Research Article

Diastolic dysfunction in apparently healthy individuals: A single center experience based on echocardiography

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ABSTRACT

Background: As the process of myocardial remodeling starts before the onset of symptoms, detection of subclinical left ventricular diastolic dysfunction is of paramount importance. This will help in the early implementation of interventions to reverse the functional and structural abnormalities. **Objectives:** This study was conducted to assess the diastolic function of apparently healthy individuals who presented with exertional chest discomfort and shortness of breath (New York Heart Association Class I) with effort tolerance more than 9 metabolic equivalents on treadmill. **Materials and Methods:** A total of 141 patients, fulfilling the inclusion criteria, were analyzed to look for diastolic dysfunction using two-dimensional and Doppler echocardiography. Peak velocities of early (E) and late (A) diastolic filling, deceleration time and Doppler tissue imaging for early (E'), and late (A') diastolic peak velocities were measured. Subsequently, mitral E/E' ratio was calculated. **Results:** Mean age of patients examined was 46.46 ± 4.27 years and 86.5% of the patients were male. Overall, the prevalence of diastolic dysfunction in the patients analyzed was 14.9%. Diastolic dysfunction in patients more than 50 years of age was 21.6%, whereas it was 12.5% in patients <50 years. The prevalence in male and female patients was 14.3% and 15.8%, respectively. Hypertension was significantly higher in patients with diastolic dysfunction in comparison to patients without diastolic dysfunction, 71.4% versus 48.3% respectively ($P < 0.05$). The prevalence of diabetes in patients with and without diastolic dysfunction was 47.6% and 35.5%, respectively (P = NS). **Conclusion:** Diastolic abnormalities are not uncommon in apparently healthy individuals. Its prevalence increases with age and hypertension is a common association.

KEY WORDS: Diastolic Dysfunction; Healthy Individuals; Echocardiography

INTRODUCTION

Diastolic heart failure (HF) is a progressive disorder characterized by impaired left ventricular (LV) relaxation, increased LV stiffness, increased interstitial deposition of collagen and modified extracellular matrix proteins. Diastolic HF currently accounts for 40-50% of all HF cases and has a prognosis, which is as ominous as that of systolic HF.[1] The growing interest for diastolic dysfunction and for diastolic HF has been developed gradually in the last 10-15 years. It rises mainly from the advancement of non-invasive imaging tools, especially Doppler echocardiography. As abnormalities of diastolic function may not always produce signs and symptoms of HF,[2] the prevalence in the community is largely uncertain.[3] Moreover, little information is available on characteristics that predispose individuals to abnormal diastolic function. In relation to the increase of the average life, information regarding diagnosis,

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prognosis, and management of subclinical left ventricular diastolic dysfunction is of paramount importance. This will help in the early implementation of interventions to reverse the functional and structural abnormalities.

MATERIALS AND METHODS

This prospective study was conducted in the Department of Cardiology, North Eastern Indira Gandhi Regional Institute of Health and Medical Sciences, Shillong, India, from October 2013 to September 2014.

Study Population

A total of 141 patients were analyzed to look for diastolic dysfunction by two-dimensional and Doppler echocardiography.

Patients of age more than 40 years, with symptoms of exertional dyspnea (New York Heart Association Class I) or exertional chest pain (Canadian Cardiovascular Society [CCS] Class I and with effort tolerance more than 9 metabolic equivalents in treadmill test was included in this study.

Patients with typical angina pectoris (CCS ≥II), severe valvular heart disease, previous or current atrial fibrillation/flutter or any rhythm disturbance, and patients with history of previous cardiac surgery, percutaneous coronary intervention or permanent pacemaker implantation were excluded from this study.

Study Design

Written informed consent was taken from each patient before enrollment. Detailed medical history, particularly for cardiovascular risk factors, cardiovascular diseases and medications, was taken.

