset. In summary, the causes of esophageal cancer are as follows: (1) Alcoholism and smoking: the aforementioned factors are high-risk factors for esophageal squamous cell carcinoma, and the incidence rate of smokers is 3–8 times higher than that of ordinary people, and the incidence of alcoholics is 7–50 times higher than that of ordinary people; (2) Nitrite: nitrosamines are mainly composed of nitrites. Food containing nitrosamines can cause esophageal epithelial hyperplasia and induce esophageal cancer. In addition, there are a lot of nitrites in pickled food, so it is not advisable to overly eat; (3) Fungi: there are a lot of mycotoxins in moldy food, which can act on nitrate, causing it to undergo a reduction reaction to generate nitrite, which in turn generates carcinogen nitrosamines; (4) Lack of trace elements: long-term lack of trace elements in large quantities can also increase the risk of cancer; (5) overly high body mass; (6) occurrence of precancerous lesions: factors such as esophageal diverticulum and esophageal burns can induce chronic esophagitis, and long-term inflammatory infiltration can cause esophageal canceration; and (7) inheritance: esophageal cancer is hereditary in families. However, the specific clinical causes of esophageal cancer are yet to elucidate, so it is difficult to prevent and treat esophageal cancer [3,4].

The risk of esophageal cancer in China is relatively high, and the pressure of diagnosis and treatment is relatively high. Based on the analysis of the physiological and anatomical structure of the esophagus, there is a rich lymphatic network inside, and the risk of cancer metastasis is high. Once it metastasizes to the mediastinal lymph nodes, it can increase the mortality of patients. At present, surgery is mostly used in clinical treatment of esophageal cancer. The conventional operation is thoracotomy, which is a large trauma operation and can increase the infection rate after surgery which then prolong the recovery time of patients. Some patients with esophageal cancer cannot tolerate it. In recent years, video-assisted thoracoscopic surgery has gradually been used in the treatment of patients with esophageal cancer. With the assistance of photography technology, advanced equipment is used to complete the operation. A clear surgical field is helpful for doctors to determine the scope of surgical operations [5]. In addition, video-assisted thoracoscopic surgery can ensure doctors completely remove esophageal lesions, thereby reducing the recurrence rate after surgery; thoracoscopic surgery can also assist doctors in fully observing the physiological structure from the top of the chest to the diaphragm and has a deep lighting function, which can improve the doctor's operation accuracy, to avoid damaging the adjacent tissues during surgical resection, thereby ensuring surgical safety [6]. Compared with traditional thoracotomy for the treatment of esophageal cancer, the video-assisted thoracoscopic operation has less trauma and is more suitable for the treatment of patients with esophageal cancer.

Combined with the data analysis in this paper, the surgical indicators of patients with esophageal cancer in group A were better than those in group B ($P < 0.05$). It is suggested that video-assisted thoracoscopic surgery is more conducive to the rehabilitation of patients with esophageal cancer. Conventional thoracotomy for esophageal cancer appears to be traumatic, which is not conducive to the prognosis of patients. However, the surgical operation under video-assisted thoracoscopic surgery can reduce the surgical incision, help doctors to observe the physiological and anatomical structure of the surgical area, and can also perform precise free operation and reduce surgical trauma, so the prognosis of patients is better [7]. Another set of data showed that IL-6, CRP, and TNF-α in patients with esophageal cancer in group A were lower than those in group B ($P < 0.05$). It shows that after video-assisted thoracoscopic treatment, the level of inflammation in patients is lower. During video-assisted thoracoscopic treatment, several small incisions are made on the chest wall, and the doctor observes the physiological structure of the chest cavity on the monitor screen and uses specific surgical instruments to carry out the surgical treatment, which is equivalent to the doctor looking directly at the

patient's chest cavity, and the thoracoscope has high-definition imaging, magnifies the local tissue function, and can expand the surgical field of view, so the surgical operation is more accurate and the adjacent tissue is less damaged, hence, the postoperative inflammatory reaction is mild [8]. In addition, the incision range of video-assisted thoracoscopic surgery is similar to that of thoracotomy, and the positive rate of intraoperative pathological biopsy is higher than that of needle biopsy, which is suitable for the treatment of patients with esophageal cancer [9]. In this study, the SF-36 score of group A was higher than that of group B ($P < 0.05$). Lymph node dissection and resection of esophageal cancer lesions are important factors affecting the prognosis of patients with esophageal cancer. Video-assisted thoracoscopic treatment can expand the physician's surgical field and facilitate the evaluation of the tissue gap during the separation period. At the same time, the recurrent laryngeal nerve and lymphatic vessel location can be observed, so the postoperative recovery of patients is better, and the quality of life score is higher [10,11]. The last group of data showed that the postoperative complication rate of patients with esophageal cancer in group A was lower than that in group B ($P < 0.05$). Video-assisted thoracoscopic surgery has a slight impact on the patient's abdominal breathing, which is conducive to the patient's spontaneous coughing, and single-lung ventilation can avoid the risk of secondary cardiopulmonary injury after surgery, which is safe and efficient.

