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Clinical and 2d Echocardiography Profile in Heart Failure with Preserved Ejection Fraction

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ABSTRACT

Heart Failure with Preserved Ejection Fraction (HFpEF) is a common subtype of heart failure marked by typical symptoms of heart failure despite a normal left ventricular ejection fraction. This study was conducted to evaluate the clinical profile and 2D echocardiographic findings in patients diagnosed with HFpEF at a tertiary care hospital over a period of 18 months. It was designed as a cross-sectional descriptive study in the Department of General Medicine at Adichunchanagiri Hospital and Research Centre. The study included 100 patients who presented with clinical features of heart failure and had a left ventricular ejection fraction (LVEF) greater than 50%. Data were gathered on the demographic characteristics, clinical history, laboratory investigations, and echocardiographic parameters. Statistical analysis was performed using SPSS software, and chi-square tests were used to analyze the categorical variables. The findings revealed that the majority of patients were in the 30 to 49-year age group, with a male predominance of 57%. The most common presenting symptoms included dyspnea in 97% of patients, paroxysmal nocturnal dyspnea in 55%, and lower limb swelling in 40%. On echocardiographic evaluation, 54% of patients showed Grade II diastolic dysfunction, while 42% had abnormalities in the left atrial volume index (LAVI). Additionally, elevated NT-Pro BNP levels were observed, further supporting the diagnosis of HFpEF. The study highlights that HFpEF is frequently associated with both significant clinical symptoms and echocardiographic abnormalities, underlining the importance of timely diagnosis and appropriate management strategies. The findings suggest that the incorporating advanced imaging modalities and focusing on early risk factor modification can contribute to improved outcomes in patients with HFpEF.

Keywords: *HFpEF, Heart Failure, Echocardiography, Diastolic Dysfunction, NT-Pro BNP*

INTRODUCTION:

Heart failure (HF) is a significant cardiovascular disorder where the heart's ability to pump blood is insufficient to meet the body's needs. It presents a growing global health concern due to increasing life expectancy and improved survival after cardiac events. HF can result from a range of structural or functional heart problems affecting contraction, relaxation, conduction, or electrical activity. Common underlying conditions include coronary artery disease, high blood pressure, valvular disease, and cardiomyopathy. The fundamental issue in HF is reduced cardiac output, which prompts compensatory mechanisms like activation of the sympathetic nervous system and the renin-angiotensin-aldosterone system. Though initially beneficial, these mechanisms eventually increase cardiac stress, resulting in myocardial hypertrophy and fibrosis that progressively deteriorate heart function [1,2].

Patients with heart failure often experience fatigue, breathlessness, and fluid retention. These symptoms manifest through pulmonary congestion, making breathing difficult when lying down or during sleep, and peripheral edema due to systemic fluid overload. As the disease advances, it can affect multiple organs and lead to complications such as liver dysfunction and cachexia. Symptoms may start during physical activity but eventually occur at rest, significantly affecting quality of life. Heart failure is commonly classified by ejection fraction (EF): reduced EF (HFrEF) indicates impaired pumping with an EF below 40%, while preserved EF (HFpEF) involves EF of 50% or more and is marked by impaired ventricular relaxation. An intermediate group, HF with mid-range EF (HFmrEF), encompasses EF between 40-49% [3,4].

HF can also be classified based on its presentation. Acute heart failure occurs suddenly, often triggered by myocardial infarction or severe illness, and requires emergency care. Chronic heart failure develops

gradually and is characterized by periods of stability interspersed with acute episodes, often caused by infections, poor diet, or missed medications. The New York Heart Association (NYHA) classification is used to assess how HF affects daily physical activity, ranging from Class I (no limitation) to Class IV (symptoms at rest), and serves as a guide for treatment planning and monitoring disease progression [5-7].

Treatment strategies for heart failure depend on the type and severity. In HFrEF, medications like ACE inhibitors, ARBs, beta-blockers, and MRAs aim to relieve symptoms, reduce hospitalizations, and improve survival. Newer agents, such as SGLT2 inhibitors, have shown benefits even in patients without diabetes. For HFpEF, the focus is on managing comorbidities like hypertension and atrial fibrillation, as fewer specific treatments are available. Non-pharmacological interventions include lifestyle modifications such as low-sodium diets, fluid restriction, regular physical activity, and weight management. Patients are advised to monitor their weight to detect fluid retention early [8,9].