Two-dimensional echocardiography was done using JE vivid E9 machine. Two-dimensional echocardiograms from standard left parasternal and apical windows, derived M-mode echocardiograms, and Doppler, together with a simultaneous electrocardiogram signal was recorded. The LV internal diameter and interventricular septal and posterior wall thickness were measured at end-diastole from the two-dimensionally guided M-mode tracing as described in the guidelines of the American Society of Echocardiography. LV end-systolic (LVESV) and end-diastolic (LVEDV) volumes were calculated with the use of Teicholtz's method. The ejection fraction was calculated as EF = (LVEDV-LVESV)/LVEDV. Doppler echocardiographic recordings were performed by pulsed wave Doppler with the sample volume at the tips of the mitral valve in the apical four chamber view. Early (E) and late (A) diastolic velocities, velocity time integrals and ratios of early and late velocities, velocity time integrals (E/A) as well as isovolumetric relaxation time was determined.

Diastolic dysfunction was defined as E/E' ratio more than 15 as derived from tissue Doppler.

Hypertension was considered at a blood pressure of ≥140/90 mmHg, current intake of antihypertensive medication, or both. Diabetes mellitus was defined as a history of diabetes or on oral hypoglycemic drugs or insulin. LV hypertrophy was LV mass index of exceeding 125 g/m^2 in men and 110 g/m^2 in women. Obesity was body mass index of 30 kg/m^2 or higher. This study has been approved by Institutional Review Committee and Institute Medical Ethical Committee.

Statistical Methods

Participants with or without evidence of diastolic abnormalities or diastolic dysfunction were characterized. Normally, distributed data were presented as mean ± standard deviation. The prevalence of diastolic dysfunction and significance (*P* value) of comparison among different groups were calculated by Z-test using SPSS software. $P < 0.05$ was considered to indicate statistical significance.

RESULTS

The baseline characteristics of the study population are as described in Table 1. Mean age of patients were 46.46 ± 4.27 years with 86.5% male. Among the patients, 37 (26.2%) were >50 years of age.

Table 1: Baseline characteristics of all patients participated in the study with and without diastolic abnormalities

Parameters	Patient characteristics (*n*=141)
Age (mean), years±SD	46.46±4.27
Age>50 years, number (%)	37 (26.2)
Age≤50 years, number (%)	104 (73.8)
Male, number (%)	122 (86.5)
Hypertension, number (%)	73 (51.8)
Diabetes, number (%)	53 (37.6)
Current smoking, number (%)	60 (42.6)

SD: Standard deviation

Table 2: Characteristics of patients in the study having diastolic dysfunction

Parameters	Patient characteristics (*n*=21)
Age (mean), years±SD	47.48±4.69
Male, number, %	18 (85.7)
Hypertension, number, %	15 (71.4)
Diabetes, number, %	10 (47.6)
Current smoking, number, %	11 (52.4)

SD: Standard deviation

Overall, the prevalence of diastolic dysfunction in the population analyzed was 14.9% (21 out of 141). Among patients with diastolic dysfunction, 71.4% were hypertensive and 47.6% were diabetic (Table 2).

The prevalence of diastolic dysfunction in patients more than 50 years of age was 21.6%, whereas it was 12.5% in patients <50 years. Characteristics of patients with diastolic dysfunction on the basis of age are shown in Table 3 and Figure 1.

The prevalence of diastolic dysfunction among male and female patients was 14.8% (18 out of 122 patients) and 15.8% (3 out of 19 patients), respectively. Sex characteristics of patients with diastolic dysfunction are shown in Table 4 and Figure 2.

Prevalence of hypertension in patients with diastolic dysfunction was 71.4%, whereas it was 48.3% in patients without diastolic dysfunction ($P = 0.04714$). Similarly, diabetes in patients with and without diastolic dysfunction was 47.6% and 35.8%, respectively ($P = 0.29310$), (Table 5 and Figure 3).