In summary, video-assisted thoracoscopic surgery for patients with esophageal cancer can reduce postoperative complications of esophageal cancer, reduce postoperative inflammatory response, and enhance the quality of life of patients, which has a promotion value.

Disclosure statement

The author declares no conflicts of interest.

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Efficacy and Safety of Percutaneous Closure in Patients with Patent Foramen Ovale and Migraine

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Abstract: *Objective:* To analyze the therapeutic effect of percutaneous closure of patent foramen ovale (PFO) and migraine. *Methods:* A total of 150 patients with PFO and migraine who were admitted to the hospital from January 2021 to May 2023 were recruited and divided into groups by random number table, the study group took percutaneous closure and drug treatment, and the control group took conventional drug treatment. The treatment effects between the groups were compared. *Results:* The total effective rate of the study group was higher than that of the control group ($P < 0.05$). Before treatment, there was no difference in migraine quantitative evaluation indicators between the groups ($P > 0.05$). After treatment, the migraine quantitative evaluation indicators in the study group were better than those in the control group ($P < 0.05$). The complication rate of the study group was lower than that of the control group ($P < 0.05$). Followed up for 1 to 3 months, the recurrence rate of the study group was lower than that of the control group ($P < 0.05$). *Conclusion:* Percutaneous closure for patients with PFO and migraine can improve the symptoms of migraine, enhance the curative effect, and have fewer postoperative complications.

Keywords: Patent foramen ovale; Migraine; Percutaneous closure; Efficacy; Safety

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1. Introduction

Patent foramen ovale (PFO) is a common congenital heart abnormality, which refers to the incomplete closure of the foramen ovale of the heart tissue. Some PFO patients have no obvious clinical symptoms, and the rate of missed and misdiagnosed diseases is high. Migraine belongs to neurovascular headache, and its pathogenesis is complex and related to many factors [1,2]. In recent years, studies have found that there is an association between PFO and migraine. Some patients with PFO showed abnormal cerebral blood flow and blood oxygenation, which led to a higher frequency of migraine symptoms. Percutaneous occlusion is an interventional treatment method with a high application rate. It delivers an occluder to the foramen ovale through a skin catheter to seal the foramen ovale and close it. This method has better efficacy in treating PFO and migraine and has fewer postoperative complications [3]. This study selected 150 patients with PFO and migraine to analyze the effect of percutaneous closure and drug treatment.

2. Materials and methods

2.1. General information

A total of 150 patients with PFO and migraine who were admitted to the Fifth Affiliated Hospital of Zhengzhou University from January 2021 to May 2023 were recruited and divided into two groups using the random number table grouping. The study group consisted of 75 cases, 41 males and 34 females, aged from 14 to 65 years with a mean of 52.35 ± 1.75 years, and a course of migraine from 1 to 5 years with a mean of 3.05 ± 0.74 years. There were 75 cases in the control group, 42 males and 33 females, the age ranged from 15 to 62 years with an average of 52.04 ± 1.80 years, and a course of migraine from 2 to 6 years with an average of 3.57 ± 0.55 years. After the data were compared, it was recorded as $P > 0.05$.

2.2. Methods

The control group took conventional drug treatment: flunarizine was taken warmly before going to bed every day, with a dose of 10 mg each time and once daily. Ibuprofen sustained-release capsules were taken with a dose of 0.3 g each time and twice daily. Medications were continuous for 1 to 3 months.

The study group adopted percutaneous closure and drug therapy: D-dimer, blood coagulation function, and other related examinations were carried out for the patients after admission. Ultrasonography was performed on the bilateral femoral and carotid arteries, and a head CT scan was performed concurrently to obtain a dynamic electrocardiogram. After meeting the surgical indications, the patient's femoral vein was punctured, and the right heart catheter was sent to the left upper pulmonary vein and left atrium through the PFO. A hardened guide wire was used to establish a track, and a long sheath was placed along the track to reach the left atrium, the long sheath was used to send the PFO occluder to the foramen ovale to complete the occlusion treatment. Conventional occluders are 18/25 mm and 25/25 mm. If there is a long tubular PFO or bulge, a 30/30 mm occlude was used. Ultrasound was then used to evaluate the actual position of the occlude, and the occlude was released after ensuring that the large blood vessels and heart valves are not affected. Clopidogrel was continued for 3 months postoperatively at a daily dose of 75 mg, and aspirin was taken orally for 6 months at a daily dose of 3 to 5 mg/kg.

2.3. Observation indicators

Quantitative assessment of migraine included headache symptoms and impact on quality of life. Among them, headache symptoms included headache frequency, duration, and headache degree, and the headache degree is evaluated by the Short Pain Scale, including emotional pain grading index (PPI) with 4 items of exhaustion and distress (12 points), feeling pain rating index (PRI) with 11 items such as throbbing pain (33 points), visual analog scale (VAS) of 10 points with all positive scoring. The impact on the quality of life was evaluated using the headache impact test. There were 6 questions in total, all ranging from 6 to 13 points, giving a total of 78 points. The degree of impact on life is positively scored.

