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Diagnosis and Treatment Strategies for Diastolic Heart Failure

Shixin Kang

Department of Cardiology, Affiliated Hospital of Hebei University, Baoding, Hebei, 071000, China
1623977868qq.com

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Abstract: Diastolic heart failure is a common type of heart disease, and this type of heart failure is particularly common in the elderly population and often co-exists with conditions such as high blood pressure, coronary artery disease and diabetes. As the population ages, the incidence of diastolic heart failure is on the rise, which poses a major challenge to the public health system. Therefore, this paper focuses on the causes, clinical manifestations, diagnostic methods, and treatment and prevention strategies of diastolic heart failure. Finally, the results of two groups of controlled experiments are as follows: The sensitivity of E/A (peak e to Peak a) ratio to accurately diagnose diastolic heart failure was 95.2%, and the sensitivity of blood BNP (Brain Natriuretic Peptide) level was 88.3%. Meanwhile, the combined treatment strategy is more effective than drug therapy in the treatment of patients with diastolic heart failure. At the public health level, the findings will help raise awareness of heart disease prevention and drive the development of more effective health policies and interventions.

1. Introduction

Compared with traditional methods, image processing and recognition algorithms based on deep learning can automatically extract and learn advanced features in software information systems, thus showing higher accuracy and efficiency in processing large-scale and complex image data. These algorithms use deep neural network structures to recognize and analyze subtle patterns and changes in images, which are often difficult to achieve with traditional algorithms.

This paper first outlines the definition of diastolic heart failure, finds that it mainly affects the elderly, is often associated with chronic diseases such as hypertension and diabetes, and explains the causes of diastolic heart failure. Subsequently, this paper focuses on the analysis of the diagnostic methods of diastolic heart failure, exploring the specific procedures of symptom assessment, physical examination, cardiac ultrasound, electrocardiogram and laboratory examination, and introduces the key diagnostic indicators - E/A ratio, left atrial size, BNP level, NT-proBNP(N terminal), pulmonary vein flow rate, left ventricular wall thickness, and discusses some other calculation indicators. Then this paper discusses the treatment strategy of diastolic heart failure in detail, and discusses its control of cardiac load, improvement of diastolic function, control of concomitant diseases, lifestyle adjustment, monitoring and tracking, and advanced treatment

methods. Finally, two groups of controlled experiments proved that the diagnostic methods and treatment strategies adopted in this paper were effective, and the E/A ratio and BNP level showed high diagnostic accuracy, which could be used as important biomarkers of heart failure.

2. Related Works

The study of diastolic heart failure will not only help improve the diagnosis and treatment of patients with heart failure, it will also enhance medical professionals' understanding of this complex condition. In order to explore the application effect of the artificial intelligence algorithm model in the diagnosis of left ventricular diastolic chronic heart failure, Yu Liheng adopted the artificial intelligence deep learning model and designed a special algorithm to calculate the heart structure and function parameters based on cardiac ultrasound images, and found that artificial intelligence could quickly identify and segment cardiac ultrasound images [1]. In order to study the predictive value of heart failure ultrasound index combined with serum troponin I and brain natriuretic peptide on adverse cardiovascular events in elderly patients with diastolic heart failure, Sun Yuan-yuan tested and compared the two groups of index and serum troponin I and brain natriuretic peptide levels, and analyzed the differences in baseline data and cardiac function indexes between the two groups [2]. In order to explore the effects of aerobic exercise training based on peak oxygen uptake on cardiopulmonary function and blood-brain natriuretic peptide level in elderly patients with diastolic heart failure, Li Li compared the cardiac function of the two groups of patients after 6 months based on aerobic exercise training based on peak oxygen uptake [3]. In order to explore the application effect of dual cardiomyopathy in patients with congestive heart failure, Yang Xiaxia randomly divided the patients with heart failure into two groups, the control group adopted routine nursing, the observation group adopted dual cardiomyopathy, and compared the cardiac function indexes before and after nursing of the two groups. The experimental results found that this method could improve the patients' cardiac function, nursing effect and quality of life [4].