Advanced interventions may be necessary in severe cases. Devices like implantable cardioverter-defibrillators (ICDs) prevent sudden cardiac death, and cardiac resynchronization therapy (CRT) improves function in patients with conduction abnormalities. Mechanical circulatory support, such as left ventricular assist devices (LVADs), or even heart transplantation may be needed in end-stage HF. Despite therapeutic advances, heart failure remains a leading cause of death, with five-year survival rates hovering around 50%. Early diagnosis, routine biomarker monitoring, and integrated management are crucial in improving outcomes [10,11].

HFpEF is a distinct form of heart failure where symptoms arise despite normal ejection fraction. This form is associated with impaired ventricular filling due to stiffened heart muscles and elevated filling pressures. It is increasingly common, particularly in elderly patients and women, often coexisting with conditions like hypertension, obesity, and diabetes. Patients frequently present with multiple comorbidities, which complicate diagnosis and management. Although survival rates are slightly better than in HFrEF, overall prognosis is still poor, with mortality ranging between 30% and 50% within five years [12,13].

Studying the clinical and echocardiographic features of HFpEF is vital for accurate diagnosis and effective treatment. Echocardiography plays a key role in identifying specific structural and functional abnormalities. Advanced techniques such as 2D speckle tracking can detect myocardial strain, while parameters like the E/e′ ratio and left atrial strain provide insights into diastolic function and filling pressures. Echocardiographic markers like left ventricular hypertrophy, left atrial enlargement, pulmonary hypertension, and right ventricular dysfunction help stratify risk and predict prognosis [14].

Combining echocardiographic evaluation with other imaging modalities such as cardiac magnetic resonance enhances diagnostic precision. When integrated with clinical biomarkers, these tools support personalized treatment strategies. Echocardiography also aids in understanding HFpEF pathophysiology by revealing myocardial fibrosis, atrial dysfunction, and disrupted ventricular-arterial interaction. Markers like global longitudinal strain have potential in precision medicine, enabling tailored management. Overall, thorough clinical and echocardiographic profiling bridges the gap between complex disease mechanisms and practical care, offering promising directions for improved outcomes in HFpEF patients [15].

The aim of this study is to evaluate the clinical and 2D echocardiographic profile in patients with Heart Failure with Preserved Ejection Fraction (HFpEF). The objectives include describing the clinical features observed in patients diagnosed with HFpEF and assessing the echocardiographic characteristics associated with this condition.

MATERIAL AND METHODS

This study is a cross-sectional descriptive study conducted at the Department of General Medicine, Adichunchanagiri Hospital and Research Centre, B.G. Nagara, Nagamangala Taluk, Mandya District for 18 months. Ethical approval has been obtained from the Ethical Approval Committee of Adichunchanagiri Hospital and Research Centre, B.G. Nagara, Nagamangala Taluk, Mandya District.

Study Population

The study population comprised patients aged 18 years and above of either gender who presented with signs and symptoms of heart failure and had a left ventricular ejection fraction (LVEF) greater than 50%. Participants were included after providing written informed consent. Exclusion criteria included individuals with a history of cardiac surgery, chest wall trauma, established renal failure, pregnancy, or a diagnosis of Cor Pulmonale, ensuring a focused evaluation of HFpEF patients.

Data Analysis

Data were analyzed using SPSS software, with quantitative variables such as age, BMI, blood pressure, and laboratory parameters expressed as mean ± standard deviation, and qualitative variables like symptoms and echocardiographic findings presented as frequencies and percentages. Associations between categorical variables were assessed using the Chi-square test, while the Student's t-test was applied for comparing group means. A p-value of less than 0.05 was considered statistically significant in all analyses.

RESULTS

Among the 100 study participants, the most common age groups were 30–39 and 40–49 years, comprising 27% and 22% respectively, followed by 50–59 and 18–29 years at 19% each, and 60+ at 13%. Males constituted 57% of the sample, while females made up 43%. Clinically, dyspnea was the most prevalent symptom (97%), followed by paroxysmal nocturnal dyspnea (55%), easy fatiguability (51%), lower limb swelling and abdominal distension (40% each), angina (25%), and orthopnea (12%).