The complication rate of drowsiness, bradykinesia, gastrointestinal symptoms, impaired liver function, infection, bleeding, femoral arteriovenous fistula, and coronary embolism was observed. The patients were followed up for 1 to 3 months, and the recurrence rates of the two groups were counted.

2.4. Efficacy evaluation criteria

Significantly effective means no migraine symptoms and no abnormalities in various laboratory indicators; preliminary effective means that migraine symptoms are relieved and various laboratory indicators are slightly abnormal; no effect means no change in migraine symptoms and various laboratory indicators are serious exceptions.

2.5. Statistical analysis

The data were processed using SPSS 28.0 software, the measured values were tested by *t*-test, and the counted values were tested by χ^2 test. Statistically significant was defined as a *P* value less than 0.05.

3. Results

3.1. Comparison of the total effective rate between the two groups

Table 1 showed that the total effective rate of the study group was significantly higher than that of the control group ($P < 0.05$).

Table 1. Comparison of total effective rate between the two groups [n (%)]

Group	Number of cases	Significantly effective	Preliminary effective	No effect	Total effective rate
Study group	75	38 (50.67)	35 (46.67)	2 (2.67)	97.33 (73/75)
Control group	75	35 (46.67)	30 (40.00)	10 (13.33)	86.67 (65/75)
χ^2	-	-	-	-	5.797
P	-	-	-	-	0.016

3.2. Comparison of migraine quantitative assessment indicators between the two groups

Before treatment, there was no difference in migraine quantitative evaluation indicators between the two groups ($P > 0.05$). After treatment, the quantitative evaluation indexes of the study group were better than those of the control group ($P < 0.05$), as shown in **Table 2**.

Table 2. Comparison of migraine quantitative assessment indicators between the two groups before and after treatment (mean ± SD)

Group	Headache symptoms										Impact on quality of life (points)	
	Headache frequency (times/mth)		Duration (min/time)		Headache degree (points)							
					PPI		PRI		VAS			
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Study group ($n = 75$)	8.81 ± 1.26	1.05 ± 0.33	30.25 ± 3.26	4.26 ± 0.84	6.25 ± 1.71	1.85 ± 0.72	20.35 ± 2.74	8.11 ± 1.53	4.26 ± 1.02	1.15 ± 0.37	40.26 ± 5.31	16.34 ± 1.59
Control group ($n = 75$)	8.82 ± 1.34	1.78 ± 0.37	30.29 ± 3.17	7.49 ± 1.41	6.29 ± 1.65	2.67 ± 0.81	20.13 ± 2.65	12.84 ± 1.65	4.30 ± 1.08	1.62 ± 0.49	40.22 ± 5.19	20.18 ± 1.77
t	0.047	12.752	0.076	17.043	0.146	6.553	0.500	18.204	0.233	6.629	0.047	13.977
P	0.963	0.000	0.939	0.000	0.884	0.000	0.618	0.000	0.816	0.000	0.963	0.000

3.3. Comparison of complication rates between the two groups

Table 3 showed that the complication rate of the study group was lower than that of the control group ($P < 0.05$).

3.4. Comparison of recurrence rates between the two groups

During the follow-up of 1 to 3 months, the recurrence rate of the study group was lower than that of the control group ($P < 0.05$), as shown in **Table 4**.

Table 3. Comparison of complication rates between the two groups [n (%)]

Group	Drowsiness	Bradykinesia	Gastrointestinal symptoms	Impaired liver function	Infection	Bleeding	Femoral arteriovenous fistula	Coronary embolism	Incidence rate
Study group (n = 75)	0	1 (1.33)	0	0	1 (1.33)	1 (1.33)	0	0	4.00 (3/75)
Control group (n = 75)	3 (4.00)	2 (2.67)	4 (5.33)	1 (1.33)	0	0	0	0	13.33 (10/75)
χ^2	-	-	-	-	-	-	-	-	4.127
P	-	-	-	-	-	-	-	-	0.042

Table 4. Comparison of recurrence rates between the two groups [n (%)]

Group	Number of cases	Follow-up for 1 month	Follow-up for 2 months	Follow up for 3 months
Study group	75	0	0	1 (1.33)
Control group	75	4 (5.33)	5 (6.67)	7 (9.33)
χ^2	-	4.110	5.172	4.754
P	-	0.043	0.023	0.029