All of these methods can effectively improve treatment outcomes in patients with diastolic heart failure, but there is a lack of controlled experimental testing studies on a number of different indicators. Therefore, this paper mainly discusses the diagnostic methods, treatment strategies and prevention strategies of diastolic heart failure, and gives two sets of experiments on the accuracy evaluation of diagnostic methods and the comprehensive treatment effect evaluation of diastolic heart failure [5-6].

3. Methods

3.1 Introduction to Diastolic Heart Failure

Diastolic Heart Failure is a type of heart disease characterized by impaired function of the heart during the diastolic (congested) period [7-8]. In this case, although the heart can contract normally or nearly normally, it cannot relax and fill blood effectively during diastole, which will lead to a decrease in the output of the heart, which will affect the blood circulation of the whole body and the blood supply to tissues and organs. Its strict scientific definition is: diastolic heart failure is a heart disease manifested by limited diastolic function of the heart, resulting in insufficient filling of the heart, which affects the heart's ability to pump blood [9-10]. The main feature is that the disease is usually not accompanied by a significant decline in cardiac systolic function, but an impairment of cardiac diastolic function.

Clinically, diastolic heart failure is more common in the elderly. With the increase of age, the heart tissue becomes more rigid and the diastolic function declines [11-12]. It is also more common in people with chronic conditions such as high blood pressure, diabetes, obesity and coronary artery

disease, which can accelerate the decline in diastolic function of the heart. There are four main causes of diastolic heart failure, and the specific analysis is shown in Table 1:

Table 1: The cause and explanation of diastolic heart failure

Reason	Explain
Diseases that affect left ventricular relaxation performance	High heart disease, hypertrophic cardiomyopathy, elderly heart disease and diabetes
Diseases that affect left ventricular stiffness	Amyloidosis of myocardium, restrictive cardiomyopathy, and endocardial fibrosis
Diseases that affect left ventricular filling	Amyloidosis of myocardium, restrictive cardiomyopathy, and endocardial fibrosis
Diseases that affect ventricular interactions	Atrial septal defect, pulmonary hypertension, and acute pulmonary embolism, etc

Aging, the effects of disease, and increased stiffness of the heart make it less likely that the heart will expand during diastole, ultimately reducing the heart's ability to fill. This is one of the main pathophysiological mechanisms of diastolic heart failure, along with increased congestive pressure in the heart, which can lead to pulmonary congestion and edema due to insufficient heart filling.

3.2 Diagnostic Methods

The diagnosis of diastolic heart failure is a comprehensive process that includes history assessment, physical examination, laboratory tests, and imaging. At the beginning, the doctor will ask the patient a detailed history, such as breathing difficulties, reduced activity tolerance, and paroxysmal breathing difficulties at night. In addition, a history of high blood pressure, diabetes, coronary heart disease and some related chronic diseases is also asked, which are common risk factors for diastolic heart failure. This is followed by a physical examination, which consists of auscultation of the heart and lungs, and the search for abnormalities in heart murmurs and lung rales, as well as the examination of signs of edema of the lower extremities and of the jugular venotonic circulatory system. The medical instrument used, echocardiography, measures the diastolic function of the heart, while an electrocardiogram can detect structural abnormalities in the heart.

Table 2: Table of key diagnostic indicators of diastolic heart failure

Inspection items	Normal range	Mild abnormality	Moderate abnormality	Severe abnormality	Notes
E/A ratio	1.0-2.0	<1.0	<0.8	<0.5	Echocardiogram
Left atrial size	<40 mm	40-44 mm	44-49 mm	≥50 mm	Echocardiogram
BNP level	<100 pg/mL	100-300	300-600	>600	Blood testing
NT-pro BNP	<300 pg/mL	300-600	600-900	>900	Blood testing
Pulmonary vein velocity	Normal waveform	Minor abnormalities	Obvious abnormality	Fatal exception	Echocardiogram
Left ventricular wall thickness	6-11 mm	11-13 mm	13-15 mm	>15 mm	Echocardiogram