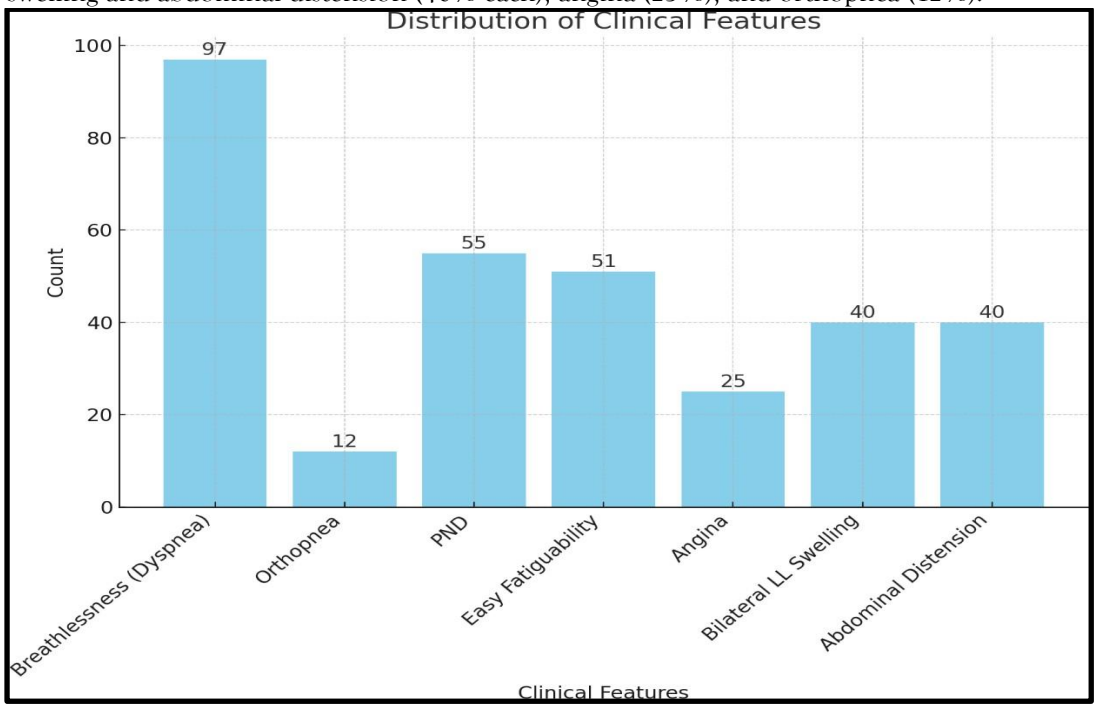

Figure 1: Clinical Features of Patients

The study reveals that breathlessness (97%) and paroxysmal nocturnal dyspnea (55%) are the most common clinical features among patients. The majority of participants have a normal or slightly elevated BMI, with 43% falling in the "Normal" category and 35% in the "Overweight" category.

The BMI distribution among the study subjects shows that 43% fall within the normal range (18.5-24.9), 35% are overweight (25-29.9), 12% are underweight (<18.5), and 10% are obese (≥30). Regarding CAG status, 70% of cases had no CAG performed, 20% had non-critical CAD, and 10% had single vessel disease. ECG findings revealed 85% with sinus rhythm, 15% with atrial fibrillation, and 30% with non-specific ST-T changes, while 10% had features of left ventricular hypertrophy. Hypertension, diabetes, and smoking were present in 30%, 25%, and 35% of patients, respectively. Laboratory tests showed varied results, with Trop I levels averaging 2.13, NT-Pro BNP levels averaging 9783.39, hemoglobin levels averaging 12.2, and urea levels averaging 22.42. Serum creatinine averaged 1.02, triglyceride levels had a mean of 129, and lipid profiles showed average HDL levels of 45, LDL levels of 88, and total cholesterol levels averaging 158.

Table 1: Descriptive Statistics of Laboratory Parameters of Study Subjects

Laboratory Parameters	Mean	Median (25th-75th Percentile)	Range
Trop I	2.19	0.1 (0.1 – 14.3)	0.1 - 21.25

NT-Pro BNP (pg/mL)	9783.39	9613.30 (4861.94 – 13639.75)	2848.46-15920.88
Hemoglobin (gm%)	12.2	12 (11-13)	10-15
Urea (mg/dL)	22.42	24 (14.75-28)	9-33
Serum Creatinine (mg/dL)	1.02	1.02 (0.82 -1.20)	0.72-1.34
Triglyceride (mg/dL)	129	121 (110-148)	90-180
HDL (mg/dL)	45	45 (37-54)	14-80
LDL (mg/dL)	88	91 (72-101)	47-135

The laboratory data shows elevated NT-Pro BNP levels (mean: 9783.39 pg/mL), suggesting possible heart failure or cardiac stress. Troponin I levels vary, indicating potential myocardial injury, while lipid profiles reveal moderately high triglycerides and LDL, with HDL at the lower normal limit, pointing to cardiovascular risk. Renal function appears preserved with normal serum creatinine and blood urea levels. The chest X-ray findings in the study revealed that 75% of the subjects had normal results, while 25% showed features of heart failure and 10% had cardiomegaly. Among the 100 study subjects, 95% had no regional wall motion abnormalities, 90% did not present with concentric left ventricular hypertrophy (LVH), and diastolic dysfunction was most common in Grade II (54%) and Grade I (42%). Pulmonary artery systolic pressure (PASP) was below 35 mmHg in 84% of patients, and average left ventricular global longitudinal strain (LV GLS) was reduced in 90% of the cases. The mean left ventricular ejection fraction (LVEF) was 59%, indicating preserved ejection fraction despite some subclinical left ventricular dysfunction.