4. Discussion

The pathogenesis of PFO with migraine is not completely clear, and it may be related to the following factors: (1) Abnormal circulatory system: PFO can easily lead to poor blood flow between the left and right atrium, making the blood contain more platelets and coagulation factors, thereby increasing blood clotting, leading to migraine symptoms [4,5]; (2) Abnormal blood oxygenation: PFO will cause arterial blood to mix with venous blood, thereby reducing arterial blood oxygen saturation. Insufficient blood oxygenation will affect the oxygen supply state of the brain, triggering migraine [6]; (3) Vasodilation and contraction: PFO can induce abnormal expansion and contraction of cerebral blood vessels, which in turn affects cerebral blood flow and blood perfusion pressure, and eventually triggers migraine attacks; (4) Inflammatory response: PFO can change brain blood flow and blood components, trigger an inflammatory response, activate inflammatory mediators, and then affect the excitability and sensitivity of neurons, thereby inducing migraine [7-9]; and (5) Abnormal neuro-regulation: PFO can affect the neuro-regulation mechanism of the brain, including vasoconstriction and dilation regulation, which can lead to migraine.

Drug therapy is a common treatment for this disease, which can regulate nerve function and blood vessel activity, and reduce the intensity and frequency of headaches, which then reduce the pain of migraine attacks [10]. Among them, flunarizine belongs to the tricyclic antidepressant drugs, which can regulate the level of neurotransmitters, inhibit cerebral vasoconstriction, and thus relieve migraine symptoms. Ibuprofen has an anti-inflammatory effect that can block the synthesis process of prostaglandins and inhibit the excessive release of inflammatory mediators, as well as has an analgesic effect that can reduce peripheral sensitivity of blood vessels and avoid massive aggregation of platelets, which then reduces the actual release of vascular endothelin to relieve migraine manifestations [11]. However, drug treatment needs to be maintained for a long time, and after stopping the drug, the risk of recurrence of migraine symptoms is high. There are many adverse reactions to drugs, such as gastrointestinal symptoms and drowsiness, which affect the quality of life of patients. Long-

term use of certain drugs may also lead to tolerance of the drug, the efficacy of the drug gradually weakening, leading to the need of increasing the dose or replacing the drug, thereby increasing the difficulty of treatment [12].

Percutaneous closure can effectively close the foramen ovale and restore normal cardiac blood flow, thereby improving cerebral blood flow and blood oxygen supply, reducing the frequency of migraine attacks, and reducing the intensity of headaches. After blocking the foramen ovale, it can prevent the mixing of platelets and coagulation factors, thereby reducing the risk of blood clot formation, and can prevent cerebrovascular accidents [13]. This procedure improves blood circulation and oxygenation, reduces inflammation in the brain, and relieves migraine symptoms. This operation is an interventional therapy, and the patient's femoral vein is punctured for closure without open surgery, therefore, the surgical trauma is small, and the postoperative recovery is faster, which can shorten the rehabilitation period of patients and reduce their treatment burden [14]. For percutaneous occlusion, the appropriate occlusion device specifications can be selected according to the specific conditions of the patient to adapt to different sizes and types of PFOs, so as to achieve individualized treatment effects.

The results showed that the total effective rate of the study group was higher than that of the control group; after treatment, the migraine quantitative evaluation index of the study group was better than that of the control group; the complication rate of the study group was lower than that of the control group; the recurrence rate of the study group was lower ($P < 0.05$). The reason is that percutaneous closure can close the foramen ovale, avoid backflow of blood when passing through the heart, and block larger blood clots and other substances from entering the circulation of the brain through the foramen ovale, thereby reducing migraine headaches. This operation also reduces the possibility of thrombosis, thereby reducing related complications [15]. In addition, percutaneous closure can adjust abnormal hemodynamics of the cardiovascular system, such as right ventricular overload, improve heart and blood vessel function, and further relieve migraine symptoms.

In summary, percutaneous closure for PFO patients with migraine can improve the curative effect, improve migraine symptoms, reduce the impact of migraine on quality of life, has high treatment safety, and a low recurrence rate.

Disclosure statement

The authors declare no conflicts of interest.

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Study on Left Atrial Function in Patients with Early Left Ventricular Remodeling in Essential Hypertension Based on Two-Dimensional Speckle Tracking Technology

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Abstract: *Objective:* To use two-dimensional speckle tracking imaging (2D-STI) to analyze the functional changes of the left atrium before hypertrophic changes in the left ventricular configuration in the early stage of hypertension and to explore the clinical value of this technology in evaluating the changes of left atrial characteristics in patients with hypertension. *Methods:* 70 cases of patients with essential hypertension who met the requirements of this study after clinical diagnosis and routine ultrasound examination were recruited and divided into two groups according to the Ganan method: 38 cases in the left ventricular standard remodeling group, 32 cases in the left ventricular concentric remodeling group, and 40 healthy people with matched age and sex were randomly selected as the control group. The mean peak strains and strain rates of the left atrial systole, early diastole, and late diastole of each group were obtained using 2D-STI. The above parameters and indicators were used for comparative analysis. *Results:* Compared with the healthy control group, the values of peak strains and strain rates during early diastole were statistically different in both remodeling groups; compared with the standard remodeling group, the values of peak strains and strain rates in all periods were significantly different in the concentric remodeling group ($P < 0.05$). *Conclusion:* 2D-STI can be more sensitive and convenient to reflect the characteristic changes of left atrial myocardium in patients with early essential hypertension.