Intermediate laboratory tests, usually blood and urine analysis. Biochemical markers of cardiac injury and dysfunction - troponin, brain natriuretic peptide (BNP), or N-terminal probrain natriuretic peptide precursor (NT-proBNP) levels were measured. The final stage is imaging, which is the key to the diagnosis of diastolic heart failure, and in most cases includes echocardiography,

cardiac magnetic resonance, and so on. Echocardiography can assess cardiac structure and function, especially left ventricular diastolic function. According to the above diagnostic methods, some key diagnostic indicators of diastolic heart failure are shown in Table 2:

Table 2 provides some basic reference values of diastolic heart failure and the classification of the degree of abnormality, but the actual diagnosis needs to be comprehensively evaluated according to the specific situation of the patient. In order to further strengthen medical quality management, standardize clinical diagnosis and treatment behaviors, and promote the standardization and homogenization of medical services, the first three indicators of psychological failure formulated by the health administration in 2021 are the detection rate of natriuretic peptide within 24 hours of admission of heart failure patients (CVD-HF-01)(Cardiovascular Disease-Heart) Failure), assessment rate of cardiac function within 48 hours of admission in patients with heart failure (CVD-HF-02), and diuretic treatment rate during hospitalization in patients with heart failure with volume overload (CVD-HF-03). Its calculation formula is as follows:

$$\text{CVD-HF-01} = \frac{TTND}{\text{TNP}} \times 100\% \tag{1}$$

TNP represented the total number of patients with heart failure during the same period, and TTND represented the total number of patients with heart failure during the same period who were tested for natriuretic peptide within 24 hours of admission.

$$\text{CVD-HF-02} = \frac{ETND}{\text{TNP}} \times 100\% \tag{2}$$

Among them, the ETND represents the total number of heart failure patients who had an echocardiogram within 48 hours of admission.

$$\text{CVD-HF-03} = \frac{DTND}{\text{Overload TNP}} \times 100\% \tag{3}$$

Among them, DTND represents the total number of patients with heart failure and volume overload who received diuretics during hospitalization. Therefore, a diagnosis can be made when a patient meets the following five conditions: (1) elevated NT-ProBNP; (2) there are typical symptoms and signs of heart failure; (3) LVEF was normal and left ventricular morphology was normal; (4) there is evidence of underlying heart disease; (5) echocardiography showed no valvular disease.

3.3 Treatment Strategies

After discussing the diagnosis of diastolic heart failure, the treatment strategy was analyzed. The program focuses on managing symptoms, improving quality of life, slowing disease progression and reducing the risk of death. The description of treatment strategies is shown in Figure 1:

Controlling cardiac load is the key to the treatment of diastolic heart failure. High blood pressure is an important risk factor for diastolic heart failure and can be effectively reduced with medications such as ACE(Angiotensin Converting Enzyme) inhibitors, ARBs(Air Refuelling Boom System) or calcium channel blockers, lighten the load on the heart. The target blood pressure of patients with diastolic heart failure should be lower than that of simple hypertension: systolic blood pressure <130mmHg and diastolic blood pressure <80mmHg. For patients with fluid retention symptoms, reducing blood volume is also a good treatment, and the use of diuretics can help reduce blood volume and reduce the load on the heart.