Table 2: Distribution of BSA

ECHO Findings	Mean	Median (25th-75th Percentile)	Range
Body Surface Area (m^2)	2.09	2.09 (**1.8 - 2.31**)	1.57-2.36

The mean body surface area (BSA) of the study population is 2.09 m^2, with a median of 2.09 m^2 and an interquartile range between 1.8 and 2.31 m^2.

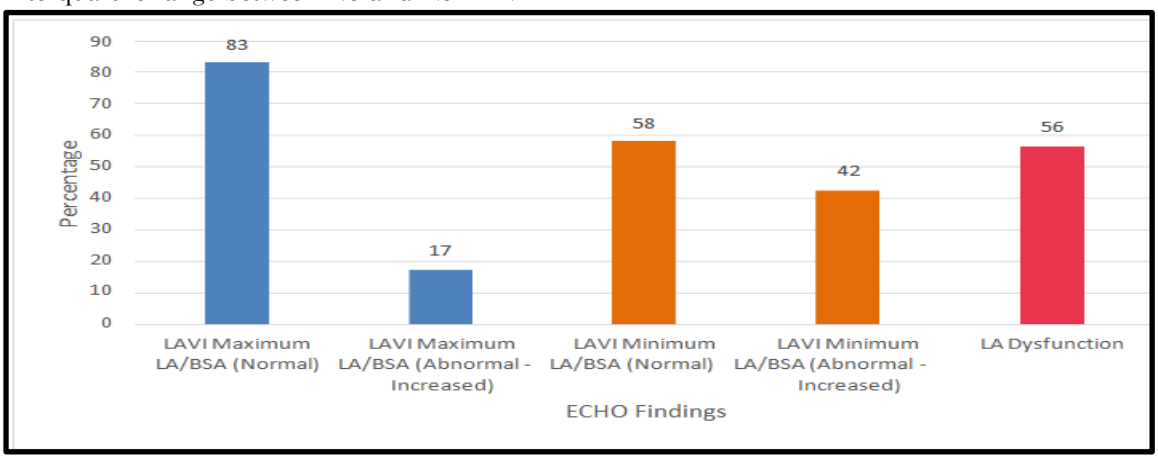

Figure 2: Distribution of Normal vs Abnormal Findings for LAVI, LAEF, and LAEFI

The majority of patients (83%) had normal LAVI Maximum values, indicating preserved left atrial size. However, 42% had increased LAVI Minimum, pointing to potential diastolic dysfunction, and 56% exhibited LA dysfunction, suggesting early-stage left atrial structural and functional abnormalities.

Table 3: Descriptive Statistics for LAVI

ECHO Findings	Mean	Median (25th-75th Percentile)	Range
LAVI Maximum LA/BSA (mL/m²)	35	35 (30-39)	22-51
LAVI Minimum LA/BSA (mL/m²)	20	17 (14-25)	9-35

The mean LAVI Maximum LA/BSA is 35 mL/m², with a median of 35 mL/m² and a range from 22 to 51 mL/m². The mean LAVI Minimum LA/BSA is 20 mL/m², with a median of 17 mL/m² and a range from 9 to 35 mL/m².

DISCUSSION

Heart failure (HF) is a serious public health issue, significantly impacting survival rates. Historically, it was described as a clinical syndrome with cardiac dilation and impaired contractility. However, recent studies have revealed that a significant portion of HF patients present with normal left ventricular function, having an ejection fraction (EF) greater than 50%. This condition is often termed heart failure with preserved ejection fraction (HFpEF) or occasionally heart failure with normal ejection fraction (HFnEF), primarily associated with diastolic dysfunction, though the exact mechanisms are still not fully understood. Extensive research on HFpEF has identified a distinct patient population that is typically older, female, and has a history of hypertension [16,17].

The clinical distinction between heart failure with reduced ejection fraction (HFrEF) and HFpEF remains significant. Studies have varied in the EF threshold used to separate these two conditions, with the range typically between 40% and 50%. However, evidence suggests that patients with an EF between 40% and 50% often resemble those with a reduced EF, supporting a 50% cutoff for distinguishing between HFpEF and HFrEF. This classification system helps in standardizing diagnosis and treatment, improving the accuracy of patient categorization [18].