Keywords: Speckle tracking; 2D; Hypertension; Left atrium

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1. Background

Essential hypertension is a major modifiable risk factor for cardiovascular morbidity and mortality, which can cause changes in the structure and function of the left heart. Studies have proven that hypertension control can prevent changes in cardiac structure and function, as well as alleviate left heart disease [1]. Hypertensive heart disease mainly manifests in changes in left ventricular (LV) structure and function. Some studies have found that the left atrial function changes are earlier than the structural changes of the left atrium and left ventricle.

Even if the left ventricular structure of hypertensive patients is typical, the left atrium's mechanical function has been damaged [2,3]. Therefore, early detection of changes in left atrial function and early clinical intervention in patients with hypertension is of great significance in improving the prognosis of patients. Two-dimensional speckle tracking imaging (2D-STI) is a relatively popular new ultrasound technology in the cardiovascular field that can study left atrial function. Based on two-dimensional grayscale images, it regards myocardial tissue as countless echo speckles, which can accurately track each speckle mark and calculate its trajectory [4], obtain multi-angle, multi-directional left atrial strain and strain rate parameters, as well as quantitatively evaluate the functional changes of the left atrium. This study used 2D-STI to measure left atrial pressure and strain rate in patients with an early left ventricular remodeling in hypertension, aiming to explore the clinical value of early left atrial function changes.

2. Materials and methods

2.1. Research objects

70 hypertensive patients who visited Nanjing First Hospital from February 2020 to May 2022 were prospectively selected. The inclusion criteria included all patients who met the WHO or ISH diagnostic criteria for hypertension. Their heart function or left ventricular ejection fraction (LVEF) was within the normal range (LVEF > 55%), and the left ventricular mass index (LVMI) was within the normal range (LVMI ≤ 116 g/m^2 for male and ≤ 109 g/m^2 for female). Exclusion criteria included patients who had coronary heart disease, rheumatic heart disease, cor pulmonale, secondary hypertension, various cardiomyopathy, diabetes, and arrhythmia. According to the classification method of Ganau [5], they were divided into two groups according to the LVMI and relative wall thickness (RWT): (1) The left ventricular standard remodeling group, which both LVMI and RWT were within the normal range (RWT ≤ 0.42), with a total of 38 cases consisted of 20 males and 18 females, and the mean age was 57 ± 7 years old; (2) the left ventricular concentric remodeling group, which LVMI within the normal range and RWT >0.42, with a total of 32 cases consisted of 17 males and 15 females, and an average age of 58 ± 5 years old. In addition, 40 healthy volunteers who had a physical examination in the hospital during the same period, and did not have cardiovascular disease through echocardiography and various physical examination results, were randomly selected as the control group, which consisted of 21 males and 19 females, with an average age of 55 ± 9 years old.

2.2. Instruments and methods

The Philips EPIQ 7C color Doppler ultrasound imager with an S5-1 two-dimensional heart probe (frequency 2.0–3.5 MHz) set at 1.0–3.0 MHz was used and equipped with a QLAB 6.0 quantitative analysis workstation. The subject was placed in the left decubitus position, and the electrocardiogram was displayed synchronously. The subject was instructed to breathe steadily, and if necessary, hold his/her breath to ensure the quality of the collected images for image acquisition. The left atrial diameter (LAD), left ventricular end-diastolic diameter (LVEDd), left ventricular end-systolic diameter (LVED) and interventricular septal end-diastolic thickness (IVST), left ventricular posterior wall thickness (LVPWT), the passive blood flow from the left atrium to the left ventricle (E wave) and the blood flow generated by active atrial contraction (A wave), as well as the early diastolic mitral annular velocity (e' velocity) and the late diastolic mitral annular velocity (a' velocity) were measured using the S5-1 two-dimensional cardiac probe, followed by an automatic calculation of the left ventricular mass (LVM), the left ventricular mass index [LVMI = LVM / body surface area (BSA)], and relative wall thickness [RWT = (IVST + LVPWT)/LVEDd] by the system, and measurement of left ventricular ejection fraction (LVEF) using Simpson method. The dynamic images of the apical three-chamber, four-chamber, and

two-chamber views were recorded, and the dynamic images of four cardiac cycles were continuously recorded for each view and stored in the hard disk.

The two-dimensional images were imported into the Philips QLAB workstation, the range and width of the myocardium in the region of interest of the atrium were manually adjusted so that the spots cover entirely the content of the myocardium, and the atrial muscle was divided into three segments (base segment, middle segment, upper segment) and five walls (the anterior wall and inferior wall of the apical two-chamber view, the atrial septum and side wall of the apical four-chamber view, and the posterior wall of the apical three-chamber view). The software was used to track the atrial wall, followed by obtaining the strain and strain rate of each segment after successful tracking. The mean peak strain (mεs, mεe, mεa) and strain rate (mSRs, mSRe, mSRa) of the left atrial myocardium during systole, early diastole, and late diastole were recorded (**Figures 1** and **2**).