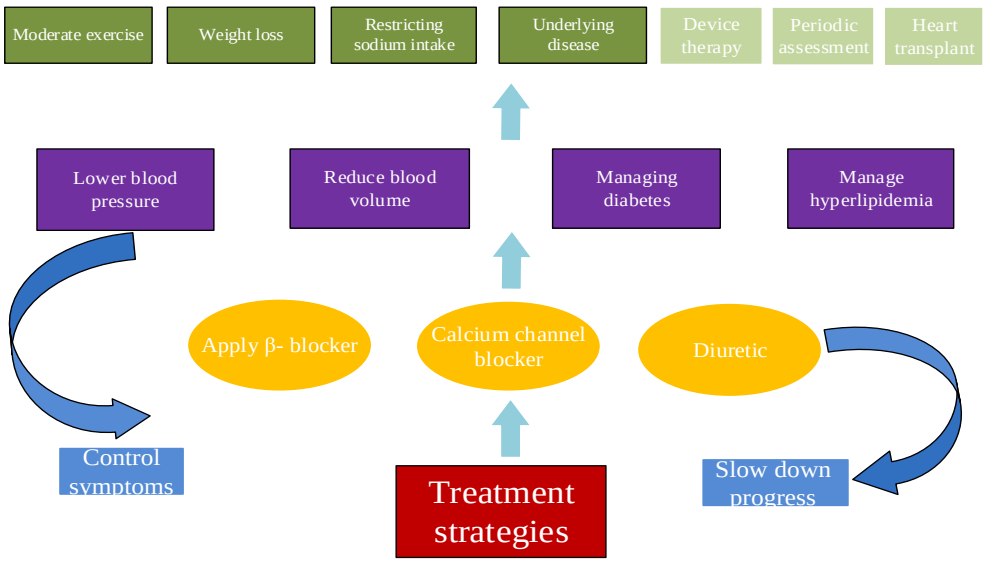

Figure 1: Therapeutic strategies for diastolic heart failure

Improving diastolic function and controlling concomitant diseases are important steps in the treatment of diastolic heart failure. The use of beta-blockers can reduce the heart rate and lengthen the diastolic period of the heart, helping to improve the filling and diastolic function of the heart, while the use of calcium channel blockers such as verapamil can also be used to improve the diastolic function of the heart. It also effectively manages diabetes and hyperlipidemia, which burden the heart, and treats diastolic heart failure by controlling these diseases with medications and lifestyle changes.

Lifestyle modification, regular heart function assessment, device therapy and heart transplantation are effective strategies in many cases. For patients who are overweight or obese, weight loss can reduce the burden on the heart; moderate aerobic exercise, such as walking and swimming, can improve heart function and overall health; reducing sodium intake can help control blood pressure and reduce fluid retention. Regular physical examinations, including echocardiograms and tests of cardiac biomarkers, are performed to monitor the progression of the disease and the effect of treatment. In some severe or difficult-to-treat conditions, cardiac resynchronization therapy or implantable heart AIDS may need to be considered.

3.4 Prevention Strategies

Currently, evidence-based medical evidence has failed to show which treatments improve long-term outcomes or reduce mortality in diastolic heart failure, so prevention strategies for diastolic heart failure have largely focused on controlling cardiovascular risk factors and regular physical examinations.

One of the priorities in preventing diastolic heart failure is to effectively control the major risk factors for cardiovascular disease. Maintaining healthy blood pressure levels, controlling cholesterol and blood sugar levels, quitting smoking, limiting alcohol consumption, maintaining an appropriate weight and healthy eating habits, and getting regular physical activity can all help strengthen heart function and reduce the risk of cardiovascular disease people with existing high blood pressure, diabetes or other chronic conditions should strictly follow their doctor's instructions to take regular medication and control these conditions.

Regular physical examination is also a more effective prevention strategy. Physical examination

can detect early signs of heart disease and other related diseases, especially the assessment of heart function is crucial. For people at risk of cardiovascular disease, regular heart checkups - auscultation, blood pressure measurements, and electrocardiograms - are recommended. Echocardiography is also a useful medical tool that can help assess heart structure and left ventricular diastolic function. With these preventive measures, the risk of developing diastolic heart failure can be significantly reduced and can help improve the overall health of patients.

4. Results and Discussion

4.1 Experimental Design

The diagnosis and treatment of diastolic heart failure is an important topic. Based on this, two controlled trials were designed for diagnostic methods and treatment strategies to evaluate the accuracy of diagnostic methods and the combined treatment effect of diastolic heart failure.