Albert J, et. al; 2021 focuses on the clinical and 2D echocardiographic profiles of patients with HFpEF admitted to a hospital over an 18-month period. The aim is to evaluate the prevalence of normal versus reduced EF and understand the presentation of HFpEF in the specific patient population. Through clinical and echocardiographic data, the study aims to provide insights into the diagnosis and management of HFpEF, a condition that is often underdiagnosed.

The demographic data of the study shows that the largest age groups were 30–39 and 40–49 years, accounting for 27% and 22% of the participants, respectively. The 50–59 age group represented 19%, while the 18–29 and 60+ age groups made up 19% and 13%, respectively. Males comprised 57% of the study population, and females accounted for 43%. Breathlessness (dyspnea) was the most common symptom, affecting 97% of the patients, followed by paroxysmal nocturnal dyspnea (PND) in 55%, easy fatigue in 51%, and bilateral lower limb edema in 40%. Less common symptoms included orthopnea in 12% and angina in 25%. These findings align with similar studies, although there were some differences in the prevalence of symptoms such as fatigue, edema, and PND [19].

In terms of body mass index (BMI), 43% of participants were in the normal weight range, 35% were overweight, 12% were underweight, and 10% were obese. Obesity has been strongly linked with HFpEF in previous studies, which often report a higher prevalence of left ventricular hypertrophy and sinus tachycardia in these patients. This highlights the need for early intervention and monitoring in overweight and obese individuals [20].

Regarding coronary artery disease (CAD), the majority of patients in this study did not undergo assessment for CAD. Of those who were assessed, 20% had non-critical CAD and 10% had single-vessel disease. Electrocardiogram (ECG) findings showed that 15% had atrial fibrillation, while the rest were in sinus rhythm. Other findings included non-specific ST-T changes in 30% and signs suggestive of left ventricular hypertrophy (LVH) in 10%. Hypertension was present in 30% of the patients, while 25% had diabetes mellitus, and 35% had a history of smoking. These cardiovascular risk factors are consistent with the HFpEF cohort in other studies [21].

Laboratory findings revealed elevated biomarkers, such as a mean Troponin I level of 2.19 ng/mL and NT-Pro BNP at 9783.39 pg/mL, with a range from 2848.46 to 15920.88 pg/mL. The variability in NT-Pro BNP levels suggests differing levels of cardiac dysfunction. Other lipid parameters, including triglycerides and LDL, were within the expected ranges, and renal function appeared normal, with minimal changes in blood urea nitrogen and serum creatinine levels. These laboratory findings are comparable to those in other HFpEF studies, although NT-Pro BNP levels are typically higher in HFpEF patients, reflecting more severe cardiac dysfunction [22].

Chest X-ray findings revealed that 75% of patients had normal results, while 25% showed features indicative of heart failure, including cardiomegaly in 10% of cases. These radiographic findings suggest that chest X-rays alone may not be sufficient to diagnose early or less severe HFpEF. Similar studies show a higher prevalence of abnormal chest X-ray findings in HFpEF patients, including cardiomegaly and pulmonary congestion [23].

Echocardiographic results in this study showed that 95% of patients had no regional wall motion abnormalities, and 10% had concentric left ventricular hypertrophy (LVH). Diastolic dysfunction was most commonly graded as II (54%), followed by grade I (42%) and grade III (4%). The majority of patients had a pulmonary artery systolic pressure (PASP) below 35 mmHg, and 90% had an average left ventricular global longitudinal strain (GLS) greater than -16%. These echocardiographic findings align with other HFpEF studies, which also report a higher prevalence of LVH, regional wall motion abnormalities, and worse GLS in more advanced stages of HFpEF [24].

Additionally, left atrial volume index (LAVI) data showed that 17% of participants had an abnormal increase in LAVI, with 56% displaying some form of left atrial dysfunction. These findings are consistent with previous studies, which highlight left atrial enlargement and dysfunction as common features of HFpEF, correlating with the severity of diastolic dysfunction and elevated filling pressures [25].

CONCLUSION

This study offers valuable insights into the clinical and echocardiographic features of HFPEF patients, emphasizing diastolic dysfunction, left atrial abnormalities, and subclinical myocardial dysfunction as key characteristics. It also identifies hypertension, diabetes, and obesity as common risk factors, underscoring the importance of early detection and management to improve patient outcomes. These findings highlight the need for a comprehensive approach to diagnosis and treatment, particularly in addressing the underlying risk factors that contribute to the progression of HFPEF.

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