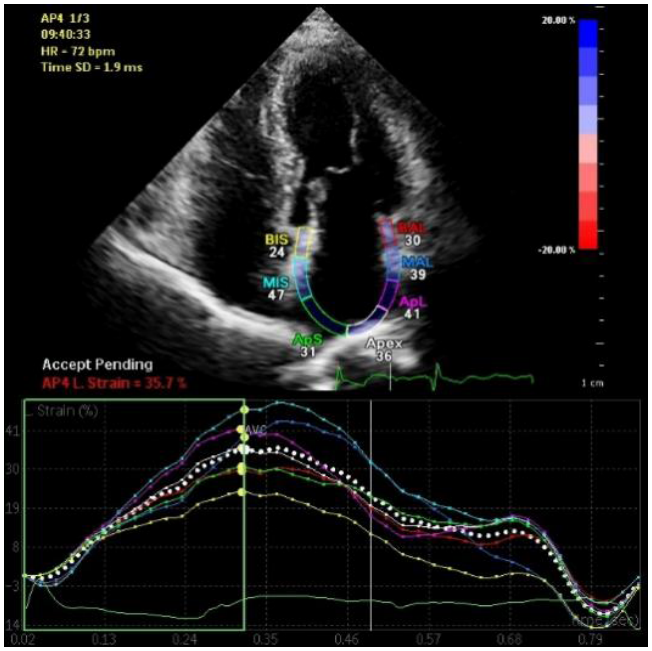

Figure 1. Left atrial strain curve in hypertensive patients

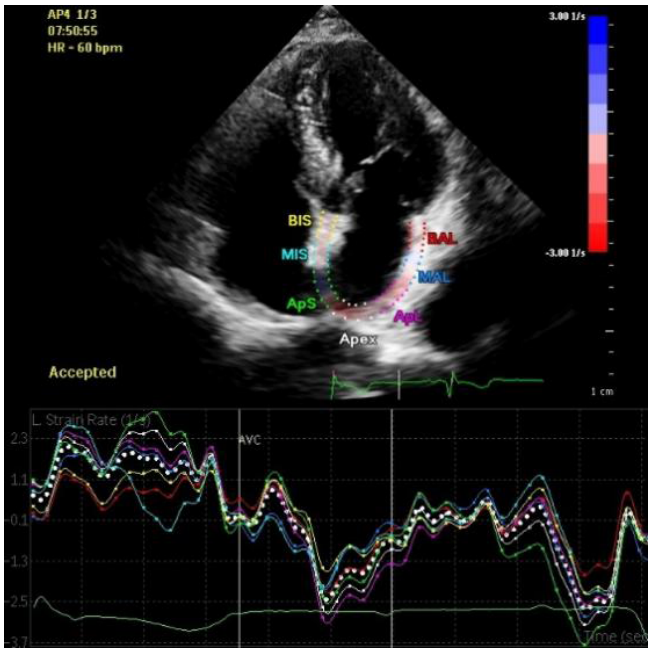

Figure 2. Left atrial strain rate curve in hypertensive patients

2.3. Statistical analysis

SPSS 23.0 statistical software was used for statistical analysis, measurement data were expressed as mean ± standard deviation (SD), comparison among multiple groups was performed by one-way analysis of variance (ANOVA), and pairwise comparison between groups was performed by LSD-*t* test. $P < 0.05$ means the difference is statistically significant.

3. Results

3.1. Comparison results of general information and conventional ultrasound parameters in each group

There was no significant difference in age, gender, BSA, heart rate, and LVEF among the three groups ($P > 0.05$). Compared with the healthy control group, the systolic and diastolic blood pressure, LAD, and E/e in both remodeling groups were all increased ($P < 0.05$), but there was no significant difference between the two subgroups of hypertension ($P > 0.05$).

Table 1. General information, conventional echocardiography, and tissue Doppler measurement parameters comparison