4.2 Experiment 1: Accuracy Evaluation of Diagnostic Methods

The objective of the experiment was to evaluate the accuracy and reliability of the said diagnostic method in distinguishing patients with diastolic heart failure from healthy people. In order to reduce the experimental error, we selected six experimental controls (named the six groups A to F), each of which included 100 participants (50 patients with confirmed diastolic heart failure and 50 healthy volunteers with no history of heart disease). The procedure was as follows: First, A detailed medical history and physical examination of all participants were performed, followed by blood and urine tests for each participant, including determination of BNP and NT-proBNP levels, followed by echocardiography to assess E/A ratios and blood BNP levels. Finally, according to the examination results, the participants were classified as patients with or without diastolic heart failure, and the sensitivity of different diagnostic indicators in the correct diagnosis of diastolic heart failure was calculated. The experimental results are shown in Figure 2:

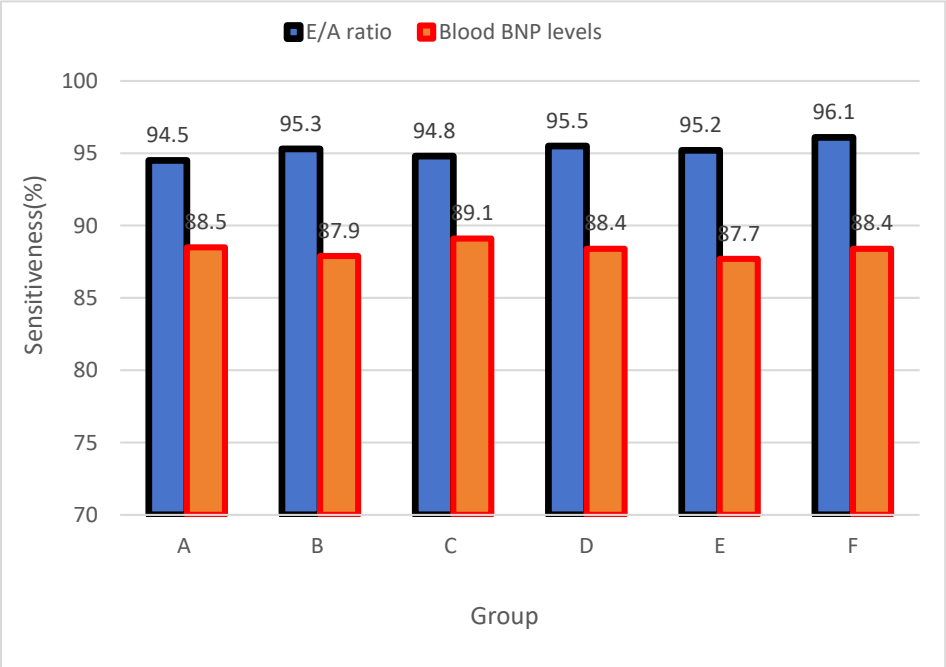

Figure 2: Experimental results to evaluate the accuracy of diagnostic methods

The blue column indicates sensitivity to accurately diagnose diastolic heart failure based on

echocardiographic E/A ratio indicators, and the orange column indicates sensitivity based on blood BNP levels. It can be seen that the sensitivity of E/A ratio index diagnosis was 94.5%, 95.3%, 94.8%, 95.5%, 95.2% and 96.1%, respectively, with a comprehensive average of about 95.2%, while the comprehensive average sensitivity of blood BNP level index diagnosis was about 88.3%. This indicates that the E/A ratio of echocardiography is a highly sensitive and specific diagnostic indicator, which is very effective in distinguishing patients with diastolic heart failure from healthy people, while the blood BNP level also shows high diagnostic accuracy, and can be used as an important biomarker of heart failure.

4.3 Experiment 2: Evaluation of the Comprehensive Treatment Effect of Diastolic Heart Failure

After discussing the evaluation results of the accuracy of the above diagnostic methods, the comprehensive treatment effect evaluation experiment was continued. The objective of the study was to evaluate the efficacy of a combination of treatment strategies (medication and lifestyle changes) in patients with diastolic heart failure. The procedure was as follows: Patients were randomly divided into two groups, with one receiving medication and the other receiving both medication and lifestyle guidance. Cardiac function (echocardiography) and quality of life (questionnaire) were regularly assessed, and patient symptom changes and treatment compliance were continuously tracked. Finally, the improvement of heart function and the change of quality of life of patients in the two groups were compared, and the experimental results were shown in Figure 3:

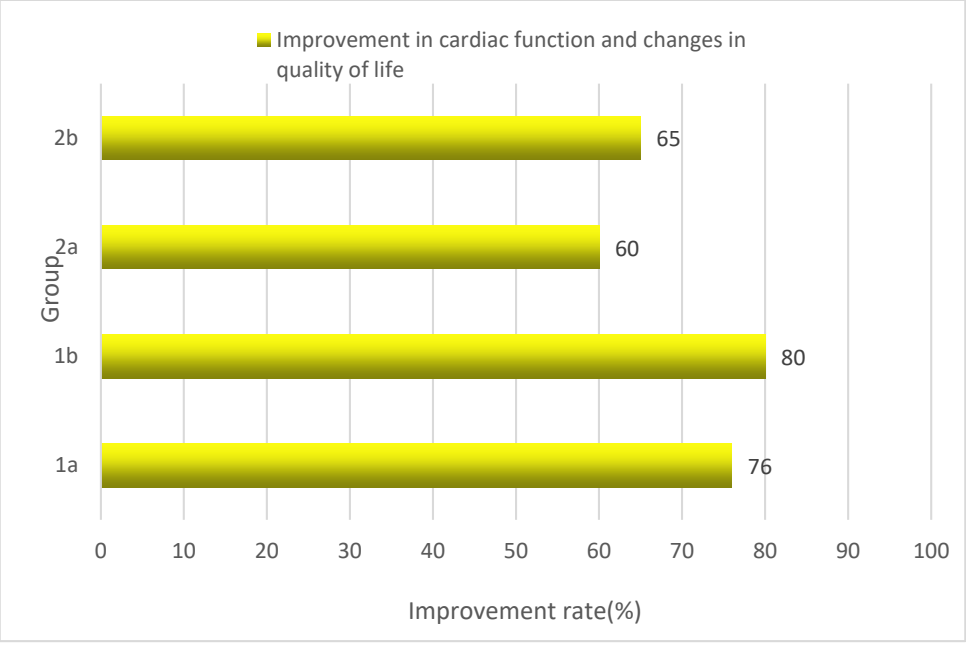

Figure 3: Experimental results of comprehensive treatment effect evaluation

Among the 50 patients with diastolic heart failure, 1a indicated that the group receiving medication and lifestyle guidance (25 patients) had a 76% improvement in heart function after 6 months, and 1b indicated an 80% improvement in quality of life in this group. 2a represented a 60% improvement in heart function in the drug-only group (25 patients), and 2b represented a 65% improvement in quality of life in that group. The comprehensive treatment strategy is more effective in the treatment of patients with diastolic heart failure, and improves the quality of life of patients while improving the heart function. This suggests that lifestyle changes play an important role in the

treatment strategy for diastolic heart failure, and in combination with medication can provide better treatment outcomes.

5. Conclusions

The study of diastolic heart failure contributes to increased awareness and understanding of this condition, especially in clinical diagnosis and treatment. Currently, the diagnosis of diastolic heart failure is often complicated because its symptoms are similar to other types of heart failure but require different treatments. Therefore, it is of great significance to study the diagnosis and treatment strategies of diastolic heart failure to improve the quality of life of patients and reduce the waste of medical resources. In this paper, the definition and epidemiology of diastolic heart failure are introduced, and the methods of diagnosis and treatment are discussed, and the prevention strategies are discussed. Due to the limited space, there is no specific exploration of drug therapy in the treatment strategy. There are still many defects and deficiencies in the subject of diastolic heart failure in this paper, and it will be further perfected and improved in the future research. Future research is focused on developing more effective diagnostic tools, exploring new drug therapies and lifestyle improvement interventions, understanding the interrelationship between diastolic heart failure and other chronic diseases, and how to improve the overall health of patients by managing these conditions comprehensively. With advances in areas such as genomics, proteomics, and metabolomics, precision medicine is likely to play an increasingly important role in the treatment of diastolic heart failure.

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