Table 3: Characteristics of patients in the study with diastolic dysfunction divided on basis of age

>50 years of age	
Parameters	**Patient characteristics (*n*=8)**
Age (mean), years±SD	52.63±1.69
Male, number, %	7 (87.5)
Hypertension, number, %	7 (87.5)
Diabetes, number, %	3 (37.5)
Current smoking, number, %	4 (50)
≤50 years of age	
Parameters	**Patient characteristics (*n*=13)**
Age (mean), years±SD	44.31±2.53
Male, number, %	11 (84.6)
Hypertension, number, %	8 (61.5)
Diabetes, number, %	7 (46.2)
Current smoking, number, %	7 (53.8)

SD: Standard deviation

Table 4: Characteristics of patients in the study with diastolic dysfunction divided on basis of sex

Male patients	
Parameters	**Patient characteristics (*n*=18)**
Age (mean), years±SD	47.61±4.68
Hypertension, number (%)	12 (66.7)
Diabetes, number (%)	9 (50)
Current smoking, number (%)	11 (61.1)
Female patients	
Variables	**Patient characteristics (*n*=3)**
Age (mean), years±SD	46.67±5.68
Hypertension, number (%)	3 (100)
Diabetes, number (%)	1 (33.3)
Current smoking, number (%)	0

SD: Standard deviation

DISCUSSION

HF with preserved LV systolic function is common in clinical practice and is found in approximately one-third of patients hospitalized for heart failure.[4] The gold standard for assessing diastolic function is the pressure-volume relationship, but this requires an invasive approach. However, measurement of mitral inflow and the tissue Doppler imaging technique

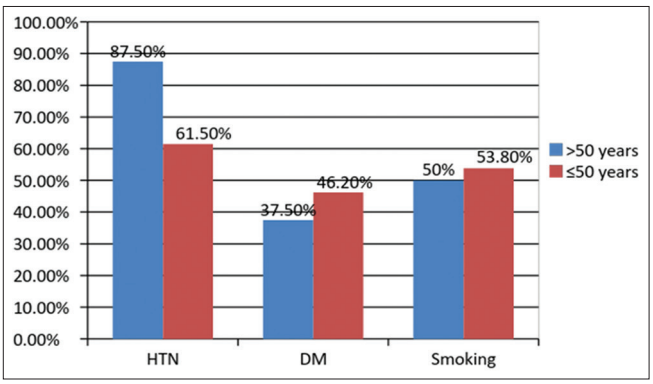

Figure 1: Comparison of risk factors in patients with diastolic dysfunction in the study divided on the basis of age

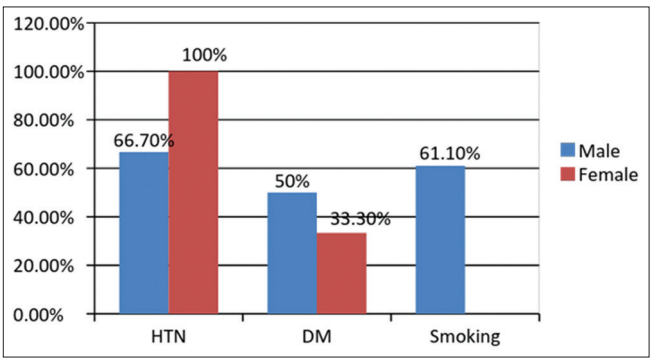

Figure 2: Comparison of risk factors in patients with diastolic dysfunction in the study divided on the basis of sex

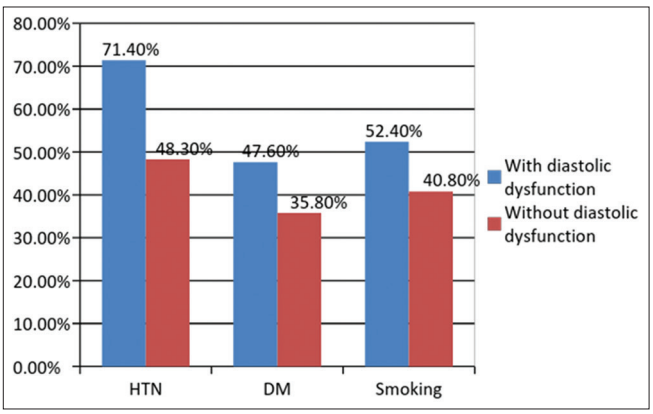

Figure 3: Comparison of risk factors among patients in the study with and without diastolic dysfunction