Index	Healthy control group	Standard remodeling group	Concentric remodeling group
Age (years)	54.8 ± 9.4	56.7 ± 6.6	57.5 ± 4.7
Gender (Male/Female)	21/19	20/18	17/15
Systolic blood pressure (mmHg)	107.7 ± 9.4	135.4 ± 10.6*	136.4 ± 11.8*
Diastolic blood pressure (mmHg)	75.4 ± 6.8	96.3 ± 9.6*	98.8 ± 10.6*
LAD (mm)	32.2 ± 2.6	35.5 ± 4.8	37.5 ± 3.8*
IVST (mm)	8.8 ± 0.1	9.8 ± 0.3	10.6 ± 0.4
LVEDd (mm)	45.9 ± 0.3	46.6 ± 0.4	47.6 ± 0.3
LVPWT (mm)	8.90 ± 0.07	9.10 ± 0.06	10.50 ± 0.07
LVMI (g/m^2)	90.4 ± 13.1	91.7 ± 8.2	92.2 ± 9.1
SV	65.1 ± 3.5	66.5 ± 3.7	66.6 ± 4.6
LVEF (%)	66.7 ± 4.3	66.8 ± 4.7	65.6 ± 5.3
E (dm/s)	6.6 ± 0.7	7.6 ± 0.9*	7.9 ± 0.8*
E/A	1.14 ± 0.09	0.94 ± 0.01*	0.95 ± 0.15*
e' (dm/s)	0.80 ± 0.32	0.70 ± 0.25	0.60 ± 0.39
E/e'	8.1 ± 1.0	9.3 ± 1.6*	9.9 ± 1.6*

Abbreviations: LAD, left atrial diameter; IVST, interventricular septal end-diastolic thickness; LVEDd, left ventricular end-diastolic diameter; LVPWT, left ventricular posterior wall thickness; LVMI, left ventricular mass index; SV, stroke volume; LVEF, left ventricular ejection fraction; E, the passive blood flow velocity from the left atrium to the left ventricle; E/A, the ratio between early and late transmitral velocity; e', the early diastolic mitral annular velocity; E/e', E wave divided by e' velocities to evaluate the LV filling pressure. *$P < 0.05$ when compared with the healthy control group.

3.2. Comparison results of left atrial strain rate parameters detected by 2D-STI

The strain (ε) and strain rates (SR) of the left ventricular standard remodeling group and the concentric remodeling group were compared with those of the healthy control group. The values of strain and strain rates during early diastole in the standard remodeling group were significantly different as compared to the healthy control group, whereas the strain and strain rates during all periods in the concentric remodeling group were

significantly different as compared to the healthy control group ($P < 0.05$). The strain and strain rates of the concentric remodeling group during systole and early diastole were significantly different as compared to the standard remodeling group ($P < 0.05$).

Table 2. Comparison of average strain rates among the three groups

	Healthy control group	Standard remodeling group	Concentric remodeling group
mεs	43.17 ± 6.50	42.16 ± 4.60	36.64 ± 4.0*#
mεe	12.59 ± 0.76	10.51 ± 0.44*	8.47 ± 0.33*#
mεa	-7.43 ± 0.32	-8.48 ± 0.64	-9.94 ± 0.54*
mSRs	2.77 ± 0.45	2.65 ± 0.44	2.36 ± 0.66*#
mSRe	-2.78 ± 0.57	-2.52 ± 0.45*	-2.23 ± 0.69*#
mSRa	-2.97 ± 0.32	-3.02 ± 0.67	-3.23 ± 0.33*

Abbreviations: mεs, mean left atrial strain during left ventricular systole; mεe, mean left atrial strain during left ventricular early diastole; mεs, mean left atrial strain during left ventricular late diastole; mSRs, mean left atrial strain rate in left ventricular systole; mSRe, mean left atrial strain rate in left ventricular early diastole; mSRa, mean left atrial strain rate in left ventricular late diastole. *$P < 0.05$ when compared with the healthy control group; #$P < 0.05$ when compared with the normal configuration group.

4. Discussion

In recent years, with the development of new ultrasound technology, the research on the functional structure of the left atrium in patients with hypertension has gradually attracted the attention of clinicians. In regulating left ventricular filling in the cardiac cycle, the left atrium can be divided into 3 phases, a reservoir during systole, a conduit during early diastole, and a booster pump during late diastole according to their functional characteristics. The three time-image functions of the left atrium play an essential role in maintaining left ventricular filling and left cardiac output [6]. The hemodynamic changes caused by long-term hypertension not only affect the changes in left ventricular morphology but also cause the adaptation and adjustment of the three-phase functions of the left atrium. Currently, echocardiography clinically evaluates patients' left atrial structure changes by measuring parameters such as left atrial volume and diameter. The American Society of Echocardiography guidelines only use the left atrial volume index, which represents left atrial structural parameters, as prognostic reference indicators [7], but these parameters cannot be used to evaluate the functional changes of left atrial myocardium in an early and intuitive way [8]. The two-dimensional speckle tracking technology conducts quantitative research on myocardial structural changes in the region of interest by automatically tracking the myocardial movement speckle echo. Subclinical local myocardial dysfunction can be detected in real time [9].

Relevant studies have shown that with the help of two-dimensional speckle tracking technology, the strain and strain rate parameters of the left atrium systole, early diastole, and late diastole can be obtained, respectively [10-12]. Among them, mεs and mSRs reflect the reservoir function of the left atrium during left ventricular systole, mεe and mSRe reflect the conduit function of the left atrium in early diastole, whereas mεa and mSRa reflect the booster pump function of the left atrium in late diastole. The reservoir function of the left atrium is mainly affected by the relaxation and stiffness of the left atrium myocardium and the contractility of the left ventricle. The function is influenced primarily by the contractility of the left atrial myocardium.

This study used two-dimensional speckle tracking technology to record the strain and strain rate indicators of the left atrial wall myocardium to quantitatively analyze the changes in left atrial function during different

early stages of hypertension. The results showed that compared with the healthy control group, mεs, mSRs, mεe, and mSRe were significantly different in the hypertension group, and the change in the left ventricular concentric remodeling group was also statistically significant compared with the left ventricular standard remodeling group; the mεa and mSRa were also different in the left ventricular concentric remodeling group, with statistical significance. Changes in these indicators indicate that the reservoir function and conduit function of the left atrium in patients with hypertension are significantly reduced, and there is a trend of further reduction with the development of hypertension; the blood booster pump function of the left atrium in patients with hypertension has been enhanced. The reason for the analysis of the results of this study is that due to the increase in cardiac afterload in patients with hypertension, the left atrium has to resist the increased afterload while maintaining the ejection volume of the left ventricle, causing its pressure to increase, and due to its pressure gradient with the left ventricular became smaller, the blood intake into the left ventricle becomes lesser, and the residual blood volume in the left atrium increases, hence increasing preload. The increase in long-term pressure and volume load will cause the left atrium and ventricular myocardial interstitium, as well as the collagen fiber synthesis and myocardial stiffness to increase, while deformation ability, compliance, and the reservoir function of the left atrium decrease. While the left ventricular afterload and stiffness increase, the abstract effect on the left atrium decreases in early diastole, resulting in the further decline of the blood entering the left ventricle and the conduit function of the left atrium; the residual blood volume in the left atrium increases in late diastole. According to the Frank-Starling Law, the left atrium increases its contraction to maintain the filling of the left ventricle and ensure that the left ventricle is filled with blood so the booster pump function of the left atrium is enhanced. Dai used two-dimensional speckle tracking imaging and real-time three-dimensional echocardiography to observe early changes in left atrial structure and function in patients with hypertension and found that the left atrial conduit function decreased and the auxiliary pump kinetic energy increased [13]. Chang *et al.* applied two-dimensional speckle tracking technology to evaluate the relationship between atrial septal thickness and left atrial function in patients with essential hypertension and found that the left atrial compliance gradually decreased, the conduit function and reservoir function weakened, while the booster pump function enhanced [14]. Chen *et al.* used magnetic resonance to detect left atrial enlargement in the early hypertension stage quantitatively [15]. They found that the ejection fraction and strain of the left atrial reservoir period and conduit period were significantly reduced compared with the control group, whereas the booster pump function was preserved. The results of this study are consistent with the aforementioned related research results. In summary, two-dimensional speckle tracking technology can accurately and sensitively detect functional changes in the left atrial myocardium of patients with hypertension at an early stage.

Two-dimensional speckle tracking technology has the advantages of non-invasiveness, no angle dependence, little influence from adjacent tissue traction, and high repeatability. Compared with traditional echocardiography to evaluate the left atrial function, two-dimensional speckle tracking technology can provide more accurate quantitative analysis and detect the movement of the local myocardium in real-time [16,17]. However, this study also has some limitations: Firstly, the two-dimensional speckle tracking technology has relatively high requirements for the quality of the two-dimensional image, which directly affects the quality of tracking detection; Secondly, the left atrial wall is relatively thin and has extremes such as the opening of the pulmonary vein and the interatrial septal fossa ovale. It is easy to cause echo loss, which will also affect tracking and detection; Lastly, tracking based on a two-dimensional plane cannot reflect the three-dimensional motion of the left atrium, concerning the accuracy of the results [18]. In addition, the sample size included in this study is relatively small, and further large-scale randomized controlled studies can be conducted in the future to support this study.

There are still many shortcomings in the research on left atrial detection using two-dimensional speckle tracking technology. With the further development of technology and in-depth research, automatic analysis algorithms based on machine learning artificial intelligence and other imaging technologies can be combined to study left atrial function in the future. Multimodal assessment can provide a more accurate basis for early clinical diagnosis, treatment, and evaluation of the prognosis of hypertension.

Disclosure statement

The authors declare no conflicts of interest.

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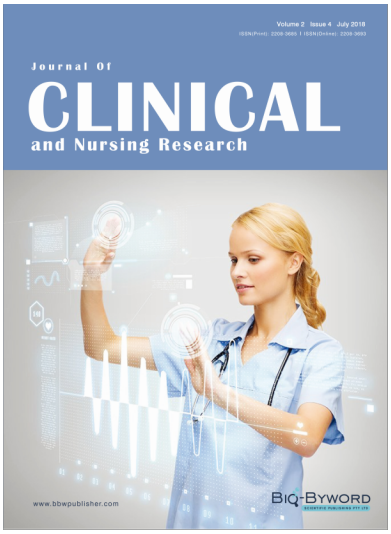

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