Table 5: Comparison of risk factors of patients in the study with and without diastolic dysfunction

Parameters	Patients with diastolic dysfunction (*n*=21)	Patients without diastolic dysfunction (*n*=120)	*P* value
Hypertension, number (%)	15 (71.4)	58 (48.3)	0.04714
Diabetes, number (%)	10 (47.6)	43 (35.8)	0.29310
Smoking, number (%)	11 (52.4)	49 (40.8)	0.39949

by echocardiography open up the possibility of evaluating diastolic function noninvasively.[5] Strong controversy exists regarding definition, with opposite scientific views. According to the American point of view, diastolic HF is "definite" only when an invasive hemodynamic assessment shows diastolic alterations in the temporal proximity of the acute episode.[6] On the contrary, the European Group on Diastolic HF has defined diastolic HF according to criteria including clinical examination, echocardiographic assessment, and Doppler indexes.[2]

In this study, the overall prevalence of diastolic dysfunction by echocardiography was 14.9%. The reported prevalence in general population[7-10] varies from 11.1% to 34.7% and is influenced by a number of factors such as characteristics of the population studied, choice of the imaging modalities, and the criteria applied to diagnose LV diastolic dysfunction.

This study showed an increased prevalence of diastolic dysfunction in patients more than 50 years of age as compared to <50 years (21.6% and 12.5% respectively), corresponding to the previous studies.[3,11,12]

In this study, the prevalence of diastolic dysfunction in female was slightly higher than male (15.8% vs. 14.3%, respectively). However, in some previous reports, diastolic abnormalities were noted to be more common in males than in females.[3] The possible reason of this discrepancy may be due to the lower number of female patients with diastolic dysfunction in this study.

In this study, the incidence of hypertension was significantly higher in patients with diastolic dysfunction than patients without diastolic dysfunction (71.4% vs. 48.3%, $P = 0.04714$). The predominant role of arterial hypertension for the development of diastolic HF was initially established by the Framingham Heart Study.[13-15] LV hypertrophy, which represents progressive sequelae of hypertension on the heart, may constitute an intermediate step toward the precipitation of diastolic dysfunction.

On the other hand, there was insignificant difference of diastolic dysfunction in patients with and without diabetes (47.6% vs. 35.8%, $P = 0.29310$) which is contrary to previous studies. As per other reports, type two diabetes patients reveal a prevalence of diastolic dysfunction in up to 30% cases,[16] and with Doppler techniques, it may be even greater (40-75%) in individuals with diabetes without overt coronary artery disease.[17]

Great heterogeneity exists also for results in prognosis of diastolic HF. By the Framingham meta-analysis, the annual mortality varies from 1.3% to 17.5%.[11]

Two important studies, the PIUMA[18] and Strong Heart Study[9] have pointed out the prognostic value of Doppler indexes of LV diastolic function and in particular of transmitral E/A ratio.

Limitations

This study was carried out over a short period with less number of patients. A study involving more number of patients over a longer period would have given more accurate information regarding the prevalence of diastolic dysfunction in these apparently healthy individuals. Moreover, the study is limited by its exclusive utilization of echocardiographic techniques for the diagnosis of diastolic abnormalities. A further potential source of error is the large variability of the echocardiographic parameters.

CONCLUSION

The prevalence of diastolic abnormalities is a common, especially in hypertensive patients. It also increases with age and may not always produce signs and symptoms of HF. Thus, diagnosing diastolic dysfunction noninvasively at an early stage is valuable for management of such patients.

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